Fundamentals of Anorectal Surgery

David E. Beck
Scott R. Steele
Steven D. Wexner
Editors

Third Edition

Springer

Fundamentals of Anorectal Surgery

David E. Beck • Scott R. Steele
Steven D. Wexner
Editors

Fundamentals of Anorectal Surgery

Third Edition

Springer

Editors
David E. Beck
Department of Colon and Rectal Surgery
Ochsner Clinic Foundation
New Orleans, LA
USA

Scott R. Steele
Department of Colon and Rectal Surgery
Cleveland Clinic
Cleveland, OH
USA

Steven D. Wexner
Department of Colon and Rectal Surgery
Cleveland Clinic Florida
Weston, FL
USA

Originally published by WB Saunders, Philadelphia, 1998
ISBN 978-3-319-65965-7 ISBN 978-3-319-65966-4 (eBook)
https://doi.org/10.1007/978-3-319-65966-4

Library of Congress Control Number: 2018949946

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface to the Third Edition

It has been 25 years since the publication of the first, and almost 20 years since the publication of the second, edition of *Fundamentals of Anorectal Surgery.* The delay was not from a lack of interest by the editors or the authors, but the result of a period of inadequate interest by the publishers. Fortunately, this attitude has changed, resulting in a third edition. As with the previous editions, this volume was designed not to replace the numerous excellent textbooks of colon and rectal surgery, but to provide expanded coverage of the evaluation and management of the anus and rectum, as these disorders (rather than colonic pathology) often pose a greater difficulty to practitioners. The first two editions included many talented young surgeons from a variety of practices, all of whom shared the common goal of disseminating well-written information about anorectal topics.

Due to the plethora of new information and diagnostic and therapeutic maneuvers regarding disorders of the anorectum, a third edition was necessary. To accomplish this task, a bevy of eminently qualified, internationally acclaimed experts spent a considerable amount of time to completely rewrite the chapter that includes all of the new advances and updates pertinent to each respective subject area. The individuals who have made these contributions are exceptionally well qualified to have made these improvements. The text continues with thirty-two chapters, but there have been several changes. Significant progress has been made in the prevention and therapy of acquired immunodeficiency syndrome, so the latest information has been included into the sexually transmitted disease chapter. Advances in our knowledge of anal intraepithelial neoplasia and pelvic floor disorders each merit its own chapter. When the first edition was written, minimally invasive surgery was in its infancy. As the second edition was produced, laparoscopic colorectal surgery was routinely performed at numerous locations throughout the world. Today these techniques have matured and become integrated into routine colorectal practices. Accordingly, minimally invasive techniques are incorporated into individual management chapters.

Half of these 32 chapters provide a comprehensive in-depth survey of all anorectal topics, including both benign and malignant disorders. The first four chapters discuss anatomy including congenital disorders, as well as means of evaluating anorectal dysfunction and disease. The next two chapters (Chaps. 5 and 6) evaluate perioperative and operative techniques. Chapters 7 through 9 evaluate functional disorders including prolapse and incontinence; a variety of additional benign anorectal disorders are evaluated in Chaps. 10

through 18. Chapters 19 through 26 review anorectal neoplasia. Rectal cancer remains a major focus, with several world experts updating and emphasizing the critical need for a multidisciplinary approach.

Chapter 22 describes the newer transanal techniques of TEM and TAMIS. Chapter 27 delves into sexually transmitted diseases and AIDS. Chapter 28 evaluates anorectal trauma. Chapters 29 through 30 analyze inflammatory disorders of the anus and rectum. Chapter 31 examines pelvic floor disorders related to urology and gynecology and Chap. 32 outlines nursing considerations including ostomy management.

These chapters have been carefully crafted neither to stand independently nor to duplicate each other. One of the marked and immediate obvious advantages of a multiauthored textbook is the skillfully executed interplay among authors. These authors have deftly intertwined their chapters to provide the reader with all the current concepts, theories, and practices relative to anorectal surgery. Clearly, enunciation of this ideal and execution of the concept to fruition are not necessarily synonymous. The goal was realized only through the outstanding indefatigable efforts of the numerous practicing clinicians who authored the chapters contained herein. Specifically, the third edition of *Fundamentals of Anorectal Surgery* has been authored exclusively by energetic colorectal surgeons, gastroenterologists, and nurses. This composition has enabled the textbook to impart a uniquely current perspective on the evaluation and management of anorectal disorders. The chapters have been well written, amply illustrated, and comprehensively referenced. As such, this book provides an excellent resource for both the practicing surgeon as well as surgical residents and fellows in training and medical students in school.

New Orleans, LA, USA — David E. Beck
Cleveland, OH, USA — Scott R. Steele
Weston, FL, USA — Steven D. Wexner
2019

Dedications and Acknowledgments

I thank our contributors for taking time from work and family to produce superb chapters, and my colleagues Steve and Scott for their efforts in editing this ongoing project. Steve and I remain lifelong friends and colleagues. Our relationship strengthened by the stresses and challenges of projects like Fundamentals. Scott has the enthusiasm of youth and his energy and ability will help mold the future of our specialty. Elektra did her usual outstanding job as a Developmental Editor. I remain indebted to my partners, colleagues, and trainees who continue to support and stimulate my clinical and academic efforts. Finally, I reaffirm my love and appreciation to my wife, Sharon, for her support and encouragement for all the nights and weekends spent in my office working on this project.

David E. Beck

I would first again like to thank our outstanding Developmental Editor, Elektra McDermott, for her extraordinary efforts in overseeing this edition and ensuring its timely completion and thoroughness. Having had the privilege of working with her on several texts, she never fails to amaze and deliver. I would also like to thank my fellow editors, Dave and Steve, for their tremendous vision and hard work throughout this entire process. They continue to be mentors, colleagues, and friends—and for the opportunities they have each given to me, I am forever grateful. Finally, and most importantly, thank you to Michele, Marianna (& Piper and Flynn) for supporting, encouraging, and giving me time to complete this wonderful project.

Scott R. Steele

I also echo my appreciation to Elektra McDermott for her superlative editorial skills without which this text would not have come to timely fruition. In addition I also thank Dave and Scott for their efforts, expertise, time, talent, and friendship; it has been a pleasure working with them on this project. I also express my eternal gratitude to the most important people in my life who have supported me with love as I have pursued my academic endeavors: Mariana Berho, Wesley, and Trevor for their love, understanding, and patience during the conception, creation, and completion of this book.

Steven D. Wexner

Contents

Contributors

Nouf Y. Akeel, MD Department of Colorectal Surgery, Cleveland Clinic Foundation, Cleveland, OH, USA

Bonnie Alvey, RN, WOCN, APC Enterostomal Therapy Clinic, Ochsner Medical Center, New Orleans, LA, USA

Reza Arsalani-Zadeh, MD, MRCS Department of Colorectal Surgery, University of Rochester Medical Center, Rochester, NY, USA

Amir L. Bastawrous, MD, MBA, FACS, FASCRS Swedish Colon and Rectal Clinic, Swedish Cancer Institute, Seattle, WA, USA

David E. Beck, MD, FACS, FASCRS Department of Colon and Rectal Surgery, Ochsner Clinic, New Orleans, LA, USA

Brian L. Bello, MD, FACS Colorectal Surgery Program, MedStar Washington Hospital Center, Washington, DC, USA

Jasneet Singh Bhullar, MD, MS Department of Surgery, UPMC Susquehanna Health, Williamsport, PA, USA

Joshua I.S. Bleier, MD Department of Surgery, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA

Liliana Bordeianou, MD, MPH Department of General Surgery, Pelvic Floor Disorders Center, Massachusetts General Hospital, Boston, MA, USA

Gina Brown, MBBS, MRCP, FRCS The Royal Marsden NHS Foundation Trust and Imperial College of London, London, UK

Ramon A. Brown, MD The Ochsner Clinic Foundation, Ochsner Clinical School, Ochsner Clinic, New Orleans, LA, USA

Carlos V.R. Brown, MD, FACS University Medical Center Brackenridge, Austin, TX, USA

Kelli M. Bullard Dunn, MD, FACS, FASCRS Surgery, University of Louisville, Louisville, KY, USA

Joseph C. Carmichael, MD Department of Surgery, University of California, Irvine, Orange, CA, USA

Christina Cellini, MD Department of Surgery, University of Rochester Medical Center, Rochester, NY, USA

Sami A. Chadi, MD, MSc, FRCSC Department of Surgery, University Health Network, Toronto Weston Hospital, Toronto, ON, Canada

Giovanna Dasilva, MD Department of Colorectal Surgery, Cleveland Clinic Florida, Weston, FL, USA

Mit Dattani, BSc, MB ChB, MRCS Pelican Cancer Foundation, Basingstoke, Hampshire, UK

Bradley R. Davis, MD, FACS, FASCRS Department of Surgery, Division of Colon and Rectal Surgery, University of Cincinnati College of Medicine, Cincinnati, OH, USA

Daniel L. Feingold, MD, FACS, FASCRS Department of Surgery, Columbia University, New York, NY, USA

Julio Garcia-Aguilar, MD, PhD Department of Surgery, Memorial Sloan Kettering Cancer Center, New York, NY, USA

Lester Gottesman, MD Division of Colon and Rectal Surgery, Department of Surgery, Mount Sinai, New York, NY, USA

Jose G. Guillem, MD, MPH Department of Surgery, Memorial Sloan Kettering Cancer Center, New York, NY, USA

Brooke Gurland, MD Division of Colorectal Surgery, Stanford University, Stanford, CA, USA

Stanford University, Stanford, CA, USA

Tracy Hull, MD Department of Colorectal Surgery, Cleveland Clinic Foundation, Cleveland, OH, USA

Eric A. Hurtado, MD Department of Gynecology, Section of Urogynecology and Reconstructive Pelvic Surgery, Cleveland Clinic Florida, Weston, FL, USA

Cora Ianiro, BS Department of Surgery, Division of Colorectal Surgery, Mount Sinai Hospital, New York, NY, USA

Eric K. Johnson, MD, FACS, FASCRS Colorectal Surgery, Uniformed Services University of the Health Sciences, Bethesda, MD, USA

Department of Colon and Rectal Surgery, Cleveland Clinic, Cleveland, OH, USA

Matthew F. Kalady, MD, FACS, FASCRS Department of Colorectal Surgery, Digestive Disease Institute, Cleveland Clinic, Cleveland, OH, USA

Brian R. Kann, MD, FACS, FASCRS Department of Colon and Rectal Surgery, Ochsner Medical Center, New Orleans, LA, USA

Sepehr Khorasani, BSc, MD, FRCSC Division of General Surgery, Department of Surgery, Toronto Western Hospital, University of Toronto, Toronto, ON, Canada

Anne Kim Mackow, MD/MPH Division of Pediatric Surgery, Rainbow Babies and Children's Hospital, University Hospitals, Case Medical Center, Cleveland, OH, USA

Cindy J. Kin, MD, MS Department of Surgery, Stanford University School of Medicine, Stanford, CA, USA

Anjali S. Kumar, MD Colorectal Surgery Program, Virginia Mason Medical Center, Seattle, WA, USA

Sean Joseph Langenfeld, MD, FACS, FASCRS Department of Surgery, University of Nebraska Medical Center, Omaha, NE, USA

Daniel S. Lavy, MD Department of Colorectal Surgery, Cleveland Clinic Florida, Weston, FL, USA

Jennifer K. Lee, MD Swedish Colon and Rectal Clinic, Swedish Cancer Institute, Seattle, WA, USA

Steven A. Lee-Kong, MD Department of Surgery, Columbia University, New York, NY, USA

Amy L. Lightner, MD Department of Colon and Rectal Surgery, Cleveland Clinic, Cleveland, OH, USA

David A. Margolin, MD, FACS, FASCRS The Ochsner Clinic Foundation, Ochsner Clinical School, Ochsner Clinic, New Orleans, LA, USA

The University of Queensland School of Medicine, St. Lucia, QLD, Australia

Matthew J. Martin, MD, FACS Scripps, San Diego, CA, USA

Justin A. Maykel, MD Division of Colon and Rectal Surgery, Department of Surgery, UMass Memorial Health Care, Worcester, MA, USA

Michael F. McGee, MD, FACS, FASCRS Department of Surgery, Division of Gastrointestinal and Oncologic Surgery, Section of Colon and Rectal Surgery, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

Andrew H. Miller, MD Department of Surgery, The University of Texas at Austin Dell Medical School, Austin, TX, USA

Ravi Moonka, MD Department of Surgery, Virginia Mason Medical Center, Seattle, WA, USA

Arun Nagarajan, MD Department of Radiation Oncology, Cleveland Clinic Florida, Weston, FL, USA

Timothy Nguyen, MD Department of Hematology/Oncology, Cleveland Clinic Florida, Weston, FL, USA

D. Owen Young, MD Virginia Mason Medical Center, Seattle, WA, USA

Ian M. Paquette, MD Division of Colon and Rectal Surgery, University of Cincinnati College of Medicine, Christ Hospital Center for Pelvic Floor Disorders, Cincinnati, OH, USA

Colin B. Peirce, MD, FRCS Department of Colorectal Surgery, Digestive Disease Institute, Cleveland Clinic, Cleveland, OH, USA

Elizabeth R. Raskin, MD, FACS, FASCRS Division of Surgical Oncology, Department of Surgery, Loma Linda University Health, Loma Linda, CA, USA

Dana R. Sands, MD Department of Colorectal Surgery, Cleveland Clinic Florida, Weston, FL, USA

Julia Saraidaridis, MD, MMSc Department of General Surgery, Massachusetts General Hospital, Boston, MA, USA

Radhika Smith, MD Department of Colorectal Surgery, University of Chicago Medical Center, Chicago, IL, USA

Jonathan R. Snyder, MD Department of Surgery, Division of Colon and Rectal Surgery, University of Cincinnati Medical Center, Cincinnati, OH, USA

Scott R. Steele, MD Department of Colon and Rectal Surgery, Cleveland Clinic, Cleveland, OH, USA

Emily Steinhagen, MD University Hospitals, Cleveland, OH, USA

Pasithorn A. Suwanabol, MD Department of Surgery, Division of Colorectal Surgery, University of Michigan, Ann Arbor, MI, USA

Patricia Sylla, MD Department of Surgery, Division of Colorectal Surgery, Mount Sinai Hospital, New York, NY, USA

Icahn School Medicine, New York, NY, USA

Amy J. Thorsen, MD Colon and Rectal Surgery Associates, Minneapolis, MN, USA

University of Minnesota, Minneapolis, MN, USA

Carol-Ann Vasilevsky, MD, CM, FRCSC, FACS Division of Colon and Rectal Surgery, Jewish General Hospital, Montreal, QC, Canada

Jon D. Vogel, MD, FACS, FASCRS Department of Surgery, University of Colorado, Aurora, CO, USA

Mark L. Welton, MD, MHCM Fairview Health Services, Corporate Department, Minneapolis, MN, USA

Department of Surgery, University of Minnesota School of Medicine, Minneapolis, MN, USA

Mark H. Whiteford, MD Oregon Health and Science University, Portland, OR, USA

Aaron Womer, BS Case Western Reserve University School of Medicine, Cleveland, OH, USA

1 Anorectal Anatomy and Physiology

Ravi Moonka and Joseph C. Carmichael

Introduction

The physiology of the pelvic floor is intrinsically related to its anatomy. Although, the basic anatomic concepts were established as early as 1543 by the anatomist Andreas Vesalius, many refinements were only appreciated after advances in surgery. Unlike the anatomist, the colorectal surgeon has the advantages of in vivo dissection as well as physiologic and endoscopic examinations.

Anatomy of the Anal Canal

The "anatomic" anal canal begins at the dentate line and extends distally to the anal verge. This definition is solely based on the embryology and histology of the anal canal and does not take into account the function of the anal canal as a whole. For surgeons, this strict anatomic definition of the anal canal bears little relevance in the practice of anorectal surgery. For this reason, in their 1934–1937 manuscripts, Milligan and Morgan [1, 2] advanced the argument that for clinical purposes, we must consider the anal canal in different terms. The "surgical" anal canal, as first defined by Milligan and Morgan, extends from the anorectal ring to the anal verge. The anorectal ring is a composite fibromuscular band composed of the upper portion of the internal anal sphincter, conjoined longitudinal muscle, puborectalis and external sphincter (Fig. 1.1) and is most easily identified posteriorly on rectal examination by palpating the sling-like fibers of the puborectalis portion of the levator ani [1]. This surgical definition of the anal canal takes in to account the surrounding musculature that is critical to consider during the conduct of operations from low anterior resection to anal fistulotomy. The surgical anal canal also more accurately reflects the physiology of anal continence. For these reasons, whenever the anal canal is referred to in this chapter, it is the "surgical" anal canal.

On average, the surgical anal canal is longer in males than in females. Intraoperative measurements of the posterior anal canal have estimated the surgical anal canal to be 4.4 cm in men compared with 4.0 cm in women [4]. In addition, the anal canal was shown to be a unique muscular unit in that its length did not vary with age.

The anatomy of the anal canal has also been characterized using magnetic resonance imaging. MR imaging did not show a difference in the length of the posterior anal canal in men and women, but did show that the anterior and posterior external anal sphincter length (not including puborectalis) was significantly shorter in women [5].

R. Moonka · J. C. Carmichael (✉)
Department of Surgery, Virginia Mason Medical Center, Seattle, WA, USA
e-mail: Ravi.Moonka@virginiamason.org; jcarmich@uci.edu

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_1

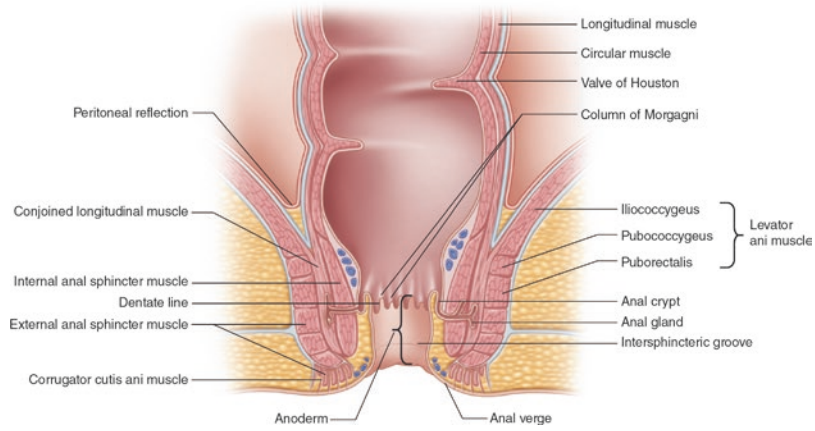


Fig. 1.1 Anal canal. From [3]. With permission © 2016 Springer

The anal canal forms proximally where the rectum passes through the pelvic hiatus and joins with the puborectalis muscle. Starting at this location, the muscular anal canal can be thought of as a "tube within a tube". The inner tube is the visceral smooth muscle of the internal anal sphincter and longitudinal layer that is innervated by the autonomic nervous system. The outer muscular tube consists of somatically-innervated, skeletal muscles including the components of the puborectalis and external anal sphincter [6]. It is the outer muscular tube that provides conscious control over continence and is strengthened during Kegel exercises. The external anal sphincter extends distal to the internal anal sphincter and the anal canal terminates at the anal verge where the superficial and subcutaneous portions of the external anal sphincter join the dermis.

Anal Canal Epithelium

The proximal anal canal has a pink appearance and is lined by the columnar epithelium of the rectal mucosa. Approximately 6–12 mm proximal to the dentate line, the anal transition zone (ATZ) begins, which appears purple in color and represents an area of gradual transition of columnar epithelium to squamous epithelium. The columns of Morgagni are noted in this area where redundant columns of tissue are noted with anal crypts at their base. This forms the rippled dentate line (or pectinate line), which can be most easily identified by locating the anal crypts at the base of the Columns of Morgagni.

From a histologic standpoint, the anal canal has three zones. The proximal zona columnaris is lined with simple columnar epithelium and extends from the apex of the anorectal ring to the dentate line. Below the dentate line, is the zona hemorrhagica that is lined by stratified squamous non-keratinized epithelium that ends at the intersphincteric groove, also referred to as Hilton's white line [7]. Below the intersphincteric groove is the zona cutanea that is lined by stratified squamous keratinized epithelium.

Anal crypts connect through anal ducts to underlying anal glands (Fig. 1.1), which are the presumed source of sepsis in the majority of anorectal abscesses and fistula. On average, there are six anal glands surrounding the anal canal (range 3–12) [6–9] and they tend to be more concentrated in the posterior quadrants. More than one gland may open into the same crypt and some crypts may not be connected to anal glands. The anal gland ducts proceed inferior and lateral from the anal canal and enter the submucosa where two-thirds enter the internal anal sphincter and half terminate in the intersphincteric plane [8]. It is theorized that obstruction of these ducts leads to anal fistula and abscess [6]. Knowledge of the anatomy also explains why the internal opening of a "cryptoglandular" anal fistula should typically be at the dentate line.

Distal to the dentate line, the anoderm begins and extends for approximately 1.5 cm. Anoderm has squamous histology and is devoid of hair,

sebaceous glands and sweat glands. At the anal verge, the anal canal lining becomes, thickened, pigmented and contains hair follicles—this represents normal skin.

The dentate line represents a true division between embryonic endoderm and ectoderm. Proximal to the dentate line, the innervation is via the sympathetic and parasympathetic systems, with venous, arterial and lymphatic drainage associated with the hypogastric vessels. Distal to the dentate line, the innervation is via somatic nerves with blood supply and drainage from the inferior hemorrhoidal system. In clinical practice, this anatomy is why malignant tumors below the dentate line can metastasize to superficial inguinal lymph nodes and external hemorrhoids (that always originate below the dentate line) are painful.

Internal Anal Sphincter

The internal anal sphincter (IAS) is the downward continuation of the circular smooth muscle of the rectum and terminates with a rounded edge approximately 1 cm proximal to the distal aspect of the external anal sphincter. The terminus of the internal anal sphincter is easily palpated on digital rectal exam and marks the intersphincteric groove. 3D imaging studies of this muscle demonstrate the overall volume does not vary according to gender, but the distribution is different with women tending to have a thicker medial/distal internal anal sphincter [10]. Overall, the IAS was found to be approximately 2 mm in thickness and 35 mm in length. The authors note that on any study, it is difficult to identify the proximal portion of the IAS as it is a continuation of the wall of the lower rectum.

Conjoined Longitudinal Muscle

The conjoined, "combined" or "conjoint" longitudinal muscle (CLM) measures approximately 0.5–2.0 mm in thickness and lies in between the internal and external anal sphincters. It begins at the anorectal ring as an extension of the longitudinal rectal muscle fibers and descends caudally joined by fibers of the puborectalis muscle [11]. In this respect, the CLM is composed of longitudinal rectal muscle fibers and levator ani muscles. The extent to which the CLM is composed of smooth longitudinal rectal muscle fibers versus skeletal levator ani muscle fibers is a point of debate. A recent study using a novel immunohistochemistry technique to analyze cadaveric specimens found that the muscle tissue between the internal anal sphincter and external anal sphincter was not a conjoined muscle at all, but consisted mainly of smooth muscle from the longitudinal rectal muscle fibers [12]. These authors concluded that the levator ani muscle attaches directly to the longitudinal rectal muscle and a mixed layer of smooth and skeletal muscle fibers does not exist between the internal and external anal sphincter. This significant departure in interpretation of the anatomy would seem to require further validation in future studies.

At its most caudal aspect, some of the conjoined longitudinal muscle fibers (referred to as *corrugator cutis ani muscle*) traverse the distal external anal sphincter and insert into the perianal skin and some of the fibers enter the fat of the ischiorectal fossa. Fibers of the conjoined longitudinal muscle also pass obliquely and caudally through the internal anal sphincter to interlace in a network within the subepithelial space. These subepithelial smooth muscle fibers were originally described by Treitz in 1853 [13] and have been referred to as Treitz's muscle. They have also been referred to *corrugator cutis ani*, *musculus submucosae ani*, *mucosal suspensory ligament* and *musculus canalis ani* [14] It has been hypothesized by Thomson that disruption of Treitz's muscles results in anal cushion prolapse, vascular outflow obstruction and hemorrhoidal bleeding and thrombosis [15]. Haas and Fox have hypothesized that the conjoined longitudinal muscle, and the network of connective tissue that it supports, plays a role in minimizing anal incontinence after sphincterotomy.

External Anal Sphincter

The external anal sphincter (EAS) is composed of striated (skeletal) muscle that forms an ellipti-

cal tube around the internal anal sphincter and conjoined longitudinal muscle. As it extends beyond the distal most aspect of the internal anal sphincter the intersphincteric groove is formed. At its distal most aspect, *corrugator cutis ani muscle* fibers from the conjoined longitudinal muscle traverse the external anal sphincter and insert into the perianal skin. Milligan and Morgan described the external anal sphincter as having three distinct divisions from proximal to distal that were termed: sphincter ani externus profundus, superficialis, and subcutaneus [1]. However, with time, this theory of three distinct divisions of the external anal sphincter was proven invalid by Goligher who demonstrated that the external anal sphincter was truly a continuous sheet of skeletal muscle extending up to the puborectalis and levator ani muscles [16]. While the external anal sphincter does not have three distinct anatomic layers, it is not uncommon to still see the proximal portion of the EAS referred to as deep EAS, the mid-portion referred to as the superficial EAS and the most distal aspect as the subcutaneous EAS. The mid EAS has posterior attachment to the coccyx via the anococcygeal ligament (discussed below) and the proximal EAS becomes continuous with the puborectalis muscle. Anteriorly, the proximal EAS forms a portion of the perineal body with the transverse perineal muscle (Fig. 1.2). There are clear differences in the morphology of the anterior external anal sphincter that have been demonstrated on both MRI and three dimensional endoanal ultrasound studies in normal male and female volunteers [17, 18]. The normal female external anal sphincter has a variable natural defect occurring along its proximal anterior length below the level of the puborectalis sling that was demonstrated in 75% of nulliparous volunteers. This defect correlated with findings on anal manometry and the authors noted that it can make interpretation of an isolated endoanal ultrasound difficult resulting in over-reporting of obstetric sphincter defects [17]. This natural defect of the anterior anal sphincter provides justification why anterior anal sphincterotomy is not routinely recommended in women.

The external anal sphincter is innervated on each side by the inferior rectal branch of the pudendal nerve (S2 and S3) and by the perineal branch of S4 (Fig. 1.3). There is substantial overlap in the pudendal innervation of the external anal sphincter muscle on the two sides which enables re-innervation to be partially accomplished from the contralateral side following nerve injury [19].

Anatomy of the Pelvic Floor

Perineal Body

The perineal body (Fig. 1.2) represents the intersection of the external anal sphincter, superficial transverse perinei, deep transverse perinei and bulbospongiosus (also referred to as bulbocavernosus) muscles. Recent research, based on advanced magnetic resonance and ultrasound imaging, has suggested that the transverse perinei (TP) and bulbospongiosus (BS) muscles contribute significantly to anal incontinence [20]. It has been proposed that the EAS, TP and BS muscles be collectively referred to as the "EAS complex muscles". In this theory, the EAS complex morphology is "purse string" shaped rather than the typical "donut" shape previously considered. When these muscles are considered as a functional unit, it lends further support to the idea that it is critical to attempt to repair the perineal body during overlapping sphincter reconstructions.

Anococcygeal Ligament

Cadaveric studies reveal the anococcygeal ligament is composed of two layers: a thick ventral layer extending from the presacral fascia to the conjoint longitudinal layer of the anal canal and a thin dorsal layer extending between the coccyx and external anal sphincter [21]. The clinical implication of this is that the thick ventral layer requires division during intersphincteric proctectomy or very low anterior resection. Both the ventral and dorsal layers would be divided during abdominoperineal resection [21]. Due to

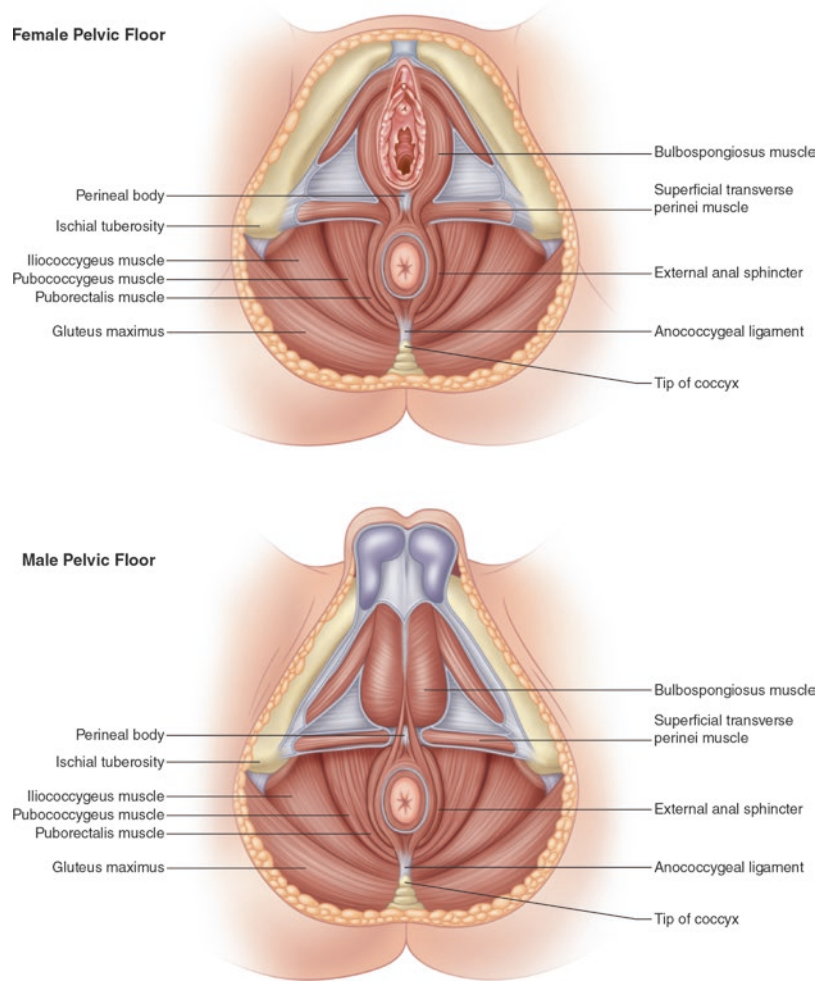


Fig. 1.2 Pelvic floor muscles. From [3]. With permission © 2016 Springer

the weak insertion into the coccyx and wavy course, it is felt that the superficial (dorsal) anococcygeal ligament is unlikely to provide a stable mechanical support to maintain configuration of the external anal sphincter [22].

Pelvic Floor Muscles

In addition to the anal sphincter and perineal body, the levator ani (LA) muscles contribute to pelvic organ support. For example, injury to the LA is seen in 55% of women with pelvic organ prolapse, but in only 16% without prolapse [23]. The LA has three subdivisions including the pubococcygeus (aka pubovisceral), puborectalis, and iliococcygeus (Figs. 1.2 and 1.4). Some authors had previously suggested that the puborectalis was part of the deep portion of the EAS [24]; however, a significant amount of evidence has been presented to the contrary. In vivo MRI measurements in women have shown distinct, visible muscle fascicle directions for each of the three LA component muscles [25]. Embryology studies have also demonstrated that the puborectalis muscle is a portion of the LA muscle and shares a common primordium with the iliococcygeus and pubococcygeus muscles [26]. Histologically, the three component muscles of the levator ani muscle (puborectalis, iliococcygeus and pubococcygeus) cannot be distinguished from one another [12].

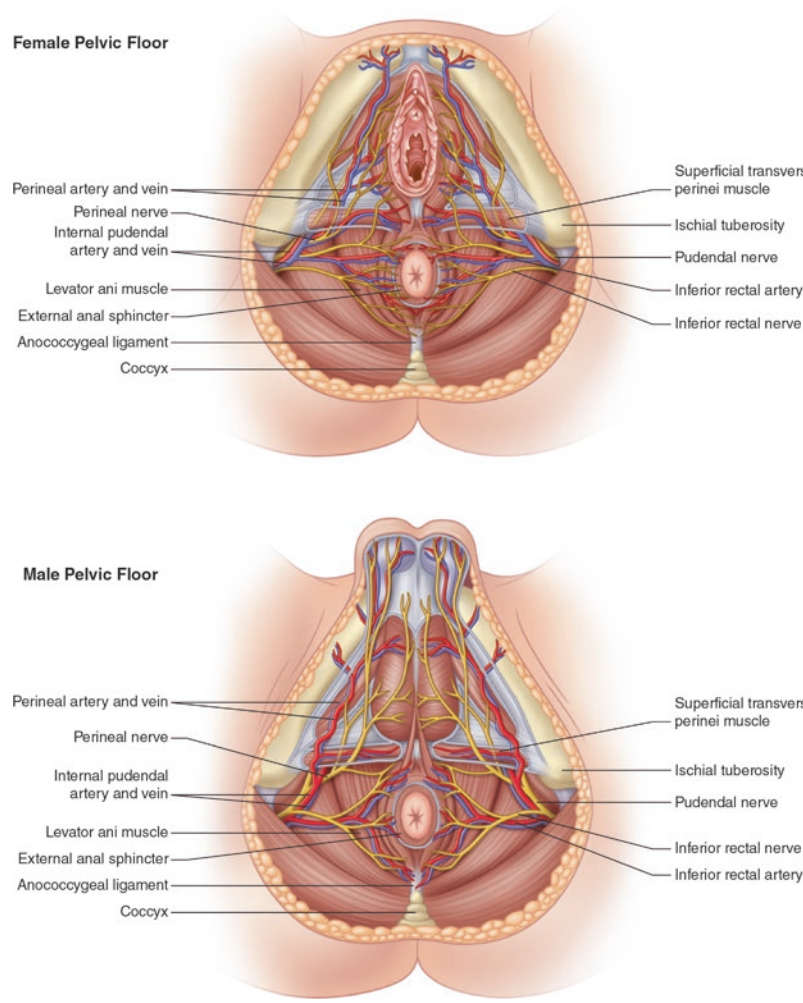


Fig. 1.3 Pelvic floor nerves and blood supply. From [3]. With permission © 2016 Springer

Innervation of the levator ani muscles has been described in detailed cadaveric studies [27]. The contemporary cadaveric studies suggest that the LA muscles are innervated by the pudendal nerve branches: perineal nerve and inferior rectal nerve as well as direct sacral nerves S3 and/or S4 (aka levator ani nerve) [28]. The pubococcygeus muscle and puborectalis muscle are primarily innervated by the pudendal nerve branches while the iliococcygeus muscle is primarily innervated by the direct sacral nerves S3 and/or S4.

Puborectalis Muscle

The puborectalis muscle (PRM) fibers arise from the lower part of the symphysis pubis and from the superior fascia of the urogenital diaphragm and run alongside the anorectal junction. Posterior to the rectum, the fibers join forming a sling. The "anorectal ring" is composed of the upper borders of the internal anal sphincter and puborectalis muscle [1]. Contraction of the PRM sling causes a horizontal force [25] that closes the pelvic diaphragm and decreases the anorectal angle during squeeze. This is widely considered the most important contributing factor to gross fecal continence.

Iliococcygeus Muscle

Iliococcygeus muscle (ICM) fibers arise from the ischial spines and posterior obturator fascia, pass inferior/posterior and medially and insert into the distal sacrum, coccyx and anococcygeal raphe.

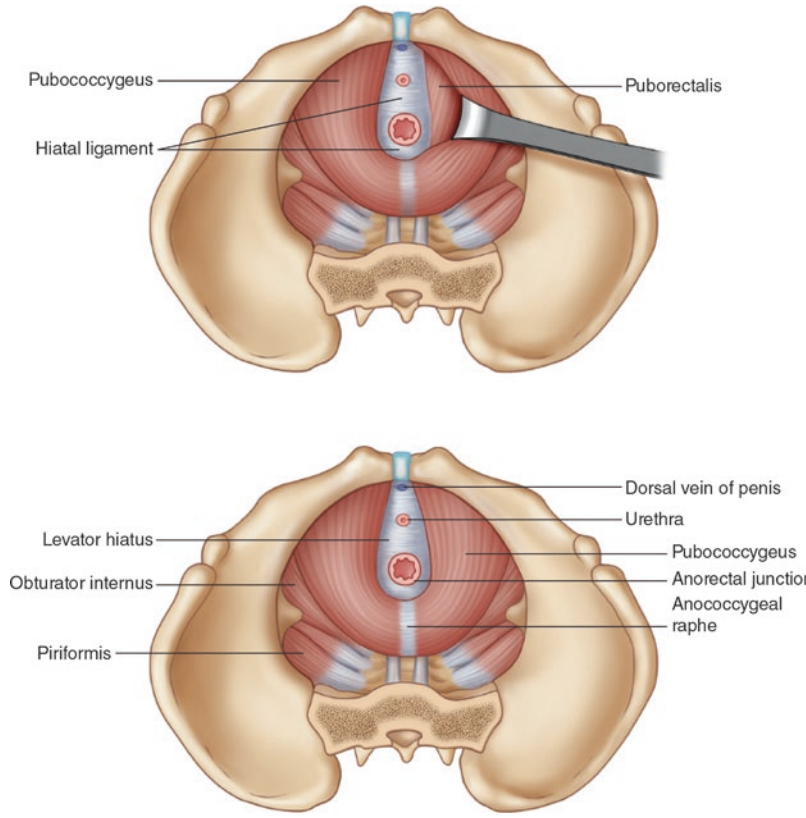


Fig. 1.4 Pelvic floor anatomy, abdominal view. From [3]. With permission © 2016 Springer

The ICM, along with the pubococcygeus muscle, contributes to "lifting" of the pelvic floor [25].

Pubococcygeus Muscle

The pubococcygeus (PCM) muscle lies medial to the PRM. PCM fibers arise from the anterior half of the obturator fascia and the high posterior pubis. The PCM fibers are directed posterior/inferior and medially, where they intersect with fibers from the opposite side and form the anococcygeal raphe (or anococcygeal ligament). PCM muscle fibers insert in the distal sacrum and tip of the coccyx. Portions of the PCM contribute to the conjoined longitudinal muscle. The PCM forms the "levator hiatus" (Fig. 1.4) as it ellipses the lower rectum, urethra, and either the vagina in women or the dorsal vein of the penis in men. The levator hiatus is connected to the intrahiatal organs by a fascial condensation called the "hiatal ligament". The hiatal ligament arises circumferentially around the hiatal margin as a continuation of the fascia on the pelvic surface of the levator muscle [29]. Enlargement of the levator hiatus has been implicated as a cause of female pelvic organ prolapse [30]. The PCM is the portion of the levator ani that is typically injured during traumatic vaginal delivery [31].

Anatomy of the Rectum

The rectum is arbitrarily considered to have three distinct parts: the upper, middle and lower rectum. Although not anatomically distinct, the upper, mid, and lower rectal divisions are important when considering surgical treatment of rectal cancer. From the anal verge, the lower rectum is 0–7 cm; middle rectum, 7–12 cm; and upper rectum 12–15 cm [32]. However, the rectum is actually variable in length and may extend beyond 15 cm from the anal verge. During surgery, the upper rectum can be distinguished from the sigmoid colon by the absence of taenia coli and epiploic appendages on the rectum.

The majority of the rectum lies outside of the peritoneal cavity, although anteriorly and laterally the upper rectum is covered by a layer of visceral peritoneum down to the peritoneal reflection. The location of the anterior peritoneal reflection is highly variable and can be significantly altered by disease such as rectal prolapse. One study sought to identify the location of the anterior peritoneal reflection in 50 patients who were undergoing laparotomy [33]. It was found that the anterior peritoneal reflection was located on average 9 cm from the anal verge in females and 9.7 cm from the anal verge in males—there was no statistically significant difference based on gender.

Valves of Houston

The rectum has been classically described to have three distinct, semicircular, inner folds called valves of Houston with the superior and inferior valves located on the left side of the rectum and the more prominent middle rectal valve on the right. However, this is not uniformly the case [34]. In one anatomic study, only 45.5% of patients had the classic three valve rectal anatomy with 32.5% having only two valves; and, 10.25% with four valves.

Mesorectum

The origin of the word "mesorectum" is difficult to identify and may be attributed to Maunsell in 1892 [35], but was certainly later popularized by Heald et al. [36]. Unfortunately, the term mesorectum is a misnomer that is not generally acknowledged in classic texts of anatomy such as the *Nomina Anatomica* [37]. In anatomic terms, the prefix "meso" refers to two layers of peritoneum that suspend an organ and the suffix applied indicates the target organ (e.g. mesocolon). The term "meso", cannot be assigned to the rectum, as it implies a mobile, suspended rectum, which may only be the case in patients with rectal prolapse.

The mesorectum is a term employed by surgeons to describe the fascial envelope of the rectum that is excised during surgical treatment of rectal cancer. Indeed, failure to completely excise this envelope intact has been associated with an increased incidence of local recurrence of rectal cancer [38]. The mesorectum is contained within the fascia propria. The fascia propria is an upward projection of the parietal endopelvic fascia that lines the walls and floor of the pelvis. The fascia propria encloses the perirectal fat, lymphatics, blood vessels and nerves and is not considered a barrier strong enough to prevent the spread of infection or malignancy [39].

Presacral Fascia

The presacral fascia (Fig. 1.5) is a thickened portion of the parietal endopelvic fascia overlying the sacrum that covers the presacral veins and hypogastric nerves. It extends laterally to cover the piriformis and upper coccyx. As the presacral fascia extends laterally, it becomes continuous with the fascia propria and contributes to the lateral ligaments of the rectum. Caudally, this fascia extends to the anorectal junction covering the anococcygeal ligament. During total mesorectal excision, the fascia propria is elevated sharply off the presacral fascia. Leaving the presacral fascia intact eliminates the possibility of causing presacral bleeding.

Retrosacral Fascia

The retrosacral fascia originates at the third and fourth portion [40] of the sacrum and extends anteriorly to the posterior layer of the fascia propria 3–5 cm proximal to the anorectal junction [41]. This tough fascia layer is surgically relevant as it must be sharply incised during total mesorectal excision [39]. The space posterior to the retrosacral fascia is referred to as the supralevator space (Fig. 1.6) and is the location where supralevator abscesses are found.

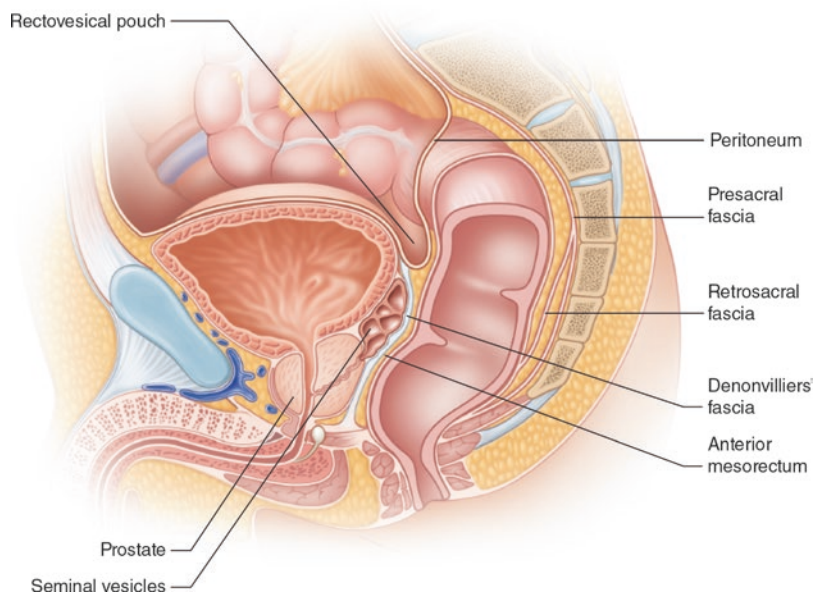


Fig. 1.5 Fascial relationships of the rectum. From [3]. With permission © 2016 Springer

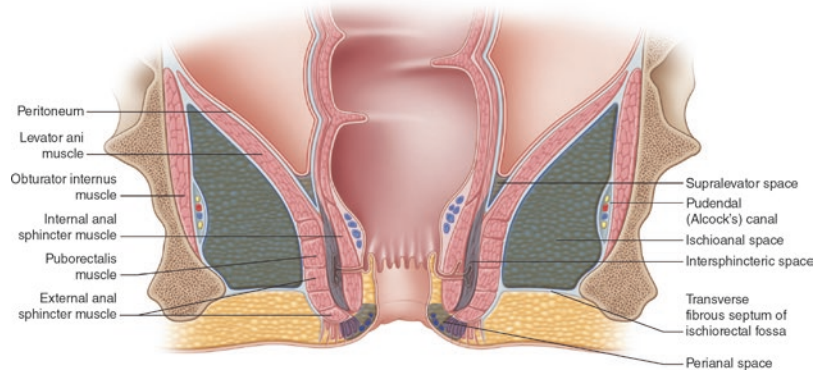


Fig. 1.6 Perianal and perirectal spaces, coronal view. From [3]. With permission © 2016 Springer

Waldeyer's Fascia

There is significant confusion about what Waldeyer's fascia represents as the eponym has been used to describe the presacral fascia, the retrosacral fascia or all fascia posterior to the rectum. In Waldeyer's original description of pelvic fascia, there was no particular emphasis on the presacral component [39, 41]. While the debate continues regarding Waldeyer's fascia, it is important to simply understand that can have the potential to mean presacral fascia, retrorectal fascia or both [42].

Denonvilliers' Fascia

Denonvilliers' fascia arises from the fusion of the two walls of the embryological peritoneal cul-de-sac and extends from the deepest point of the rectovesical pouch to the pelvic floor [43]. Originally described by Denonvilliers in 1836 as a 'prostatoperitoneal' membranous layer between the rectum and seminal vesicles, Denonvilliers fascia is also present in females as part of the rectovaginal septum and is sometimes referred to as rectovaginal fascia. It is found immediately beneath the vaginal mucosa and is clearly what

most would consider as part of the vaginal wall. It merges superiorly with the cardinal/uterosacral complex in females or the rectovesical pouch in males. It merges laterally with the endopelvic fascia overlying the levator muscle and distally with the perineal body. It contains collagen, some strands of smooth muscle, and heavy elastin fibers. Rectoceles represent a defect in this layer that allows the rectum to bulge anteriorly [44].

Microscopically, the Denonvilliers' fascia has two layers; however, it is not possible to discern two layers during pelvic dissection [43]. In the anterior rectal plane, the mesorectum is contained by the fascia propria which lies dorsal to Denonvilliers' fascia. The cavernous nerves run in neurovascular bundles at the anterolateral border of Denonvilliers' fascia.

Anorectal Spaces

It is important to acknowledge and understand the anorectal spaces created by the various myofascial relationships in the pelvis as these spaces help us understand how anorectal sepsis can spread throughout the pelvis.

Perianal Space

The perianal space (Fig. 1.6) contains external hemorrhoid cushions, the subcutaneous external anal sphincter and the distal internal anal sphincter. The perianal space is in communication with the intersphincteric space. The perianal space has it's cephalad boundary at the dentate line and laterally to the subcutaneous fat of the buttocks or is contained by fibers extending from the conjoined longitudinal muscle often referred to as *corrugator cutis ani* muscle fibers. Otherwise, the perianal space is contained by anoderm.

Intersphincteric Space

The intersphincteric space is the potential space that lies between the internal and external anal sphincter and is continuous with the perianal space. Like the other anorectal spaces, it is important to understand that this space communicates circumferentially around the anorectum (Fig. 1.7). This space is of clinical importance as cryptoglandular infections tend to begin in this area and expand elsewhere to create anal fistula [6].

Submucous Space

This space lies between the medial boarder of the internal anal sphincter and the anal mucosa proximal to the dentate line. It is continuous with the submucosa of the rectum. This area contains internal hemorrhoid vascular cushions.

Ischioanal/Ischiorectal Space

The ischioanal (also referred to as ischiorectal) space is the largest anorectal space. It has been described as a pyramid shape with its apex at the levator muscle insertion into the obturator fascia. The medial boarder is thus the levator ani muscle and external anal sphincter. The obturator internus muscle and obturator fascia make up the

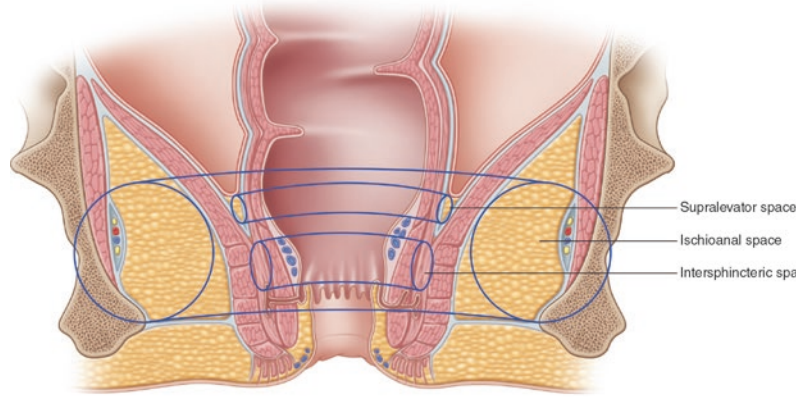


Fig. 1.7 Communication of the anorectal spaces. From [3]. With permission © 2016 Springer

lateral boarder of the ischioanal space. The posterior boundary is formed by the lower border of the gluteus maximus muscle and the sacrotuberous ligament. The space is has an anterior boundary formed by the superficial and deep transverse perineal muscles. The caudal boundary is skin of the perineum. The ischioanal fossa contains adipose tissue, pudendal nerve branches and superficial branches of the internal pudendal vessels. The right and left ischioanal space communicate posteriorly through the deep postanal space between the levator ani muscle and anococcygeal ligament [45]. When the ischioanal and perianal spaces are regarded as a single space, it is referred to as the ischioanal fossa [42].

Supralevator Space

The upper boundary of the supralevator space is the peritoneum, the lateral boundary is the pelvic wall, the medial boundary is the rectum and the inferior boarder is the levator ani muscle (Fig. 1.8).

Superficial and Deep Postanal Spaces

These spaces are located posterior to the anus and inferior to the levator muscle. The superficial postanal space is more caudal and is located between the anococcygeal ligament and the skin. The superficial postanal space allows communication of perianal space sepsis.

The deep postanal space (retrosphincteric space of Courtney) [46] is located between the levator ani muscle and the anococcygeal raphe. This space allows ischioanal sepsis to track from one side to the other resulting in the so called "horseshoe" abscess.

Retrorectal Space

The retrorectal space is found between the presacral fascia and fascia propria. It contains no major blood vessels or nerves. It is limited laterally by the lateral ligaments of the piriformis fascia and inferiorly by the retrosacral fascia. The fascia propria and presacral fascia come together at the apex of this space [39].

Lateral Ligaments

The lateral ligaments of the rectum are a point of controversy [47]. First, some argue that the lateral ligaments do not exist at all. Second, there is considerable controversy about what they contain if they in fact do exist. Miles referred to division of the lateral ligaments of the rectum in his seminal description of a performing abdominoperineal resection in 1908. Specifically, he notes "In these structures the middle haemorrhoidal arteries are found but seldom require a ligature" [48]. It is interesting to note that at least one modern cadav-

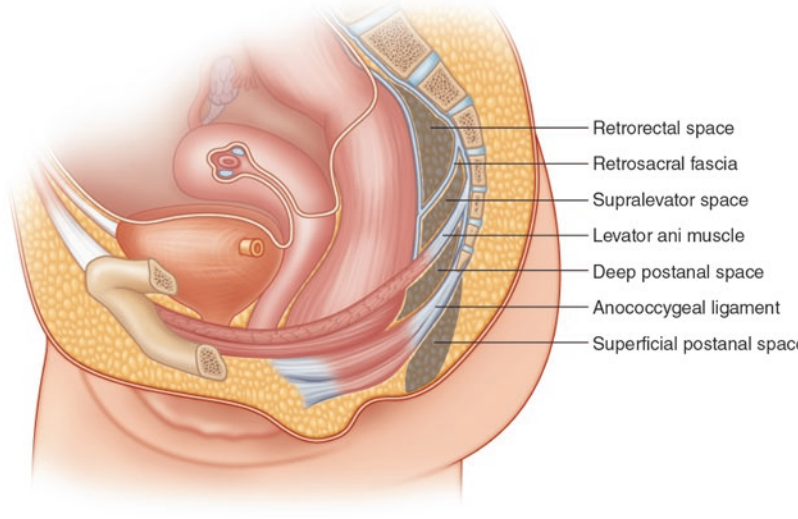


Fig. 1.8 Perianal and perirectal spaces, lateral view. From [3]. With permission © 2016 Springer

eric dissection study identified the presence of a middle rectal artery in only 22% of specimens [40] which could be a contributing factor as to why Miles saw no significant bleeding in this area.

Total mesorectal excision, as popularized by Heald involves sharp dissection along the fascia propria circumferentially to the pelvic floor. While acknowledging that the middle rectal vessels are "divided as far from the carcinoma as possible" Heald does not mention, "lateral ligaments" of the rectum at all [49].

In an extensive review of the anatomy of the lateral ligament, Church notes that it is a common misconception that the lateral ligaments contain the middle rectal artery at all. It appears that the lateral ligaments comprise "primarily nerves and connective tissue" and their division without bleeding attests to the absence of a "significant accessory rectal artery in this location in the majority of patients" [39].

In a separate cadaveric study, the lateral ligaments of the rectum were identified as trapezoid structures originating from mesorectum and anchored to the endopelvic fascia at the level of the midrectum. It was recommended that, as lateral extensions of the mesorectum, the ligaments must be cut and included in the total mesorectal excision (TME) specimen. It was further noted that the lateral ligaments did not contain middle rectal arteries or nerve structures of importance. The urogenital bundle runs just above the lateral ligament at its point of insertion on the endopelvic fascia, the middle rectal artery (if present) runs posterior to the lateral ligament and the nervi recti fibers (which originate from the inferior hypogastric plexus) course transversely under the lateral ligament to the rectal wall [50]. Other modern cadaveric investigations note the rarity of middle rectal arteries and the absence of clinically relevant neurovascular structures in the lateral ligaments [51].

Rectal Blood Supply

The rectum is supplied by the superior, middle, and inferior rectal (hemorrhoidal) arteries. Both the middle and inferior hemorrhoidal vessels are paired arteries and the superior rectal artery is not (Fig. 1.9).

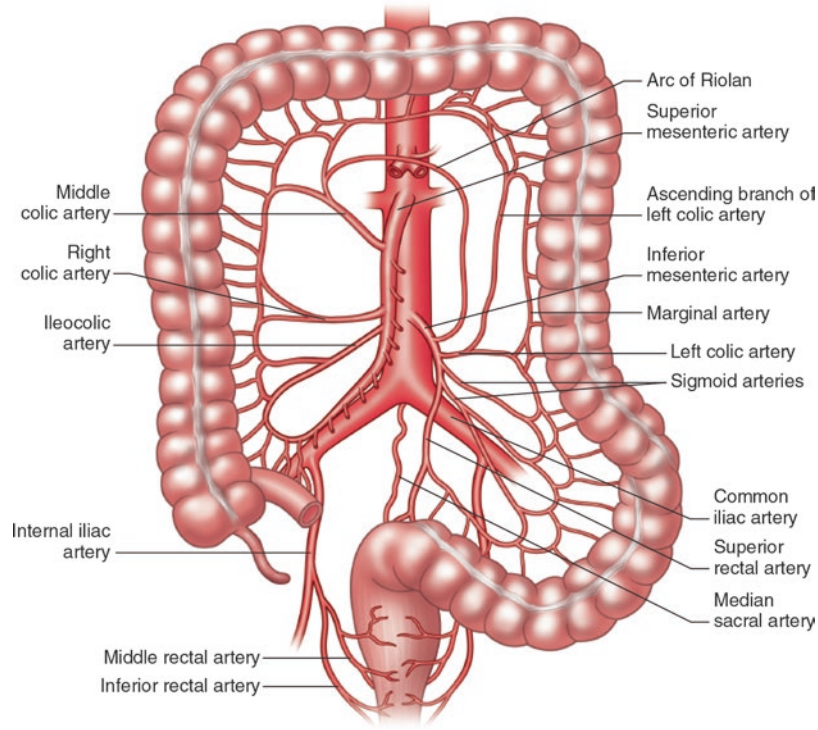


Fig. 1.9 Arterial anatomy of the colon and rectum. From [3]. With permission © 2016 Springer

Superior Rectal Artery

The superior rectal artery (SRA) is the continuation of the inferior mesenteric artery and is so named after the inferior mesenteric artery crosses the left iliac vessels. The SRA gives off a recto-sigmoid branch, an upper rectal branch, and then bifurcates into a right and left terminal branches in 80% [52] of cases as it descends caudally in the mesorectum. On average, eight terminal branches of the SRA have been identified in the distal rectal wall [53].

Middle Rectal Artery

The middle rectal artery (MRA) has been variably noted in many studies. It may be found on one or both sides of the rectum and has been noted to be present 12–28% of the time [51, 54]. At least one study reported the presence of the middle rectal artery in at least 91% of cadaveric specimens [50]. The MRA originates from the anterior division of the internal iliac or pudendal arteries. Please see the "Lateral Ligament" discussion above for more review on the anatomic course of the middle rectal artery.

Inferior Rectal Artery

The inferior rectal arteries (IRA) are paired vessels that originate as branches of the internal pudendal artery, which receives its blood supply from the internal iliac artery. The artery originates in the pudendal canal and is entirely extrapelvic (caudal to the levator ani) in its distribution. The IRA traverses the obturator fascia, the ischiorectal fossa and pierces the wall of the anal canal in the region of the external anal sphincter [39].

Venous and Lymphatic Drainage of the Rectum and Anus

Venous drainage from the rectum and anus occurs via both the portal and systemic systems. Middle and inferior rectal veins drain to the systemic systems via the internal iliac vein while the superior rectal vein drains the rectum and upper anal canal into the portal system via the inferior mesenteric vein (Fig. 1.10).

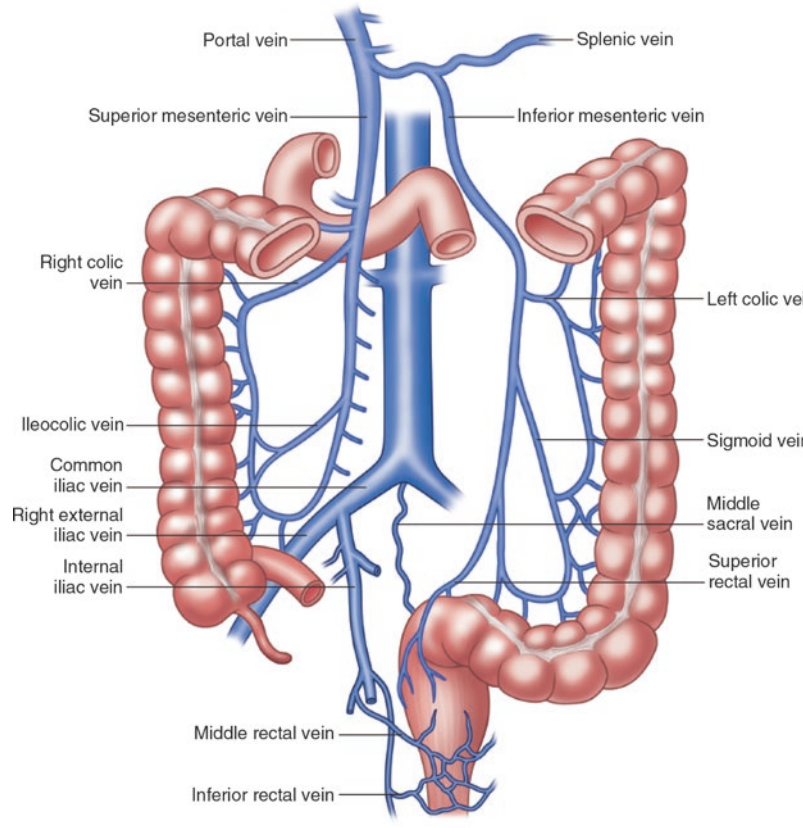


Fig. 1.10 Venous anatomy of the colon and rectum. From [3]. With permission © 2016 Springer

Lymphatics from the upper two-thirds of the rectum drain to the inferior mesenteric lymph nodes and then to the para-aortic lymph nodes. Lymphatic drainage from the lower third of the rectum occurs along the superior rectal artery and laterally along the middle rectal artery to the internal iliac lymph nodes. In the anal canal, lymphatic above the dentate drain to the inferior mesenteric and internal iliac lymph nodes. Below the dentate line lymphatics drain along the inferior rectal lymphatics to the superficial inguinal nodes.

Innervation of the Rectum and Anus

Sympathetic fibers arise from L1, L2, and L3 and pass through the sympathetic chains and join the preaortic plexus (Fig. 1.11). From there, they run adjacent and dorsal to the inferior mesenteric artery as the mesenteric plexus and innervate the upper rectum. The lower rectum is innervated by the presacral nerves from the hypogastric plexus. Two main hypogastric nerves, on either side of the rectum, carry sympathetic information from the hypogastric plexus to the pelvic plexus. The pelvic plexus lies on the lateral side of the pelvis at the level of the lower third of the rectum adjacent to the lateral stalks (please see discussion of lateral stalks above).

Parasympathetic fibers to the rectum and anal canal originate from S2, S3 and S4 to penetrate through the sacral foramen and are called the nervi erigentes. These nerves course laterally and anterior to join the sympathetic hypogastric nerves and form the pelvic plexus on the pelvic sidewall. From here, postganglionic mixed parasympathetic and sympathetic nerve fibers supply the rectum, genital organs and anal canal. The periprostatic plexus is considered a subdivision of the pelvic plexus and supplies the prostate, seminal vesicles, corpora cavernosa, vas deferens, urethra, ejaculatory ducts, and bulbourethral glands.

The internal anal sphincter is innervated by sympathetic (L5) and parasympathetic (S2, S3 and S4) nerves following the same route as the nerves to the rectum as noted above. The external anal sphincter is innervated on each side by the inferior rectal branch (Fig. 1.3) of the internal

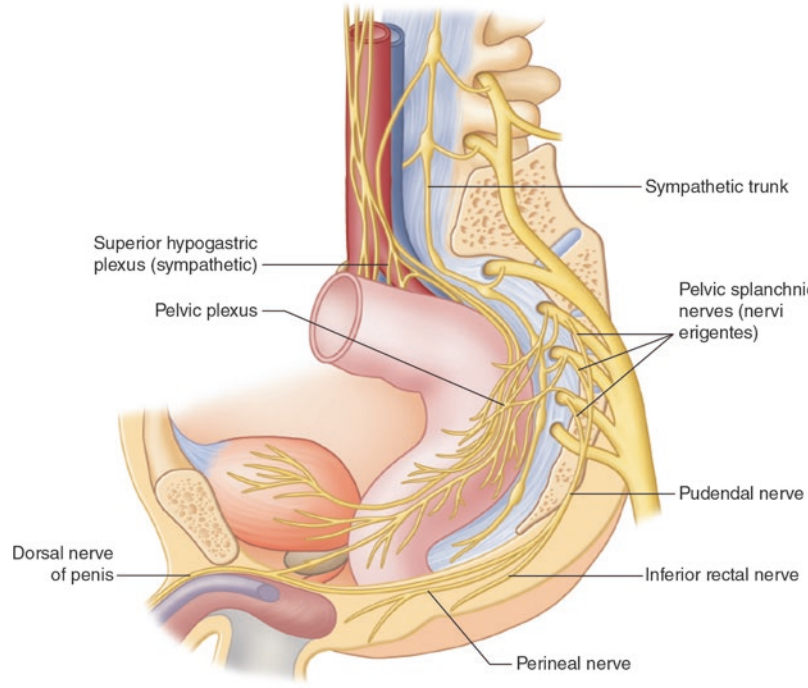


Fig. 1.11 Nerves of the rectum. From [3]. With permission © 2016 Springer

pudendal nerve (S2 and S3) and by the perineal branch of S4. The pudendal nerve mediates conscious external sphincter contraction, but does not play a role in unconscious anal sphincter contraction [55]. The pudendal nerve supplies afferent sensory pathways from the skin of the anal canal and perineum [56].

Physiology

Normal physiology of defecation results in the voluntarily controlled evacuation of stool at a frequency and with an effort, which the individual does not find distressing. While somewhat in the eye of the beholder, normal frequency of defecation in the great majority of people is between three times a day and once every 2 days [57]. Bowel habits outside of that range however are not necessarily pathologic, and if acceptable to the individual are acceptable to the physician if unaccompanied by other symptoms or signs of disease. Stool frequency within that range should still be characterized as abnormal if excessive time and effort are required to eliminate. Incontinence is easier to define, and because continence mechanisms work best with a solid or semisolid stool consistency, fecal elimination is a process dependent on the proper functioning of the entire gastrointestinal tract, but particularly of the colon, rectum, and anal sphincter complex.

Colonic Role in Normal Defecation

Colonic Absorption

The colon absorbs water, sodium and chloride and secretes potassium and bicarbonate. In healthy individuals, colonic absorption of water reduces the 1000–1500 mL of fluid which enters the colon each day to about 100–150 mL [58]. Absorption of fluid is greatest in the right and transverse colon, though compensatory mechanisms enhance absorption in the remaining colon following a right colon resection, as demonstrated in animal models and as is seen clinically in the normalization of bowel function following that operation [59].

Failure of colonic absorption due either to rapid transit or mucosal absorptive failure results in a liquid stool, which when emptied rapidly into the rectum results in great stress on the sphincters and, even in normal subjects, may occasionally produce urgency and incontinence. The mean values for normal total colonic transit time is approximately 32 and 41 h for men and women respectively, though can be as long as 72 h in adults. The mean segmental transit times are 12, 14 and 11 h for right colon, left colon and rectosigmoid, respectively [60]. Colonic absorption is mostly likely assisted by non-propagated contractions of the muscular wall of the colon. These contractions, which are not thought to move the fecal bolus a significant distance in either direction in a coordinated way, mostly likely serve to expose various aspects of the stool to the colonic absorptive surface to maximize fluid retention [61]. This may explain the relatively long 30–40 h transit time of the colon, compared to the much shorter transit times associated with small bowel.

Colonic Motility

The colon is capable of sustained and powerful contractile force when distended, which all experienced endoscopists have witnessed. Propagated contractions are so named for their ability to move the fecal bolus downstream towards the rectum and anus. They tend to be low pressure with an amplitude under 50 mm Hg, or high pressure with an amplitude over 100 mm Hg [62]. The manometric presence of High Amplitude Propagated Contractions (HAPC's) corresponds to radiographically seen movement of stool in a coordinated way in an aboral direction. These high-pressure waves can begin anywhere in the colon, and tend to terminate in the sigmoid and rectum. They are present on awakening and tend to be absent during the night. They also occur within minutes of initiating a meal, and are responsible for the gastrocolic reflex [63]. Significant psychological and physiologic stress can also trigger HAPC's, and distance runners often note the urge to defecate after completion of a long event. Although their frequency is highly variable, they occur on average five to six times a day, and are

probably less frequent in patients with constipation. Similarly, the proportion of retrograde contractions may be higher in patients with infrequent defecation. A propagated contraction generally precedes the urge to defecate in normal controls, and the contraction is usually high amplitude. Low Amplitude Propagated Contractions (LAPCs) are much more frequent than HAPCs, occurring 40–120 times a day, and may also be less frequent in constipated patients compared to normal controls [64], and may also be less well linked from the proximal colon-to-distal [65].

Colonic contractions are mediated by Auerbach's plexus, which lies between the circular and longitudinal muscle layers, and Meissner's plexus, which lies in the submucosa. The general rate of contraction can be modulated by inhibitory impulses from the sympathetic nervous system and stimulatory impulses from the parasympathetic nervous system. Coordination of intrinsic colonic motility is coordinated the pacemaker like interstitial cells of Cajal.

Role of the Rectosigmoid Junction

It is tempting to consider the abdominal colon as a monofunctional tube whose sole purpose is to deliver stool to the capacious rectum, which when adequately distended signals the need to defecate. Several observations run counter to this notion, including the tendency of constipated patients to have an empty rectum on physical exam, and the generally empty nature of the rectum in normal controls between bowel movements. The sigmoid and the rectosigmoid junction, although still a matter of substantial controversy, may play a role in fecal continence. The sigmoid may act as a reservoir, which when distended leads to relaxation of a physiologic sphincter-like apparatus at the rectosigmoid junction, which then leads to rapid filling of the rectum and the subsequent need to defecate. Accordingly, an electrically hyperactive segment has been found at the rectosigmoid junction, particularly in constipated patients; moreover, a high pressure zone has been noted in at least 50% of the normal population [66].

Rectal Function

Filling of the rectum results in the need to defecate. Balloon distension of the rectum causes urgency, while the same maneuver in the abdominal colon causes only pain [67]. The non-diseased rectum has both viscous and elastic properties which allow it to maintain a low intraluminal pressure while being filled in order to preserve continence, and these properties can to some extent be appreciated surgically in the way the rectum responds to manipulation and division with greater elasticity than the intra-abdominal colon. When rectal compliance deteriorates, smaller volumes of feces will result in higher intraluminal pressures causing urgency and frequency. This phenomenon is observed in patients with ulcerative colitis [68] and radiation proctitis [69]. The preservation of compliance associated with ileal and colonic J-pouches explains the greater functionality associated with those surgical strategies compared to straight anastomoses [70].

Although rectal distension is a crucial signal for impending defecation, the sensory nerves responsible for communication this distension lie mostly outside the rectum [71]. Perhaps the most compelling evidence for the extrarectal location for signaling is the preserved sense of the need to stool in patients having had complete removal of the rectum with an ileoanal or coloanal anastomosis. Also, stimulation of the stretch receptors in the pelvic floor or puborectalis results in urgency [72]. Anesthetizing the rectum does alter sensory aspects of defecation suggesting the rectum itself is also responsible for some aspect of signaling and likely explains the imperfect bowel function seen in patients having sphincter sparing rectal surgery.

Failure of the sensory nature of the rectum and pelvic floor can lead to both incontinence and failure to evacuate. Even if the innervation of the rectum is intact, excessively high thresholds required to activate the afferent neural cascade can also lead to excessive rectal filling. Similarly, excessive rectal compliance can also contribute to a failure on the patient's part to detect rectal distension [73].

During defecation, the contribution of rectal contraction to evacuation is not well described. It may be that different individuals rely on rectal smooth muscle contractions to varying degrees, with some relying solely on an increase in intra-abdominal pressure through the Valsalva maneuver and the like, while others depend on a substantial contribution from the rectum itself.

The Pelvic Floor

The pelvic floor musculature (Fig. 1.2), consisting of the levator ani muscles (iliococcygeus, pubococcygeus, puborectalis), is generally in a state of tonic contracture, which support the abdominal and pelvic organs. Not surprisingly the muscles of the pelvic floor are composed primarily of Type 1 fibers, which are associated throughout the body with tonic contracture [74]. The pelvic floor also creates an acute angle between the rectum and the anal canal, which assists in continence and fecal storage. Of the pelvic floor muscles, the puborectalis plays the largest role in creating this angle and is innervated by the S3 and particularly the S4 nerve roots [75]. A preserved cutaneous-anal reflex suggests intact S4 sensory and motor nerve roots. This is skeletal muscle and can be voluntarily contracted to stave off imminent defecation. Increased abdominal pressure can result in reflex contracture of the pelvic floor as with a cough, or in reflex relaxation when defecation occurs. How these different reflex actions are mediated is not clear. Relaxation results in straightening and inferior movement anorectal angle, which facilitates defecation. Failure of the pelvic floor to relax can sometimes be seen on defecography and is a potential cause of obstructed defecation [76]. Hip flexion also straightens the anorectal angle, emphasizing the importance of posture, be it sitting or squatting, in facilitating a bowel movement [77].

The Anal Sphincter Complex

Internal Anal Sphincter (IAS)

As a smooth muscle, the IAS is in a state of continuous maximum contraction. This is due to both intrinsic myogenic and extrinsic autonomic neurogenic properties. The IAS represents a natural barrier to the involuntary loss of stool. The mean anal canal resting tone in healthy adults is generally in the range of 50–70 mm Hg, and tends to decrease in women and in the elderly [78]. The IAS is responsible for 50–85% of the composition of the resting tone, the EAS accounts for 25–30%, and the remaining 15% is attributed to expansion of the anal cushions [79].

A gradual increase in pressures is noted from proximal to distal in the anal canal; the highest resting pressures are usually recorded 1–2 cm cephalad to the anal verge. This high pressure zone or functional anal canal length corresponds anatomically to the condensation of the smooth muscle fibers of the internal anal sphincter and is shorter in women (2–3 cm) compared to men (2.5–3.5 cm) [78]. Interestingly, although parity may contribute to this difference, nulliparous women still have a significantly shorter functional anal canal than men [80].

Rectal distension causes reflexive transient relaxation of the internal sphincter and the subsequent descent of rectal contents into the proximal anal canal. This rectoanal inhibitory reflex (RAIR) can be recreated through balloon distension of the rectum with simultaneous measurement of a decrease in anal resting pressure. The exposure of the highly innervated anal canal to rectal contents allows discrimination between the various potential consistencies of rectal contents, and facilitates passing of gas without stool. This sampling reflex is mediated by the enteric nervous system, which is why the RAIR is manometrically absent in Hirschsprung's disease, and why the reflex persists following denervation of the rectum and anus.

Although the IAS relaxes in response to rectal distension, it gradually reacquires its tone as the rectum accommodates to the distension. Pronounced impairment of IAS function has been noted in 25% of patients with idiopathic fecal incontinence. Spontaneous relaxation of the IAS without a compensatory increase in EAS activity may be an important factor leading to fecal incontinence [81].

Conjoined Longitudinal Muscle

Possible functions of the conjoined longitudinal muscle (CLM) include its role in attaching the anorectum to the pelvis and acting as a skeleton supporting and binding the rest of the internal and external sphincter complex together [82]. Shafik considers the CLM to play only a minimal role in continence, potentiating the action of the base loop in maintaining an anal seal [83]. He ascribes its main role during defecation to shortening and widening of the anal canal and eversion of the anal orifice and proposes the term "evertor ani muscle". Haas and Fox consider the meshwork composed by the CLM may minimize functional deterioration of the sphincters after its surgical division; and acts as a support against hemorrhoidal and rectal prolapse [11]. Finally the CLM and its extensions to the intersphincteric plane divide the adjacent tissues into subspaces and may play a role in the containment of sepsis [84].

The External Sphincter and Sequence of Defecation

Defecation is a complex and incompletely understood phenomenon related to several integrated mechanisms, all under the influence of the central nervous system. Defecation is triggered by filling of the rectum from the sigmoid colon. Rectal distension is interpreted, via stretch receptors located in the pelvic floor muscles, at a conscious level as a desire to defecate. Rectal distension also initiates the RAIR. The IAS relaxation, by opening the upper anal canal, exposes the rectal contents to the highly sensitive anal mucosa and then differentiation between flatus and stool can be made. This "sampling" mechanism determines the urgency of defecation. Meanwhile, the simultaneous EAS reflex contraction maintains continence. If defecation is to be deferred, conscious contraction of the EAS, assisted by the mechanism of rectal compliance, yields time for recuperation of the IAS function.

If the call to stool is answered, either the sitting or squatting positions are assumed, and then the anorectal angle is "opened". Increase in both intrarectal and intra-abdominal pressures result in reflex relaxation in EAS, IAS and puborectalis; at this point, defecation may occur without straining. Contraction of the conjoint longitudinal muscle helps pull the vascular cushions out of the anal canal and alongside the anal wall and shortens the anal canal. Consequently, pelvic floor descending and funneling occurs, and the rectal contents are expelled by direct transmission of the increased abdominal pressure through the relaxed pelvic floor. Stool consistency will determine either mass peristaltic emptying of the left colon or the intermittent passing of stools. Transient EAS and puborectalis contraction after completion of rectal evacuation, the "closing reflex", restores IAS tonus and closes the anal canal.

References

1. Milligan ETC, Morgan CN. Surgical anatomy of the anal canal: with special reference to anorectal fistulae. Lancet. 1934;2(5804):1150–6.
2. Milligan ETC, Morgan CN, Jones LE, Officer R. Surgical anatomy of the anal canal, and the operative treatment of haemorrhoids. Lancet. 1937;2:1119–24.
3. Carmichael JC, Mills S. Anatomy and embryology of the colon, rectum, and anus. In: Steele SR, Hull TL, Saclarides TJ, Senagore AJ, Whitlow CB, editors. The ASCRS textbook of colon and rectal surgery. 3rd ed. New York: Springer; 2016. p. 3–26.
4. Nivatvongs S, Stern HS, Fryd DS. The length of the anal canal. Dis Colon Rectum. 1981;24(8):600–1.
5. Morren GL, Beets-Tan RG, van Engelshoven JM. Anatomy of the anal canal and perianal structures as defined by phased-array magnetic resonance imaging. Br J Surg. 2001;88(11):1506–12.
6. Parks AG. Pathogenesis and treatment of fistuila-in-ano. Br Med J. 1961;1(5224):463–9.
7. Hiller RI. Anal anatomy with reference to the white line of Hilton and the pecten of Stroud. Ann Surg. 1935;102(1):81–5.
8. Lilius HG. Fistula-in-ano, an investigation of human foetal anal ducts and intramuscular glands and a clinical study of 150 patients. Acta Chir Scand Suppl. 1968;383:7–88.
9. Barleben A, Mills S. Anorectal anatomy and physiology. Surg Clin N Am. 2010;90(1):1–15.
10. Sboarina A, Minicozzi A, Segattini C, Leopardi F, Lombardo F, Passeri V, et al. Shape and volume of internal anal sphincter showed by three-dimensional anorectal ultrasonography. Eur J Radiol. 2012;81(7):1479–82.
11. Haas PA, Fox TA Jr. The importance of the perianal connective tissue in the surgical anatomy and function of the anus. Dis Colon Rectum. 1977;20(4):303–13.

12. Tsukada Y, Ito M, Watanabe K, Yamaguchi K, Kojima M, Hayashi R, et al. Topographic anatomy of the anal sphincter complex and levator ani muscle as it relates to intersphincteric resection for very low rectal disease. Dis Colon Rectum. 2016;59(5):426–33.
13. Treitz W. Ueber einen neuen Muskel am Duodenum des Menschen, uber elsatische Sehnen, und einige andere anatomische Verhaltnisse. Vierteljahrschrift Praktische Heilkunde (Prager). 1853;37:133–44.
14. Chang SC, JJM S, Shih JYM, Lee HHC. Review of Treitz's muscles and their implications in a hemorrhoidectomy and hemorrhoidopexy. Fu-Jen J Med. 2006;4(1):1–6.
15. Thomson WH. The nature of haemorrhoids. Br J Surg. 1975;62(7):542–52.
16. Goligher JC, Leacock AG, Brossy JJ. The surgical anatomy of the anal canal. Br J Surg. 1955;43(177):51–61.
17. Bollard RC, Gardiner A, Lindow S, Phillips K, Duthie GS. Normal female anal sphincter: difficulties in interpretation explained. Dis Colon Rectum. 2002;45(2):171–5.
18. Hussain SM, Stoker J, Lameris JS. Anal sphincter complex: endoanal MR imaging of normal anatomy. Radiology. 1995;197(3):671–7.
19. Wunderlich M, Swash M. The overlapping innervation of the two sides of the external anal sphincter by the pudendal nerves. J Neurol Sci. 1983;59(1):97–109.
20. Mittal RK, Bhargava V, Sheean G, Ledgerwood M, Sinha S. Purse-string morphology of external anal sphincter revealed by novel imaging techniques. Am J Physiol Gastrointest Liver Physiol. 2014;306(6):G505–14.
21. Kinugasa Y, Arakawa T, Abe S, Ohtsuka A, Suzuki D, Murakami G, et al. Anatomical reevaluation of the anococcygeal ligament and its surgical relevance. Dis Colon Rectum. 2011;54(2):232–7.
22. Jin ZW, Hata F, Jin Y, Murakami G, Kinugasa Y, Abe S. The anococcygeal ligaments: cadaveric study with application to our understanding of incontinence in the elderly. Clin Anat. 2015;28(8):1039–47.
23. DeLancey JO, Morgan DM, Fenner DE, Kearney R, Guire K, Miller JM, et al. Comparison of levator ani muscle defects and function in women with and without pelvic organ prolapse. Obstet Gynecol. 2007;109(2 Pt 1):295–302.
24. Shafik A. New concept of the anatomy of the anal sphincter mechanism and the physiology of defecation. II. Anatomy of the levator ani muscle with special reference to puborectalis. Investig Urol. 1975;13(3):175–82.
25. Betschart C, Kim J, Miller JM, Ashton-Miller JA, DeLancey JO. Comparison of muscle fiber directions between different levator ani muscle subdivisions: in vivo MRI measurements in women. Int Urogynecol J. 2014;25(9):1263–8.
26. Levi AC, Borghi F, Garavoglia M. Development of the anal canal muscles. Dis Colon Rectum. 1991;34(3):262–6.
27. Grigorescu BA, Lazarou G, Olson TR, Downie SA, Powers K, Greston WM, et al. Innervation of the levator ani muscles: description of the nerve branches to the pubococcygeus, iliococcygeus, and puborectalis muscles. Int Urogynecol J. 2008;19(1):107–16.
28. Wallner C, Maas CP, Dabhoiwala NF, Lamers WH, DeRuiter MC. Evidence for the innervation of the puborectalis muscle by the levator ani nerve. Neurogastroenterol Motil. 2006;18(12):1121–2.
29. Shafik A. A new concept of the anatomy of the anal sphincter mechanism and the physiology of defecation. VIII. Levator hiatus and tunnel: anatomy and function. Dis Colon Rectum. 1979;22(8):539–49.
30. Andrew BP, Shek KL, Chantarasorn V, Dietz HP. Enlargement of the levator hiatus in female pelvic organ prolapse: cause or effect? Aust N Z J Obstet Gynaecol. 2013;53(1):74–8.
31. DeLancey JO, Sorensen HC, Lewicky-Gaupp C, Smith TM. Comparison of the puborectal muscle on MRI in women with POP and levator ani defects with those with normal support and no defect. Int Urogynecol J. 2012;23(1):73–7.
32. Heald RJ, Moran BJ. Embryology and anatomy of the rectum. Semin Surg Oncol. 1998;15(2):66–71.
33. Najarian MM, Belzer GE, Cogbill TH, Mathiason MA. Determination of the peritoneal reflection using intraoperative proctoscopy. Dis Colon Rectum. 2004;47(12):2080–5.
34. Abramson DJ. The valves of Houston in adults. Am J Surg. 1978;136(3):334–6.
35. Chapuis P, Bokey L, Fahrer M, Sinclair G, Bogduk N. Mobilization of the rectum: anatomic concepts and the bookshelf revisited. Dis Colon Rectum. 2002;45(1):1–8. discussion -9.
36. Heald RJ, Husband EM, Ryall RD. The mesorectum in rectal cancer surgery—the clue to pelvic recurrence? Br J Surg. 1982;69(10):613–6.
37. Nomina anatomica, 6th ed. Singapore: Churchill Livingstone; 1989.
38. Quirke P, Steele R, Monson J, Grieve R, Khanna S, Couture J, et al. Effect of the plane of surgery achieved on local recurrence in patients with operable rectal cancer: a prospective study using data from the MRC CR07 and NCIC-CTG CO16 randomised clinical trial. Lancet. 2009;373(9666):821–8.
39. Church JM, Raudkivi PJ, Hill GL. The surgical anatomy of the rectum—a review with particular relevance to the hazards of rectal mobilisation. Int J Color Dis. 1987;2(3):158–66.
40. Sato K, Sato T. The vascular and neuronal composition of the lateral ligament of the rectum and the rectosacral fascia. Surg Radiol Anat. 1991;13(1):17–22.
41. Crapp AR, Cuthbertson AM. William Waldeyer and the rectosacral fascia. Surg Gynecol Obstet. 1974;138(2):252–6.
42. Gordon PH, Nivatvongs S. Principles and practice of surgery for the colon, rectum, and anus. 3rd ed. New York: Informa Healthcare; 2007.
43. Lindsey I, Guy RJ, Warren BF, Mortensen NJ. Anatomy of Denonvilliers' fascia and pelvic

nerves, impotence, and implications for the colorectal surgeon. Br J Surg. 2000;87(10):1288–99.
44. Richardson AC. The rectovaginal septum revisited: its relationship to rectocele and its importance in rectocele repair. Clin Obstet Gynecol. 1993;36(4):976–83.
45. Llauger J, Palmer J, Perez C, Monill J, Ribe J, Moreno A. The normal and pathologic ischiorectal fossa at CT and MR imaging. Radiographics. 1998;18(1):61–82. quiz 146.
46. Courtney H. The posterior subsphincteric space; its relation to posterior horseshoe fistula. Surg Gynecol Obstet. 1949;89(2):222–6.
47. Wang G-J. Anatomy of the lateral ligaments of the rectum: a controversial point of view. World J Gastroenterol. 2010;16(43):5411.
48. Corman ML. Classic articles in colonic and rectal surgery. A method of performing abdominoperineal excision for carcinoma of the rectum and of the terminal portion of the pelvic colon: by W. Ernest Miles, 1869-1947. Dis Colon Rectum. 1980;23(3):202–5.
49. Heald RJ, Ryall RD. Recurrence and survival after total mesorectal excision for rectal cancer. Lancet. 1986;1(8496):1479–82.
50. Nano M, Dal Corso HM, Lanfranco G, Ferronato M, Hornung JP. Contribution to the surgical anatomy of the ligaments of the rectum. Dis Colon Rectum. 2000;43(11):1592–7. discussion 7–8.
51. Lin M, Chen W, Huang L, Ni J, Yin L. The anatomy of lateral ligament of the rectum and its role in total mesorectal excision. World J Surg. 2010;34(3):594–8.
52. Michaels NA, Siddharth P, Kornblith PL, Park WW. The variant blood supply to the small and large intestines: its importance in regional resections. A new anatomic study based on four hundred dissections with a complete review of the literature. J Int Coll Surg. 1963;39:127–70.
53. Schuurman JP, Go PM, Bleys RL. Anatomical branches of the superior rectal artery in the distal rectum. Color Dis. 2009;11(9):967–71.
54. Ayoub SF. Arterial supply to the human rectum. Acta Anat (Basel). 1978;100(3):317–27.
55. van Meegdenburg MM, Heineman E, Broens PM. Pudendal neuropathy alone results in urge incontinence rather than in complete fecal incontinence. Dis Colon Rectum. 2015;58(12):1186–93.
56. Gooneratne ML, Scott SM, Lunniss PJ. Unilateral pudendal neuropathy is common in patients with fecal incontinence. Dis Colon Rectum. 2007;50(4):449–58.
57. Connell AM, Hilton C, Irvine G, Lennard-Jones JE, Misiewicz JJ. Variation of bowel habit in two population samples. Br Med J. 1965;2(5470):1095–9.
58. Phillips SF, Giller J. The contribution of the colon to electrolyte and water conservation in man. J Lab Clin Med. 1973;81(5):733–46.
59. Luboshits J, Goldberg G, Chubadi R, Achiron A, Atsmon J, Hayslett JP, et al. Functional adaptation of rat remnant colon after proximal hemicolectomy. Dig Dis Sci. 1992;37(2):175–8.
60. Jorge JM, Habr-Gama A, Wexner SD, Pinotti HW. Practical physiologic evaluation of the colon, rectum and anus. Rev Hosp Clin. 1994;49(5):196–8.
61. Cook IJ, Furukawa Y, Panagopoulos V, Collins PJ, Dent J. Relationships between spatial patterns of colonic pressure and individual movements of content. Am J Physiol Gastrointest Liver Physiol. 2000;278(2):G329–41.
62. Scott SM. Manometric techniques for the evaluation of colonic motor activity: current status. Neurogastroenterol Motil. 2003;15(5):483–513.
63. Torsoli A, Ramorino ML, Ammaturo MV, Capurso L, Paoluzi P, Anzini F. Mass movements and intracolonic pressures. Am J Dig Dis. 1971;16(8):693–6.
64. Hagger R, Kumar D, Benson M, Grundy A. Colonic motor activity in slow-transit idiopathic constipation as identified by 24-h pancolonic ambulatory manometry. Neurogastroenterol Motil. 2003;15(5):515–22.
65. Dinning PG, Zarate N, Hunt LM, Fuentealba SE, Mohammed SD, Szczesniak MM, et al. Pancolonic spatiotemporal mapping reveals regional deficiencies in, and disorganization of colonic propagating pressure waves in severe constipation. Neurogastroenterol Motil. 2010;22(12):e340–9.
66. Chowdhury AR, Dinoso VP, Lorber SH. Characterization of a hyperactive segment at the rectosigmoid junction. Gastroenterology. 1976;71(4):584–8.
67. Goligher JC, Hughes ES. Sensibility of the rectum and colon. Its role in the mechanism of anal continence. Lancet. 1951;1(6654):543–7.
68. Denis P, Colin R, Galmiche JP, Geffroy Y, Hecketsweiler P, Lefrancois R, et al. Elastic properties of the rectal wall in normal adults and in the patients with ulcerative colitis. Gastroenterology. 1979;77(1):45–8.
69. Varma JS, Smith AN, Busuttil A. Correlation of clinical and manometric abnormalities of rectal function following chronic radiation injury. Br J Surg. 1985;72(11):875–8.
70. Wexner SD, James K, Jagelman DG. The double-stapled ileal reservoir and ileoanal anastomosis. A prospective review of sphincter function and clinical outcome. Dis Colon Rectum. 1991;34(6):487–94.
71. Parks AG. Royal Society of Medicine, Section of Proctology; Meeting 27 November 1974. President's address. Anorectal incontinence. Proc R Soc Med. 1975;68(11):681–90.
72. Scharli AF, Kiesewetter WB. Defecation and continence: some new concepts. Dis Colon Rectum. 1970;13(2):81–107.
73. Buser WD, Miner PB Jr. Delayed rectal sensation with fecal incontinence. Successful treatment using anorectal manometry. Gastroenterology. 1986;91(5):1186–91.
74. Swash M. Histopathology of pelvic floor muscles in pelvic floor disorders. In: Henry MM, Swash M, editors. Coloproctology and the pelvic floor. London: Butterworth-Heinemann; 1992. p. 173–83.

75. Snooks SJ, Swash M. The innervation of the muscles of continence. Ann R Coll Surg Engl. 1986;68(1):45–9.
76. Bartolo DC, Roe AM, Virjee J, Mortensen NJ. Evacuation proctography in obstructed defaecation and rectal intussusception. Br J Surg. 1985;72(Suppl):S111–6.
77. Palit S, Lunniss PJ, Scott SM. The physiology of human defecation. Dig Dis Sci. 2012;57(6):1445–64.
78. Jorge JM, Wexner SD. Anorectal manometry: techniques and clinical applications. South Med J. 1993;86(8):924–31.
79. Gibbons CP, Trowbridge EA, Bannister JJ, Read NW. Role of anal cushions in maintaining continence. Lancet. 1986;1(8486):886–8.
80. Jorge JM, Habr-Gama A. The value of sphincteric asymmetry index analysis in anal incontinence (abstract). Dis Colon Rectum. 1997;40:A14–5.
81. Sun WM, Read NW, Donnelly TC. Impaired internal anal sphincter in a subgroup of patients with idiopathic fecal incontinence. Gastroenterology. 1989;97(1):130–5.
82. Courtney H. Anatomy of the pelvic diaphragm and anorectal musculature as related to sphincter preservation in anorectal surgery. Am J Surg. 1950;79(1):155–73.
83. Shafik A. A new concept of the anatomy of the anal sphincter mechanism and the physiology of defecation. III. The longitudinal anal muscle: anatomy and role in anal sphincter mechanism. Investig Urol. 1976;13(4):271–7.
84. Lunniss PJ, Phillips RK. Anatomy and function of the anal longitudinal muscle. Br J Surg. 1992;79(9):882–4.

Patient Evaluation

2

Pasithorn A. Suwanabol and Justin A. Maykel

Introduction

In general, any patient evaluation requires a thorough history in conjunction with a careful physical examination and additional directed diagnostic studies. In order to correctly diagnose and effectively manage diseases of the anus and rectum, symptoms are thoughtfully considered in relation to the most likely underlying etiology. While common anorectal complaints are generally a result of benign disease, more serious gastrointestinal pathology, such as inflammatory bowel disease and malignancy, must always be considered in the differential. Therefore, the combination of an accurate and detailed history, focused physical examination, and appropriate investigative testing should result in proper diagnosis in both a timely and cost-effective manner [1].

P. A. Suwanabol
Department of Surgery, Division of Colorectal Surgery, University of Michigan, Ann Arbor, MI, USA

J. A. Maykel (✉)
Division of Colon and Rectal Surgery, Department of Surgery, UMass Memorial Health Care, Worcester, MA, USA
e-mail: justin.maykel@umassmemorial.org

Anatomy

In addition to sound clinical judgment, it is essential that the clinician base their assessment on a thorough understanding of anorectal anatomy. A comprehensive review of anorectal anatomy and physiology is beyond the scope of this chapter but it is important to consider the critical points in relation to this discussion of "patient evaluation."

The rectum begins where the outer longitudinal taenia of the colon converge to form a confluent outer longitudinal muscle layer. The rectum is approximately 12–15 cm long with three intraluminal folds, the valves of Houston, with the middle valve typically corresponding to the level of the anterior peritoneal reflection. The anal canal is approximately 4 cm long and begins at the levator ani muscle and extends to the perianal skin. The anal canal is encircled by the internal anal sphincter (IAS) and the external anal sphincter (EAS). The IAS is the most distal extension of the inner circular smooth muscle layer of the rectum and is innervated by the autonomic nervous system. The IAS is therefore under involuntary control and responsible for maintaining resting anal tone. The EAS is formed by the puborectalis muscle and innervated by somatic nerves. The EAS is responsible for voluntary squeeze and maintenance of continence [2, 3].

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_2

The anal canal contains columnar epithelium proximally and transitional epithelium distally at the level of the dentate line. The dentate line defines the location of the anal crypts and glands but also marks the change in neural innervation from visceral proximally to somatic distally. Finally, the most distal portion of the anal canal, beyond the dentate line, is lined by squamous epithelium and extends to the hair-bearing area of the perianal skin (Fig. 2.1) [2, 4].

The anus is also divided anatomically into the anal canal and anal margin. The anal canal starts at the top of the anal sphincter muscles and encompasses the distance from the anorectal junction to the intersphincteric groove. The anal margin begins at the intersphincteric groove and extends to approximately 5 cm onto the perineum. This is important to distinguish for certain diagnoses such as malignancies, as management differs between anal canal and early anal margin cancers [5].

Finally, an understanding of this anatomy is critical when classifying and describing anorectal abscesses and fistulas relative to the four potential spaces surrounding the anorectum: perianal, intersphincteric, suprasphinteric, and ischiorectal (Fig. 2.2) [6]. Accurately categorizing abscesses and fistulas directs appropriate surgical management for abscesses (i.e. internal versus external drainage) or approach to transsphincteric fistulas. Additional details on the anorectal anatomy can be found in Chapter 1.

History

Chief Complaint

The critical nature of the patient history is highlighted by the fact that the ultimate diagnosis can be suggested by the history alone. Patients are often referred to a surgical specialist with a suspected diagnosis that is inaccurate based on the patient's or referring doctor's impression. For example, "hemorrhoids" is frequently used as an umbrella diagnosis for patients presenting with pain, bleeding, mass and itching yet the ultimate diagnosis is unrelated to their asymptomatic hemorrhoids [7].

Patients often present with a complicated list of symptoms, often struggling to focus on their most significant concern. Accordingly, it helps to ask them to narrow their complaints to a single or most pressing concern. With that focus, the surgeon can ask specific questions and lead the discussion towards a better understanding of their issues: change in bowel habits, rectal discomfort, tissue prolapse, mucous drainage, stool leakage. The nature, duration and severity of such symptoms as well as the relationship to meals, alleviating and aggravating factors, medications, bowel movement routines, and impact on sexual activity can then be elicited [8]. It is essential that the clinician be aware of "alarm signs" that may signify a more ominous underlying pathology such as unintended weight loss, change in stool cali-

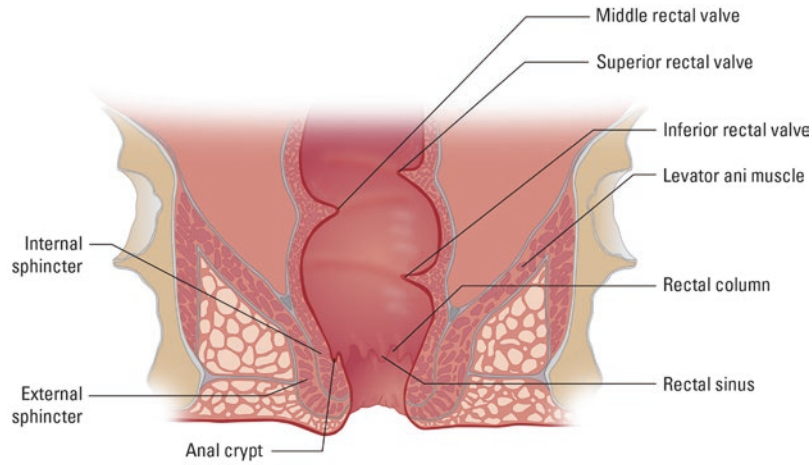


Fig. 2.1 Anorectal anatomy

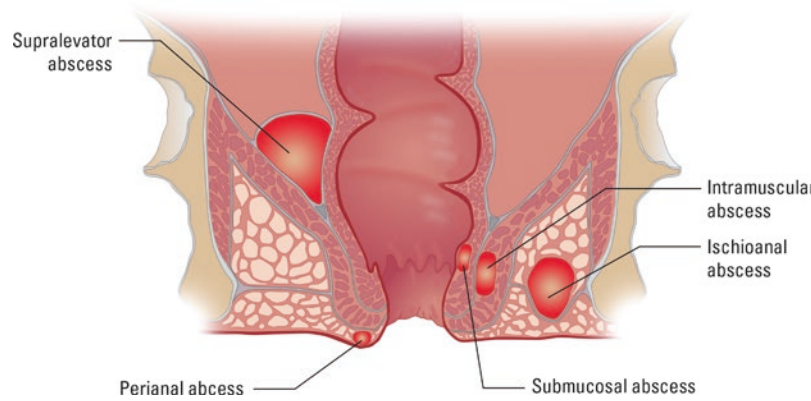


Fig. 2.2 Perirectal abscess

ber, the presence of blood in stool, and personal or family history of inflammatory bowel disease and gastrointestinal malignancies [9–11].

Bowel Habits

Bowel habits are always addressed, typically through questioning as patients are not generally willing to volunteer this information. Characterization of stool with the aid of the Bristol stool chart may be helpful; qualifying stool from separate hard lumps (type 1) to watery with no solid component (type 7) (Fig. 2.3) [12]. Further characterization about incontinence and constipation are necessary such as onset, frequency, and quantity. Details such as straining, digitation either in the rectum or vagina, splinting, rectal sensation changes, and urgency should be elicited [13–15]. For patients with complaints of incontinence, recent changes in stool consistency may point to the underlying etiology and is frequently overlooked. Additional recommendations for patients with complaints of incontinence and constipation will be discussed further.

Personal History

Medication use and the use of supplementary fiber should be asked. It is important to specifically inquire about sexual history including anoreceptive intercourse and high-risk behaviors that make patients more susceptible to sexually transmitted disease [16–21]. Furthermore, it is important to elicit any incidents of obstetric or sexual or physical trauma as these are not uncommon for patients who present with anorectal complaints [22–25]. Additional helpful information may include prolonged sitting on the commode, lack of physical activity or conversely, extreme activities that require sudden and significant increases of intraabdominal pressure such as weight lifting [13].

Personal history of anorectal, obstetric and gynecologic diseases, in addition to previous anorectal, abdominal, gynecologic and urologic surgery is an important and necessary adjunct to the patient's personal history [26–30]. Moreover, a personal history of inflammatory bowel disease, radiation, and baseline continence are essential for both surgical planning and approach, and managing patient expectations [28, 31, 32]. Obtaining a thorough history that includes specific details of bowel habits and prior surgery cannot be overstated as this will certainly impact decision for surgical intervention, surgical approach, and postoperative management.

Assessment for Ambulatory Surgery

Up to 90% of patients requiring operative interventions for anorectal diseases may be suitable for ambulatory surgery. A comprehensive evaluation will aid in determining eligibility and should include general assessment of preoperative risk profile [33–35]. A personal history of risk factors

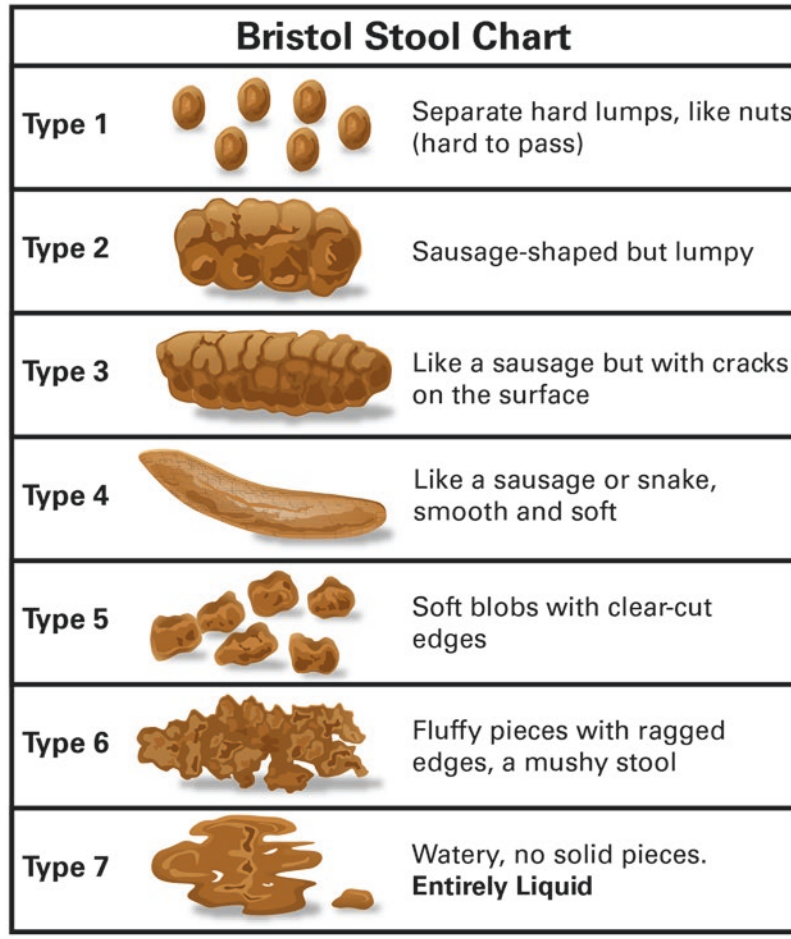


Fig. 2.3 Bristol stool chart. With permission from [3] © Taylor and Francis

that may impact the fitness for ambulatory surgery such as cardiopulmonary disease (including coronary artery disease, valvular heart disease, obstructive sleep apnea, chronic obstructive pulmonary disease), cerebrovascular disease, liver or renal dysfunction, diabetes mellitus, seizure disorder, and bleeding disorders should be obtained [8]. Functional and nutritional assessment, and the use of anticoagulant and antiplatelet medications as well as immunosuppressants should be ascertained [36]. American Society of Anesthesiology (ASA) physical status, magnitude of proposed surgery, type of anesthesia to be utilized, and patient factors such as airway, personal or family history of malignant hyperthermia, and social factors such as support at home and distance from surgery center should also be considered when assessing a patient for ambulatory surgery [36, 37]. Additional preoperative testing such as laboratory testing and electrocardiogram may be necessary; however, in patients who are candidates for ambulatory surgery, routine screening tests have rarely been found to impact the care provided [38–41]. Additional discussion is presented in Chapter 5.

Common Complaints

Bleeding

Bleeding is a distressing yet frequently encountered presenting symptom. Although internal hemorrhoid irritation is the most common cause of painless anorectal bleeding, it is critical to rule out underlying malignancy particularly when the bleeding does not resolve despite intervention. Bleeding should be characterized by its color (bright red versus dark or old blood), amount

(streaks on toilet paper, dripping into the toilet or clots), relationship to stool (blood on surface or mixed within), and duration of bleeding over time. Bleeding should be evaluated in its relationship to straining or activity, stool consistency, change in bowel habits, and pain [8, 9].

Outlet bleeding, or bleeding originating from the most distal rectum/anal canal, is characterized as blood from that is usually bright red and seen on toilet paper or in the toilet bowl. Most commonly, when outlet bleeding is associated with pain or discomfort, it is a result of anal fissures whereas painless bleeding is caused by internal hemorrhoids or proctitis. Concern for malignancy of the lower GI tract is heightened when patients have a personal or family history of colorectal malignancy, complain of dark blood associated with mucous, blood mixed with stool, or patients describe a change in bowel habits [42, 43]. The blood may be episodic but tends to persist over months. Malignancy causes discomfort or pain when the mass is distal in the rectum or anal canal (Fig. 2.4) [44]. Persistent bleeding should be further assessed with a complete endoscopic evaluation of the colon and rectum [45].

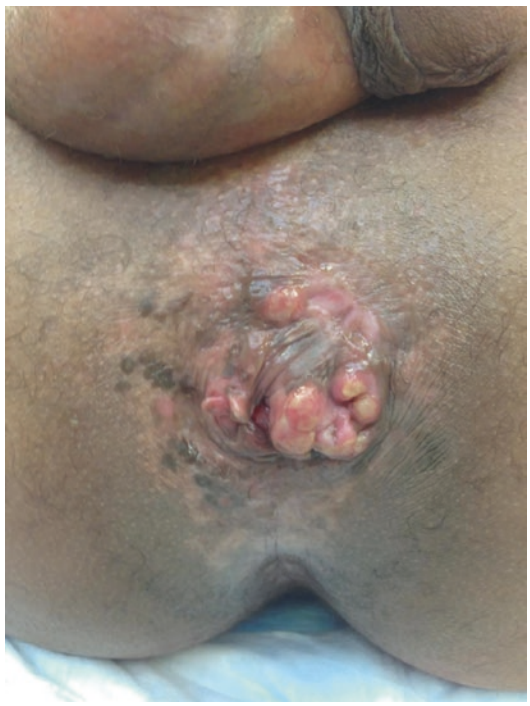


Fig. 2.4 Anal canal cancer

Pain

Pain is a unique symptom and tends to be seen in the context of a limited differential. It should be quantified in severity, duration, and its relation to defecation. It is important to inquire whether pain in the rectum is also associated with abdominal pain, which may indicate a more serious underlying pathology such as inflammatory bowel disease or malignancy [8]. Anal fissures are characterized by sharp, knife-like or tearing anal pain that occurs during and for variable time periods following a bowel movement. Pain can be described as a spasm type of pain and is associated with bright red blood on the toilet paper or dripping into the toilet bowl. Frequently patients have difficulty fully evacuating due to the associated sphincter spasm. Often a patient will recall an episode of severe constipation or diarrhea at the onset of the pain, and patients may complain of a small "mass" due to the presence of a sentinel skin tag or prolapsing papilla, particularly in the chronic setting [46]. Anorectal abscesses are characterized by constant and gradually progressive anorectal pain associated with swelling and fever (Fig. 2.5) [47]. Systemic toxicity is rare but can occur [44, 48]. Urinary dysfunction can occur

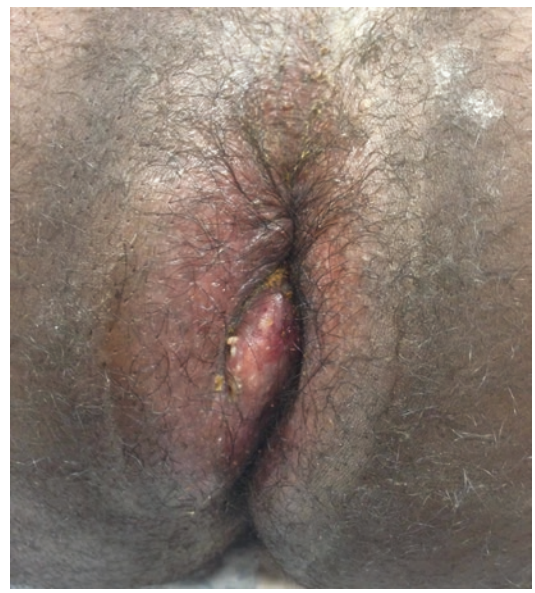


Fig. 2.5 Perianal abscess

particularly with intersphincteric and supralevator abscesses [47]. Fistulas cause pain when the tract closes and pus accumulates [44]. Patients often recall a history of swelling and pain followed by drainage and subsequent relief of the anorectal discomfort (Fig. 2.6) [47].

In general, hemorrhoids do not cause pain, as most patients present with bleeding and tissue prolapse. Patients with symptomatic mixed hemorrhoids develop "flares" when the mixed hemorrhoids become edematous and swollen, often taking days to settle and resolve. On rare occasions, patients can present acutely with an acute "hemorrhoid crisis" which can require emergent surgical intervention particularly in setting of tissue necrosis (Fig. 2.7). Sudden onset, excruciating pain associated with defecation and straining, and the presence of a grape-sized mass is typically a thrombosed external hemorrhoid. Bright red blood may be present as well [45].

Distinct from anorectal abscesses and fistulae are perianal suppurative diseases such as hidradenitis supurativa, skin furuncles, and skin infections from herpes, HIV, tuberculosis, and sexually transmitted diseases such as syphilis. Moreover, underlying Crohn's disease is suspected in the presence of multiple fissures, large skin tags, and abnormal anorectal mucosa [49–51]. Deeper pelvic pain with sitting is often due to levator ani syndrome whereas electric shock-like pain from the levator muscle is attributed to proctalgia fugax [52]. It is important to reiterate that low-lying rectal and anal malignancies can cause pain and must be ruled out. Pain from such malignancies is often associated with blood and mucous discharge [42, 43].

Itching

Perianal itching is common and most often idiopathic but can cause significant quality of life issues. Patients may complain of associated drainage or discharge, and mild bleeding can occur due to perianal skin irritation and scratching. The presence of an associated mass should help narrow down the differential. Patients should be questioned about dermatologic conditions that may also be present in locations outside of the perineal skin such as psoriasis as well as atopic conditions such as skin allergies and asthma. Patients with pruritis ani typically admit to overzealous use of soaps, detergents, wipes and topical preparations while more liquid stool consistency leads to skin irritating residue at the anal verge [53, 54]. Specific foods may trigger symptoms such as tomatoes, citrus fruits, coffee, colas or alcohol [55]. A higher index of suspicion for underlying malignancies should be made in immunosuppressed patients, in patients with open ulcers, masses or persistent symptoms (Fig. 2.8) [56]. Other conditions to consider with complaints of itching are anal condyloma, Paget's disease, high-grade squamous intraepithelial lesions, lichen sclerosis, and bacterial and fungal infections (Fig. 2.9) [57, 58].

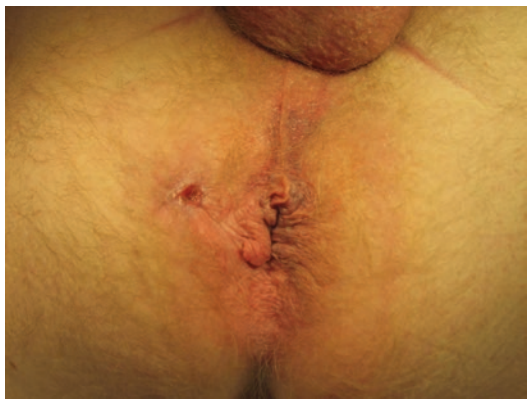


Fig. 2.6 Anal fistula

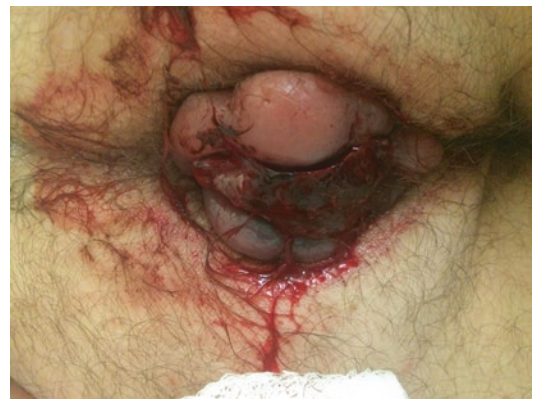


Fig. 2.7 Hemorrhoid crisis

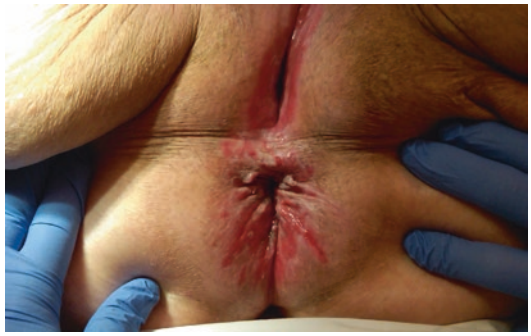


Fig. 2.8 Pruritis ani

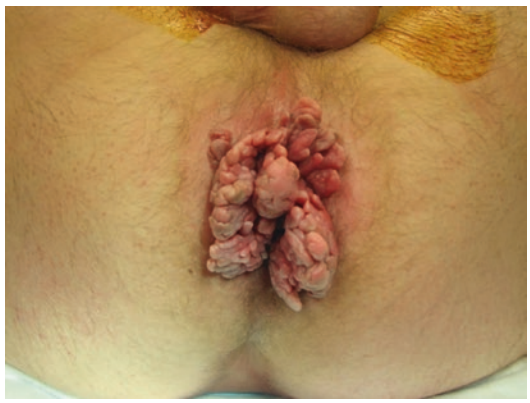


Fig. 2.9 Anal condyloma

Incontinence

Patients complaining of fecal incontinence are often nervous and shameful. They have delayed admitting their complaints following months or years of progressive symptoms. For that reason, they should be made comfortable and approached in a comfortable environment and with an empathetic and calm demeanor. In many situations, incontinence symptoms need to be specifically elicited as many patients will not offer this information.

Onset, duration, timing, and magnitude of symptoms such as severity and frequency of episodes are important to understand. Stool frequency and consistency as well as the use of supplementary fiber should be considered. Patients present with varying degrees of incontinence, from gas only to liquid stool to solid stool. Patients commonly complain of repeated wiping after a bowel movement while others may describe complete loss of control with unrecognized passage of solid stool [59]. Characterization of incontinence is aided by the use of validated fecal incontinence scoring tools such as the Fecal Incontinence Severity Index (FISI) and the Cleveland Clinic Florida Fecal Incontinence score (CCF-FIS)/Wexner score [60]. The use of these instruments is recommended by the American Society of Colon and Rectal Surgeons (ASCRS) to determine the severity of disease, guide appropriate treatment, and to objectively measure response to treatment [28, 61, 60]. The CCF-FIS/Wexner score is the most widely cited fecal incontinence score (Google Scholar October 4, 2018).

Distinguishing between active or urge incontinence and passive incontinence is crucial. Active or urge incontinence is a loss of stool despite conscious efforts whereas passive incontinence occurs when there is a lack of awareness of loss of stool. Active incontinence occurs due to EAS dysfunction with intact sensation and can be the result of a hyposensitive or hypersensitive rectum and a history of obstetric trauma or prior anorectal surgery. Passive incontinence results from IAS dysfunction or dysfunction of the sensory mechanism usually due to neurologic disease, anatomic damage or fecal impaction leading to overflow of liquid stool [59, 62]. A history of previous gynecologic and anorectal surgery as well as a thorough obstetric history including traumatic tears or episiotomies should be obtained as a guide for selecting further diagnostic studies and determining appropriate treatment [29, 63–65].

Constipation

"Constipation" has different meanings to different patients and should be clarified and documented by the clinician. Again, objective tools such as the Bristol Stool Scale to characterize stool and the Rome Criteria to distinguish true functional bowel disorders from patient-reported unacceptable defecation may aid in patient assessment [9, 66]. Constipation may be the result of obstructing masses, mechanical or physiologic outlet obstruction, or colonic inertia, and it is important to distinguish between these in order to provide appropriate

treatment. Obstructing tumors or masses should be excluded in the work up, and can be associated with bleeding, pain or mucous discharge. Patients with outlet obstruction may complain of the urge to defecate but the inability to pass stool as well as straining or the need to digitize the anus or vagina or splint on the perineum [67]. Patients with colonic inertia do not have the urge to defecate and over time patients become uncomfortable due to distension and bloating. These patients ultimately require the use of various laxatives to defecate [48, 68]. It should be emphasized that a history of psychiatric illness and both sexual and physical abuse are commonly encountered in patients who present with complaints of constipation [22–25]. Recent changes in diet or medication may also be considered when evaluating a patient with constipation. Additionally, a history of immobility and endocrine disorders should be obtained [9, 66, 69, 70]. A validated clinical constipation scoring system such as the Cleveland Clinic Florida/Wexner Constipation Score can be useful in distinguishing between these types of constipation as well as quantifying severity and documenting any changes in severity following therapy [71].

Physical Examination

The physical examination should be systematic and focused, with careful attention to the patient's general appearance, abdomen, and finally, the anorectum. It is not uncommon to confuse vaginal or scrotal complaints with anorectal complaints so one should be prepared for a genitourinary exam. The patient should be made comfortable and at ease during the examination as the most amount of information can be gained if the patient is able to tolerate this portion well. Anxiety can be minimized by assuring the patient that the exam is not prolonged or painful, and informing the patient of the steps and providing reassurance throughout [36, 48]. The patient should be allowed to undress alone, and body areas not being examined should be covered at all times [36, 48]. Finally, ensure that a chaperone is in the room during the examination.

The exam room should be clean, well-ventilated, and well-lit. A sink should be available in the room and a toilet at least nearby, preferably adjoining. A portable light or headlight, lubricant, and tissue paper should be available. It is helpful to have enemas and suction available should stool residue limit visualization. Anoscopes should be covered from view yet within reach of the examiner (Fig. 2.10). It is important to have supplies such as local anesthetic, syringes, needles and a scalpel available in the event that small procedures are necessary [72]. Preparation and easy access to instrumentation are critical; delays while searching for equipment can be uncomfortable and anxiety-invoking while reflecting disorganization.

Fig. 2.10 Examination room

Abdominal Examination

The abdominal portion of the exam should be performed while the patient is supine and must include inspection and palpation of all four quadrants from the xiphoid to pubis with attention to surgical incisions and areas where pain may be elicited. Evaluation for abdominal distension, organomegaly or masses should be performed

with attention to stigmata of conditions that may affect surgical treatment such as underlying liver or heart failure. Importantly, inguinal lymph node basins should be examined as these are the primary draining lymph nodes for both benign and malignant anal pathology.

Anorectal Examination

As this is typically most anxiety-invoking event for the patient, it is crucial that the physician set expectations, allay fears, inform the patient of the steps of the exam, and act with discretion throughout the visit. Only a relaxed patient will allow and tolerate a thorough examination. In addition to having a chaperone to witness the procedure, a nurse or medical assistant may be useful to help retract the buttocks and assist in procedures if necessary. Again, cover portions of the body that are not being examined.

Consideration of patient positioning is critical. The most commonly used position is the left lateral decubitus position (Sims position) with the hips on the edge of the table. Alternatively, the patient may be in prone jackknife or lithotomy position but these positions require special tables and may be difficult for patients with certain conditions (late pregnancy, orthopedic limitations, or recent abdominal surgery) (Fig. 2.11). No position is superior to the other and should be chosen based on examiner and patient comfort with the goal being to obtain the best visualization possible. However, from the author's perspective, the lateral position seems to be better accepted compared to the awkward prone position. However, at one of the editors prefers the prone position as it provides better exposure and allows the examiner to stand. The examiner sits on a stool or stands with illumination provided by a portable light or head light. The anorectal examination involves three distinct components: visual inspection, external palpation, and digital rectal exam.

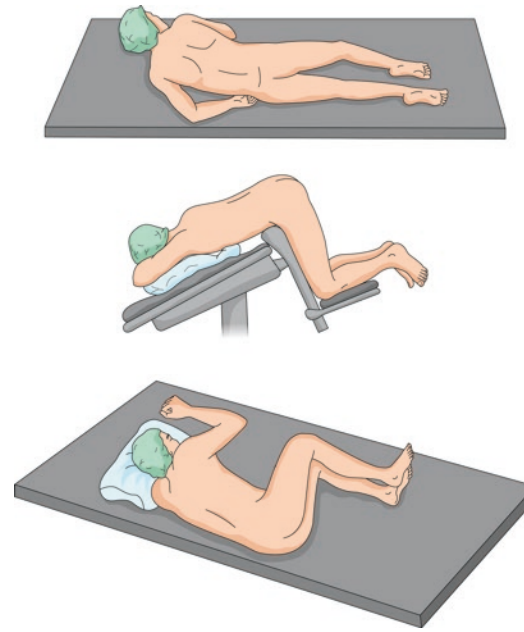


Fig. 2.11 Patient positioning. Upper figure: Sims; Middle Figure: Prone Jacknife; Lower Figure: Left lateral

Visual Inspection

Visual inspection should commence at the sacrococcygeal region to evaluate for pilonidal disease followed by the overlying skin of the ischioanal spaces. Evaluate for maceration, ulceration, drainage sites, lesions and masses. The buttocks are then parted and the anus is gently and slowly effaced. The entire perineum is evaluated for nodules, external hemorrhoids, skin tags, external fistula openings, and scarring followed by inspection of the anal verge for fissures, ulcers and prolapsing tissue as well as purulent or bloody discharge. The perineum and anus are further evaluated for dermatologic diseases or stigmata of other diseases such as sentinel piles or lateral fissures characteristic of anal fissures and Crohn's disease respectively as well as lichenification and ulcerations characteristic of pruritis ani and High-grade squamous intraepithelial lesions or Paget's disease [73]. The patient should be asked to strain to evaluate for anal masses, rectal prolapse, and perineal descent as well as evaluating for seepage and the quality of the perineal body. Visualization alone should be able to diagnose a significant number of anorectal pathology including external hemorrhoids, condyloma, prolapse, or fissures. A patulous anus can be appreciated and may indicate prolapse or the underlying etiology of fecal incontinence.

External Palpation

Palpation should follow visual inspection in a stepwise fashion. First, while evaluating the sacrococcygeal region and the ischioanal spaces. Then, once the buttocks are effaced and visual inspection of the perineum and anal verge are performed, the perineum should be palpated for fluctuance and induration, as well as for fistula tracts or masses. The anal verge is palpated to elicit pain or discomfort as well as to characterize any masses or lesions discovered.

Digital Rectal Examination

Prior to inserting the finger, apply gentle pressure to the anus to deliver a warning to the patient and to initiate sphincter relaxation. Gently and slowly insert a well-lubricated finger to assess for tenderness or discomfort of both the anal canal and perianal skin, scarring or stricturing, induration, mucosal abnormalities or masses, rectoceles and evaluation of stool presence and consistency. The finger should be slowly and carefully rotated 360 degrees to evaluate the entire circumference of the anal canal. Sphincter tone at rest and with voluntary squeeze, and the ability of the puborectalis to relax as indicated by descent coupled with posterior movement while bearing down should also be evaluated which provides information about defecatory function [74–77]. Bearing down may also allow an intrarectal mass to reach the examiner's finger. Additional maneuvers should include firm palpation of the puborectalis and levators as well as a bimanual exam of the coccyx in patients who complain of pain indicative of levator ani syndrome and coccyxdynia respectively. The presacral region posterior to the rectum can be palpated for masses. Thickness of perineal body and laxity of rectal wall should be assessed particularly in patients who complain of incontinence and defecation difficulties [78]. Once the examining finger is removed, any evidence of blood or purulence is noted as well as stool consistency. When a painful diagnosis such as an anal fissure is discovered on inspection, this portion of the exam should be deferred since it is unlikely to provide additional information in the acute setting. If a patient will not tolerate a digital rectal examination then the evaluation should be done with the assistance of sedation, either combined with endoscopy or, when indicated, in the operating room [79].

Diagnostic Studies

The clinician should have a good sense of the diagnosis following the history and physical examination. In certain situations, additional diagnostic studies need be performed to confirm the diagnosis, gather additional data, and aid in preoperative planning.

Anoscopy

Anoscopy is the most widely used tool when evaluating patients with anorectal complaints. It is inexpensive, simple, and an important adjunct to the examination. In fact, anoscopic examination should be performed for every patient with anorectal complaints unless limited by pain, such as patients with anal fissure or abscess. Often these patients are also unable to tolerate a digital exam. Evaluation of the distal rectum, anal canal, and anoderm can be performed using a tapered anoscope with a diameter no larger than 20–30 mm (Fig. 2.12) [59, 80]. Anoscopy is always preceded by digital rectal exam, which allows relaxation of the sphincter, and verbal consent from the patient. The well-lubricated scope and its obturator are gently inserted with constant gradual pressure. The use of 2% lidocaine jelly is rarely needed. However, a smaller scope may be necessary if stenosis is encountered. The obturator is removed and inspection of all quadrants of the anal canal is performed. Rather than simply rotating the scope while in the anal canal, the obturator must be reinserted into the scope prior to rotation to prevent sliding of mucosa when moving from one quadrant to the next. Alternatively, the anoscope can be repeatedly withdrawn and reinserted at a different orientation. These maneuvers also help to prevent discomfort and tearing in the anoderm [48, 59]. Internal hemorrhoids, friable mucosa, fissures, abscesses and fistulas, condyloma, hypertrophied anal papilla, proctitis, and masses are evaluated and biopsies and cultures are taken if necessary.

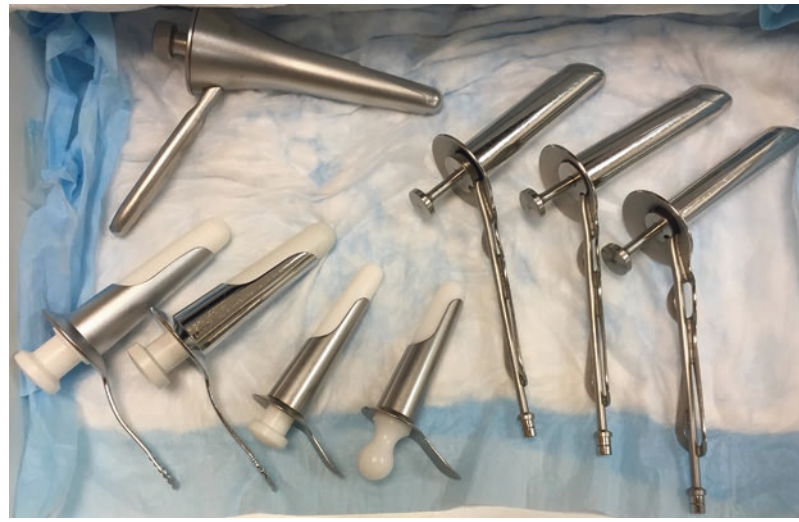


Fig. 2.12 Anoscopes

To detect internal hemorrhoidal, mucosal, or rectal prolapse, the patient may be asked to strain upon withdrawal of the scope [59, 81–83]. Anoscopy does not require bowel preparation and patient sedation is not necessary. Again, it is not recommended that anoscopy be performed in patients with known anal fissures or in patients who demonstrate significant discomfort during the digital rectal exam.

Proctoscopy

Further evaluation of the anorectum up to the distal sigmoid colon can be performed with proctoscopy and is considered the most accurate method to determine the exact location of a rectal lesion when compared to flexible endoscopy [84]. Similar to anoscopy, sedation is not necessary, however, enemas are generally required to clear the rectum of solid stool. The standard proctoscope is equipped with a light source and is 25 cm long. The outside diameter measures 19 mm although smaller diameter scopes are available if needed (11 and 15 mm) [83, 84].

In either the prone jackknife position or left lateral decubitus position, the perineum and anus are inspected followed by digital rectal examination and finally, gentle insertion of both the proctoscope and its obturator aimed posteriorly toward the sacrum initially. Once the proctoscope is inserted beyond the sphincter complex, the obturator is removed and the rectum is insufflated to visualize the area of interest. The trajectory of the rectum changes from posterior to anterior, and the examiner must follow the course of the rectum while insufflating the lumen. Generally the proctoscope can be inserted no more than 20 cm due to tight angulation at the rectosigmoid junction and the likelihood of producing crampy visceral discomfort [85]. Insertion is performed slowly under direct visualization. The proctoscope is then withdrawn in a sweeping fashion to flatten the rectal valves and allow full evaluation of all walls of the rectum. The anal canal is visualized but is generally better evaluated with a slotted anoscope. Suction can be used through the proctoscope to clear any residual stool or mucous. Prior to complete withdrawal of the proctoscope, the window is opened to allow release of any retained air.

Proctoscopy is used to assess a variety of anorectal diseases including proctitis and ulcers, and is most commonly used to rule out malignancy and evaluate rectal cancer location (distance from anal verge, anterior/posterior location). While not commonly performed in the office setting, biopsies and polypectomies can be performed, foreign bodies can be removed and topical therapies such as formalin can be applied for patients with radiation proctitis [59].

Although incredibly rare (0.005–0.01% incidence and the result of inexperience or over aggressiveness), great care must be taken to prevent perforation from using the proctoscope, and concern should be heightened in patients who become ill following the procedure [81, 82]. Additionally, anal tears and subsequent bleeding may occur from performing proctoscopy [82, 83]. The most common presenting symptoms include pain (33%) and discomfort (13%) [86].

Flexible Sigmoidoscopy

Flexible endoscopic evaluation allows a greater length of intestine to be evaluated with better magnification, optics and patient tolerance [87, 88]. A flexible sigmoidoscope is 60 cm in length and typically allows visualization up to the splenic flexure [89, 90]. Two Fleets enemas the day of the procedure are used to prepare for sigmoidoscopy, which may be performed without any sedation, depending on patient comfort. However, proper training is required and the procedure must be performed by a technician comfortable and experienced with the endoscopic equipment [83]. Additional advantages to using flexible sigmoidoscopy include a lower cost and easier maintenance when compared to colonoscopy, and can be performed at the bedside in an acute or an intensive care unit setting [59]. Potential complications of flexible endoscopy are rare and include abdominal distension and discomfort, bradycardia, subcutaneous or mediastinal emphysema, perforation (0.01%), and bleeding following biopsy or polyp removal [82, 83, 91].

Endoluminal Ultrasound

Ultrasound of the anus and rectum is a valuable diagnostic tool for both benign and malignant diseases. Endoanal ultrasound (EAUS) allows detailed evaluation of anal sphincter anatomy and any abnormalities related to fecal incontinence with sensitivity and specificity of locating a sphincter defect approaching 100% [92]. In addition, endoanal ultrasound can be used to identify and characterize abscesses and fistulas, and to evaluate patients with anal pain or perianal Crohn's disease [59]. Endorectal ultrasound (ERUS) is most commonly utilized for staging of rectal cancer, and has become a critical component in determining both tumor depth as well as regional lymph node status with T stage accuracy ranging from 63 to 93% and N stage accuracy ranging from 50 to 83% [93].

Endorectal ultrasound in 2D and 3D modes utilizing a 1850 rotating probe and 10–16 MHz transducer (BK Medical Systems Inc., Peabody, MA, USA) is performed by placing the patient in the left lateral decubitus position. Fleets enemas are used for bowel preparation and no sedation is required. A digital rectal exam and proctoscopy are performed. The proctoscope is left in place so that the handheld probe is inserted through the proctoscope to the level of interest. The proctoscope is withdrawn creating space for the latex balloon to fill and the entire rectum and anal canal are evaluated, with specific focus on the lesion of interest. The main advantages of ERUS are that it is fast, inexpensive and does not require sedation or ionizing radiation. However, ERUS is operator-dependent making reliability and accuracy a real concern [2].

Computed Tomography

Computed tomography (CT) is commonly used to evaluate diseases of the colon and rectum. Using a combination of oral and rectal contrast to opacity the bowel as well as intravenous contrast to further delineate intraabdominal anatomy, high-resolution images are captured [94–96]. Despite significant advances in diagnostic capability in detecting diseases such as diverticulitis and colorectal malignancies, rectal and pelvic floor structures demonstrate poor resolution and CT is limited in evaluating anoperineal sepsis [48]. Additionally, radiation exposure and use of iodinated contrast agents may limit the use of CT in some patient populations.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) has proven to be beneficial in evaluating complex fistulas and sphincter anatomy in patients with fecal incontinence as it provides higher resolution of pelvic structures due to smaller viewing fields dedicated to the area of interest. Additionally, MRI is able to characterize ischioanal and perirectal abscesses and fistulas better than digital rectal exam and CT respectively [97, 98]. Similarly, MRI has evolved as the preferred method of staging rectal malignancies with similar sensitivities for T and N stage as ERUS as well as clearer determination of lateral/circumferential margin status [99]. Beyond finer tissue detail, benefits of MRI over CT are the ability to avoid the use of iodinated contrast agents and ionizing radiation [100, 101].

Physiologic Testing

Reflecting the complexity of normal anorectal function, multiple tests are necessary to complete a comprehensive evaluation of pelvic floor disorders [102, 103]. Commonly used tests include anorectal manometry, balloon expulsion, neurophysiologic testing including pudendal nerve terminal motor latency (PNTML) and electromyography (EMG), anatomic assessment with EAUS and MRI, perineometry, defecography studies, and gastrointestinal transit studies. It should be reiterated that each of these test should be performed to complement and provide additional data beyond the thorough history and physical with the goal of instituting an appropriate management plan [59, 104].

Anorectal manometry measures the intraluminal pressures of the anal canal and the distal rectum to reflect internal and external sphincter function, and is most frequently used to evaluate fecal incontinence. Anorectal manometry can evaluate functional outlet obstruction by measuring changes in pressure during attempted defecation, Hirschsprung's disease by the absence of the recto-anal inhibitory reflex (RAIR), and sacral reflex arc damage [105–108]. It is particularly valuable when evaluating baseline function prior to performing any anorectal or pelvic floor procedures that may impact continence [28]. A frequently used adjunct to anal manometry is the balloon expulsion test, which evaluates the ability of the rectum to expel a balloon and diagnose obstructed defectation. Neurophysiologic testing includes PNTML and EMG. PNTML measures the integrity of motor innervation of the pelvic floor. It is useful in patients with fecal incontinence, constipation, and rectal prolapse. PNTML is performed by placing a St. Mark's electrode on the examiner's finger and inserting it into the rectum to stimulate the pudendal nerve. Any abnormal latency period is considered to be pudendal neuropathy. EMG evaluates appropriate EAS relaxation and contraction as well as potential nerve injury [109, 110]. Perineometry measures perineal descent in patients with fecal incontinence. Defecography studies with dynamic fluoroscopy and dynamic MR evaluate the function of the pelvic floor during rectal evacuation and anorectal anatomic abnormalities such as cystocele, enterocele, rectocele, and rectal prolapse and intussusception [111–113]. Finally, gastrointestinal transit studies including the colonic marker study use radiopaque markers and serial plain radiographs for up to 5 days to assess gastrointestinal motility in patients with constipation. Greater than 20% retention of the radiopaque markers is considered abnormal but distribution pattern can distinguish slow transit constipation from pelvic outlet dysfunction [114–116].

Summary

A focused but thorough history and careful and directed physical examination should accurately diagnose the majority of anorectal complaints. The patient should be made to feel at ease throughout the process, including the discussion and the anorectal examination. The use of diagnostic studies is thoughtfully considered in relation to the patient's presenting symptoms and exam, and should be used to confirm the presumed diagnosis, gather additional information and aid in preoperative planning.

Acknowledgments This chapter was written by Patricia L. Roberts, MD in the previous edition of this textbook. The authors would like to acknowledge W. Brian Sweeney, MD for providing photographs and Paul Trombley for creating the medical illustrations.

References

1. Roberts PL. Patient evaluation. In: Beck DE, editor. Fundamentals of anorectal surgery. 2nd ed. London: WB Saunders; 1992. p. 25–36.
2. Barleben A, Mills S. Anorectal anatomy and physiology. Surg Clin North Am. 2010;90(1):1–15.
3. Grigorescu BA, Lazarou G, Olson TR, Downie SA, Powers K, Greston WM, et al. Innervation of the levator ani muscles: description of the nerve branches to the pubococcygeus, iliococcygeus, and puborectalis muscles. Int Urogynecol J Pelvic Floor Dysfunct. 2008;19(1):107–16.
4. Habr-Gama JMNJA. Anatomy and embryology. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 1–22.
5. Network NCC. Anal carcinoma. In: NCCN guidelines: anal carcinoma [Internet]; 2016.
6. Abcarian H. Anorectal infection: abscess-fistula. Clin Colon Rectal Surg. 2011;24(1):14–21.
7. Singer M. Hemorrhoids. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 175–202.
8. Michael RB, Keighley NSW, Church JM, Pahlman L, Scholefield JH, Scott NA. Running a colorectal surgery service. In: Keighley MR, editor. Surgery of the anus, rectum and colon. 3rd ed. Philadelphia: Elsevier; 2008. p. 47–67.
9. Ternent CA, Bastawrous AL, Morin NA, Ellis CN, Hyman NH, Buie WD, et al. Practice parameters for the evaluation and management of constipation. Dis Colon Rectum. 2007;50(12):2013–22.
10. Brandt LJ, Prather CM, Quigley EM, Schiller LR, Schoenfeld P, Talley NJ. Systematic review on the management of chronic constipation in North America. Am J Gastroenterol. 2005;100(Suppl 1):S5–S21.
11. Whitehead WE, Palsson OS, Feld AD, Levy RL, VON Korff M, Turner MJ, et al. Utility of red flag symptom exclusions in the diagnosis of irritable bowel syndrome. Aliment Pharmacol Ther. 2006;24(1):137–46.
12. Lewis SJ, Heaton KW. Stool form scale as a useful guide to intestinal transit time. Scand J Gastroenterol. 1997;32(9):920–4.
13. Johannsson HO, Graf W, Påhlman L. Bowel habits in hemorrhoid patients and normal subjects. Am J Gastroenterol. 2005;100(2):401–6.
14. Walter S, Hallböök O, Gotthard R, Bergmark M, Sjödahl R. A population-based study on bowel habits in a Swedish community: prevalence of faecal incontinence and constipation. Scand J Gastroenterol. 2002;37(8):911–6.
15. Osterberg A, Graf W, Karlbom U, Påhlman L. Evaluation of a questionnaire in the assessment of patients with faecal incontinence and constipation. Scand J Gastroenterol. 1996;31(6):575–80.
16. Park IU, Ogilvie JW, Anderson KE, Li ZZ, Darrah L, Madoff R, et al. Anal human papillomavirus infection and abnormal anal cytology in women with genital neoplasia. Gynecol Oncol. 2009;114(3):399–403.
17. Park IU, Introcaso C, Dunne EF. Human papillomavirus and genital warts: a review of the evidence for the 2015 Centers for Disease Control and Prevention sexually transmitted diseases treatment guidelines. Clin Infect Dis. 2015;61(Suppl 8):S849–55.
18. Welton ML, Sharkey FE, Kahlenberg MS. The etiology and epidemiology of anal cancer. Surg Oncol Clin N Am. 2004;13(2):263–75.
19. Frisch M, Glimelius B, van den Brule AJ, Wohlfahrt J, Meijer CJ, Walboomers JM, et al. Sexually transmitted infection as a cause of anal cancer. N Engl J Med. 1997;337(19):1350–8.
20. Daling JR, Weiss NS, Hislop TG, Maden C, Coates RJ, Sherman KJ, et al. Sexual practices, sexually transmitted diseases, and the incidence of anal cancer. N Engl J Med. 1987;317(16):973–7.
21. Palefsky JM, Holly EA, Ralston ML, Jay N, Berry JM, Darragh TM. High incidence of anal high-grade squamous intra-epithelial lesions among HIV-positive and HIV-negative homosexual and bisexual men. AIDS. 1998;12(5):495–503.
22. Imhoff LR, Liwanag L, Varma M. Exacerbation of symptom severity of pelvic floor disorders in women who report a history of sexual abuse. Arch Surg. 2012;147(12):1123–9.
23. Leserman J, Drossman DA. Relationship of abuse history to functional gastrointestinal disorders and symptoms: some possible mediating mechanisms. Trauma Violence Abuse. 2007;8(3):331–43.
24. Leroi AM, Berkelmans I, Denis P, Hémond M, Devroede G. Anismus as a marker of sexual abuse. Consequences of abuse on anorectal motility. Dig Dis Sci. 1995;40(7):1411–6.
25. Drossman DA, Leserman J, Nachman G, Li ZM, Gluck H, Toomey TC, et al. Sexual and physical abuse in women with functional or organic gastrointestinal disorders. Ann Intern Med. 1990;113(11):828–33.
26. Townsend MK, Matthews CA, Whitehead WE, Grodstein F. Risk factors for fecal incontinence in older women. Am J Gastroenterol. 2013;108(1):113–9.
27. Wald A. Clinical practice. Fecal incontinence in adults. N Engl J Med. 2007;356(16):1648–55.
28. Paquette IM, Varma MG, Kaiser AM, Steele SR, Rafferty JF. The American Society of Colon and Rectal Surgeons' clinical practice guideline for the treatment of fecal incontinence. Dis Colon Rectum. 2015;58(7):623–36.

29. Madoff RD, Parker SC, Varma MG, Lowry AC. Faecal incontinence in adults. Lancet. 2004;364(9434):621–32.
30. Ditah I, Devaki P, Luma HN, Ditah C, Njei B, Jaiyeoba C, et al. Prevalence, trends, and risk factors for fecal incontinence in United States adults, 2005-2010. Clin Gastroenterol Hepatol. 2014;12(4):636–643.e1–2.
31. Nordgren S, Fasth S, Hultén L. Anal fistulas in Crohn's disease: incidence and outcome of surgical treatment. Int J Color Dis. 1992;7(4):214–8.
32. Bernard S, Ouellet MP, Moffet H, Roy JS, Dumoulin C. Effects of radiation therapy on the structure and function of the pelvic floor muscles of patients with cancer in the pelvic area: a systematic review. J Cancer Surviv. 2016;10:351–62.
33. Smith LE. Ambulatory surgery for anorectal diseases: an update. South Med J. 1986;79(2):163–6.
34. Lam TY, Lam SC, Kwok SP. Feasibility case-controlled study of day-case haemorrhoidectomy. ANZ J Surg. 2001;71(11):652–4.
35. Li S, Coloma M, White PF, Watcha MF, Chiu JW, Li H, et al. Comparison of the costs and recovery profiles of three anesthetic techniques for ambulatory anorectal surgery. Anesthesiology. 2000;93(5):1225–30.
36. Rafferty JF. Preoperative management. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 125–36.
37. Ternent CA, Fleming F, Welton ML, Buie WD, Steele S, Rafferty J, et al. Clinical practice guideline for ambulatory anorectal surgery. Dis Colon Rectum. 2015;58(10):915–22.
38. Kaplan EB, Sheiner LB, Boeckmann AJ, Roizen MF, Beal SL, Cohen SN, et al. The usefulness of preoperative laboratory screening. JAMA. 1985;253(24):3576–81.
39. Turnbull JM, Buck C. The value of preoperative screening investigations in otherwise healthy individuals. Arch Intern Med. 1987;147(6):1101–5.
40. Suchman AL, Mushlin AI. How well does the activated partial thromboplastin time predict postoperative hemorrhage? JAMA. 1986;256(6):750–3.
41. Freeman WK, Gibbons RJ, Shub C. Preoperative assessment of cardiac patients undergoing noncardiac surgical procedures. Mayo Clin Proc. 1989;64(9):1105–17.
42. Fijten GH, Starmans R, Muris JW, Schouten HJ, Blijham GH, Knottnerus JA. Predictive value of signs and symptoms for colorectal cancer in patients with rectal bleeding in general practice. Fam Pract. 1995;12(3):279–86.
43. Ellis BG, Thompson MR. Factors identifying higher risk rectal bleeding in general practice. Br J Gen Pract. 2005;55(521):949–55.
44. Beck DE. Benign and malignant rectal, anal, and perineal problems. In: Ashley SW, editor. ACS surgery. Seventh ed. Toronto: Decker; 2014.
45. Rivadeneira DE, Steele SR, Ternent C, Chalasani S, Buie WD, Rafferty JL, et al. Practice parameters for the management of hemorrhoids (revised 2010). Dis Colon Rectum. 2011;54(9):1059–64.
46. Rocco Ricciardi SLD, Madoff RD. Anal fissure. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 203–18.
47. Vasilevsky C-A. Anorectal abscess and fistula. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 219–44.
48. Thacker JKM. Diagnosis of colon, rectal, and anal disease. In: Yeo CJ, editor. Shackelford's surgery of the alimentary tract. Seventh ed. Philadelphia: Elsevier; 2013. p. 1740–55.
49. Billingham RP, Isler JT, Kimmins MH, Nelson JM, Schweitzer J, Murphy MM. The diagnosis and management of common anorectal disorders. Curr Probl Surg. 2004;41(7):586–645.
50. Buchmann P, Keighley MR, Allan RN, Thompson H, Alexander-Williams J. Natural history of perianal Crohn's disease. Ten year follow-up: a plea for conservatism. Am J Surg. 1980;140(5):642–4.
51. Steele SR, Kumar R, Feingold DL, Rafferty JL, Buie WD, Surgeons SPTFotASoCaR. Practice parameters for the management of perianal abscess and fistula-in-ano. Dis Colon Rectum. 2011;54(12):1465–74.
52. Bharucha AE, Wald A, Enck P, Rao S. Functional anorectal disorders. Gastroenterology. 2006;130(5):1510–8.
53. Caplan RM. The irritant role of feces in the genesis of perianal itch. Gastroenterology. 1966;50(1):19–23.
54. Allan A, Ambrose NS, Silverman S, Keighley MR. Physiological study of pruritus ani. Br J Surg. 1987;74(7):576–9.
55. Ansari P. Pruritus ani. Clin Colon Rectal Surg. 2016;29(1):38–42.
56. Daniel GL, Longo WE, Vernava AM. Pruritus ani. Causes and concerns. Dis Colon Rectum. 1994;37(7):670–4.
57. Marfing TE, Abel ME, Gallagher DM. Perianal Bowen's disease and associated malignancies. Results of a survey. Dis Colon Rectum. 1987;30(10):782–5.
58. Marchesa P, Fazio VW, Oliart S, Goldblum JR, Lavery IC. Perianal Bowen's disease: a clinicopathologic study of 47 patients. Dis Colon Rectum. 1997;40(11):1286–93.
59. Kumar AARR. Diagnostic evaluations. In: Bailey HR, editor. Colorectal surgery. Philadelphia: Saunders; 2013. p. 17–40.
60. Jorge JM, Wexner SD. Etiology and management of fecal incontinence. Dis Colon Rectum. 1993;36(1):77–97.
61. Rockwood TH, Church JM, Fleshman JW, Kane RL, Mavrantonis C, Thorson AG, et al. Patient and surgeon ranking of the severity of symptoms associated with fecal incontinence: the fecal incontinence severity index. Dis Colon Rectum. 1999;42(12):1525–32.
62. Gee AS, Durdey P. Urge incontinence of faeces is a marker of severe external anal sphincter dysfunction. Br J Surg. 1995;82(9):1179–82.

63. Markland AD, Goode PS, Burgio KL, Redden DT, Richter HE, Sawyer P, et al. Incidence and risk factors for fecal incontinence in black and white older adults: a population-based study. J Am Geriatr Soc. 2010;58(7):1341–6.
64. Johnson JK, Lindow SW, Duthie GS. The prevalence of occult obstetric anal sphincter injury following childbirth—literature review. J Matern Fetal Neonatal Med. 2007;20(7):547–54.
65. Qureshi MS, Rao MM, Sasapu KK, Casey J, Qureshi MU, Sadat U, et al. Male faecal incontinence presents as two separate entities with implications for management. Int J Color Dis. 2011;26(12):1589–94.
66. Longstreth GF, Thompson WG, Chey WD, Houghton LA, Mearin F, Spiller RC. Functional bowel disorders. Gastroenterology. 2006;130(5):1480–91.
67. Beck DE, Allen NL. Rectocele. Clin Colon Rectal Surg. 2010;23(2):90–8.
68. Krevsky B, Malmud LS, D'Ercole F, Maurer AH, Fisher RS. Colonic transit scintigraphy. A physiologic approach to the quantitative measurement of colonic transit in humans. Gastroenterology. 1986;91(5):1102–12.
69. Preston DM, Lennard-Jones JE. Severe chronic constipation of young women: 'idiopathic slow transit constipation'. Gut. 1986;27(1):41–8.
70. Walsh PV, Peebles-Brown DA, Watkinson G. Colectomy for slow transit constipation. Ann R Coll Surg Engl. 1987;69(2):71–5.
71. Agachan F, Chen T, Pfeifer J, Reissman P, Wexner SD. A constipation scoring system to simplify evaluation and management of constipated patients. Dis Colon Rectum. 1996;39(6):681–5.
72. Simon T. Minor office procedures. Clin Colon Rectal Surg. 2005;18(4):255–60.
73. Sahai A, Kodner IJ. Premalignant neoplasms and squamous cell carcinoma of the anal margin. Clin Colon Rectal Surg. 2006;19(2):88–93.
74. Keating JP, Stewart PJ, Eyers AA, Warner D, Bokey EL. Are special investigations of value in the management of patients with fecal incontinence? Dis Colon Rectum. 1997;40(8):896–901.
75. Hallan RI, Marzouk DE, Waldron DJ, Womack NR, Williams NS. Comparison of digital and manometric assessment of anal sphincter function. Br J Surg. 1989;76(9):973–5.
76. Times ML, Reickert CA. Functional anorectal disorders. Clin Colon Rectal Surg. 2005;18(2):109–15.
77. Hill J, Corson RJ, Brandon H, Redford J, Faragher EB, Kiff ES. History and examination in the assessment of patients with idiopathic fecal incontinence. Dis Colon Rectum. 1994;37(5):473–7.
78. Dobben AC, Terra MP, Deutekom M, Gerhards MF, Bijnen AB, Felt-Bersma RJ, et al. Anal inspection and digital rectal examination compared to anorectal physiology tests and endoanal ultrasonography in evaluating fecal incontinence. Int J Color Dis. 2007;22(7):783–90.
79. Henderson PK, Cash BD. Common anorectal conditions: evaluation and treatment. Curr Gastroenterol Rep. 2014;16(10):408.
80. Kelly SM, Sanowski RA, Foutch PG, Bellapravalu S, Haynes WC. A prospective comparison of anoscopy and fiberendoscopy in detecting anal lesions. J Clin Gastroenterol. 1986;8(6):658–60.
81. Gilbertsen VA. Proctosigmoidoscopy and polypectomy in reducing the incidence of rectal cancer. Cancer. 1974;34(3):suppl:936–9.
82. Nelson RL, Abcarian H, Prasad ML. Iatrogenic perforation of the colon and rectum. Dis Colon Rectum. 1982;25(4):305–8.
83. Whitlow CB. Endoscopy. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 63–75.
84. Schoellhammer HF, Gregorian AC, Sarkisyan GG, Petrie BA. How important is rigid proctosigmoidoscopy in localizing rectal cancer? Am J Surg. 2008;196(6):904–8. discussion 8.
85. Nivatvongs S, Fryd DS. How far does the proctosigmoidoscope reach? A prospective study of 1000 patients. N Engl J Med. 1980;303(7):380–2.
86. Takahashi T, Zarate X, Velasco L, Mass W, Garcia-Osogobio S, Jimenez R, et al. Rigid rectosigmoidoscopy: still a well-tolerated diagnostic tool. Rev Investig Clin. 2003;55(6):616–20.
87. Marks G, Boggs HW, Castro AF, Gathright JB, Ray JE, Salvati E. Sigmoidoscopic examinations with rigid and flexible fiberoptic sigmoidoscopes in the surgeon's office: a comparative prospective study of effectiveness in 1,012 cases. Dis Colon Rectum. 1979;22(3):162–8.
88. Winnan G, Berci G, Panish J, Talbot TM, Overholt BF, McCallum RW. Superiority of the flexible to the rigid sigmoidoscope in routine proctosigmoidoscopy. N Engl J Med. 1980;302(18):1011–2.
89. Lehman GA, Buchner DM, Lappas JC. Anatomical extent of fiberoptic sigmoidoscopy. Gastroenterology. 1983;84(4):803–8.
90. Ott DJ, Wu WC, Gelfand DW. Extent of colonic visualization with the fiberoptic sigmoidoscope. J Clin Gastroenterol. 1982;4(4):337–41.
91. Lohsiriwat V, Sujarittanakarn S, Akaraviputh T, Lertakyamanee N, Lohsiriwat D, Kachinthorn U. What are the risk factors of colonoscopic perforation? BMC Gastroenterol. 2009;9:71.
92. Deen KI, Kumar D, Williams JG, Olliff J, Keighley MR. Anal sphincter defects. Correlation between endoanal ultrasound and surgery. Ann Surg. 1993;218(2):201–5.
93. Wong DGKWD. Endoluminal ultrasound. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 107–23.
94. Horton KM, Corl FM, Fishman EK. CT evaluation of the colon: inflammatory disease. Radiographics. 2000;20(2):399–418.
95. Horton KM, Abrams RA, Fishman EK. Spiral CT of colon cancer: imaging features and role in management. Radiographics. 2000;20(2):419–30.
96. Hulnick DH, Megibow AJ, Balthazar EJ, Naidich DP, Bosniak MA. Computed tomography in the evaluation of diverticulitis. Radiology. 1984;152(2):491–5.

97. Buchanan GN, Halligan S, Bartram CI, Williams AB, Tarroni D, Cohen CR. Clinical examination, endosonography, and MR imaging in preoperative assessment of fistula in ano: comparison with outcome-based reference standard. Radiology. 2004;233(3):674–81.
98. Maruyama R, Noguchi T, Takano M, Takagi K, Morita N, Kikuchi R, et al. Usefulness of magnetic resonance imaging for diagnosing deep anorectal abscesses. Dis Colon Rectum. 2000;43(10 Suppl): S2–5.
99. National Accreditation Program for Rectal Cancer, American College of Surgeons. https://www.facs.org/quality-programs/cancer/naprc.
100. Baker ME, Einstein DM, Veniero JC. Computed tomography enterography and magnetic resonance enterography: the future of small bowel imaging. Clin Colon Rectal Surg. 2008;21(3):193–212.
101. Berman L, Israel GM, McCarthy SM, Weinreb JC, Longo WE. Utility of magnetic resonance imaging in anorectal disease. World J Gastroenterol. 2007;13(23):3153–8.
102. Leigh RJ, Turnberg LA. Faecal incontinence: the unvoiced symptom. Lancet. 1982;1(8285):1349–51.
103. Jorge JM, Wexner SD. Anatomy and physiology of the rectum and anus. Eur J Surg. 1997;163(10):723–31.
104. Mellgren AF. Physiologic testing. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 49–61.
105. Bharucha AE. Outcome measures for fecal incontinence: anorectal structure and function. Gastroenterology. 2004;126(1 Suppl 1):S90–8.
106. Bharucha AE. Pro: anorectal testing is useful in fecal incontinence. Am J Gastroenterol. 2006;101(12):2679–81.
107. Deutekom M, Dobben AC, Terra MP, Engel AF, Stoker J, Bossuyt PM, et al. Clinical presentation of fecal incontinence and anorectal function: what is the relationship? Am J Gastroenterol. 2007;102(2):351–61.
108. Lam TJ, Kuik DJ, Felt-Bersma RJ. Anorectal function evaluation and predictive factors for faecal incontinence in 600 patients. Color Dis. 2012;14(2):214–23.
109. Snooks SJ, Henry MM, Swash M. Anorectal incontinence and rectal prolapse: differential assessment of the innervation to puborectalis and external anal sphincter muscles. Gut. 1985;26(5):470–6.
110. Kiff ES, Swash M. Normal proximal and delayed distal conduction in the pudendal nerves of patients with idiopathic (neurogenic) faecal incontinence. J Neurol Neurosurg Psychiatry. 1984;47(8):820–3.
111. Henry MM, Parks AG, Swash M. The pelvic floor musculature in the descending perineum syndrome. Br J Surg. 1982;69(8):470–2.
112. Mahieu P, Pringot J, Bodart P. Defecography: I. Description of a new procedure and results in normal patients. Gastrointest Radiol. 1984;9(3):247–51.
113. Hetzer FH, Andreisek G, Tsagari C, Sahrbacher U, Weishaupt D. MR defecography in patients with fecal incontinence: imaging findings and their effect on surgical management. Radiology. 2006;240(2):449–57.
114. Southwell BR, Clarke MC, Sutcliffe J, Hutson JM. Colonic transit studies: normal values for adults and children with comparison of radiological and scintigraphic methods. Pediatr Surg Int. 2009;25(7):559–72.
115. Lin HC, Prather C, Fisher RS, Meyer JH, Summers RW, Pimentel M, et al. Measurement of gastrointestinal transit. Dig Dis Sci. 2005;50(6):989–1004.
116. Pomerri F, Frigo AC, Grigoletto F, Dodi G, Muzzio PC. Error count of radiopaque markers in colonic segmental transit time study. AJR Am J Roentgenol. 2007;189(2):W56–9.

Anorectal Physiology Testing

3

Ian M. Paquette and Joshua I. S. Bleier

Introduction

Throughout the past several decades, we have learned a great deal about the complex physiology of the distal rectum, pelvic floor, and anal canal. The majority of these discoveries have come through the advent of testing modalities including anal manometry, electromyography (EMG), cinedefecography, rectal compliance measurements, and measurements of specific anorectal reflexes. These testing modalities have led to a better understanding of the complex interplay between pelvic muscle and nerve functions as they relate to normal physiology as well as the ways that these mechanisms change in the setting of various disease states.

As knowledge of physiologic parameters has increased over time, the differing techniques have had ranges of "normal" values reported. Though these can be helpful guides in interpreting these studies, any given value needs to be evaluated in context because variations in measurement technique may provide differing results [1, 2]. It is most important for the surgeon to have knowledge of their own testing equipment and interpret testing values in the context of those typically seen with their own devices. Anal physiology testing has also allowed us to understand many different reflex arcs such as the bulbocavernosus reflex [3, 4], the cough reflex [5–7], cutaneous-anal reflex [8], the rectoanal excitatory reflex [9, 10], and rectoanal inhibitory reflex [11, 12]. Though most of these reflexes can be an important part of determining overall spinal nerve function, the rectoanal inhibitory reflex (RAIR) is the most relevant to the study of colorectal disease as it has been noted to affect such conditions as Hirschsprung's disease [13] and fecal incontinence [14]. Similarly, its abolition after low anterior resection may be associated with many of the post-operative functional disorders that affect patients. In recent years, many of the techniques have been modified and enhanced with the addition of modalities such as magnetic resonance defecography (MR defecography) [15, 16], high resolution anal manometry [17, 18], and anal canal vector volume manometry [19].

This chapter will provide a broad overview of the techniques commonly used to evaluate anorectal and pelvic floor anatomy and physiology. We will first describe the techniques in detail and describe the interpretation of the results both in the instance of normal findings as well as in states

I. M. Paquette
Division of Colon and Rectal Surgery, University of Cincinnati College of Medicine, Christ Hospital Center for Pelvic Floor Disorders, Cincinnati, OH, USA

J. I. S. Bleier (✉)
Department of Surgery, University of Pennsylvania Perelman School of Medicine, Philadelphia, PA, USA
e-mail: Joshua.bleier@uphs.upenn.edu

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_3

of disease. Finally, we will address present day clinical correlations, and how testing methodology can be used to guide clinical decision-making, or conversely, in which instances clinical judgment should supersede the need for testing.

Techniques

Anorectal Manometry

Instrumentation and Technique

There are a variety of methods for performing anorectal manometry testing. The essential components involve a pressure measuring probe, pressure transducers, a recording component, and in the setting of water perfusion methods, a hydraulic pump. Many modern devices are now self-contained systems, offering advanced functionality (Fig. 3.1). The most common difference in setup is in the transducing catheter, where small balloons filled with air or water, water-perfusion catheters, and solid state catheters have been used [20]. Currently, the most commonly utilized transduction system uses a soft multichannel catheter, which is perfused with water or air. The unit then measures the pressure needed to overcome the sphincter pressure during various states such as resting or squeeze (Fig. 3.2).

A variety of techniques to measure pressures throughout the anal canal are used. Some techniques include stationary measurements, where the catheter is left in one location. However, the more common techniques involve slowly withdrawing the catheter from the rectum by hand. Many systems are using an automated rather than manual pullback method, including those, which use vector volume techniques (Fig. 3.3) [19, 21–24].

The standard pull through technique involves placing the catheter into the rectum until it is above the sphincter complex. Subsequently, resting and squeeze pressures are measured at each station, usually in 1 cm intervals. Directional pressures (anterior, posterior, and left or right lateral) can be measured at each station. Squeeze duration may also be measured to determine the stamina exhibited by the sphincter muscles. During this process, rectal compliance and the RAIR can also be elucidated [20].

The newest techniques are the vector volume manometry technique and high-resolution anal

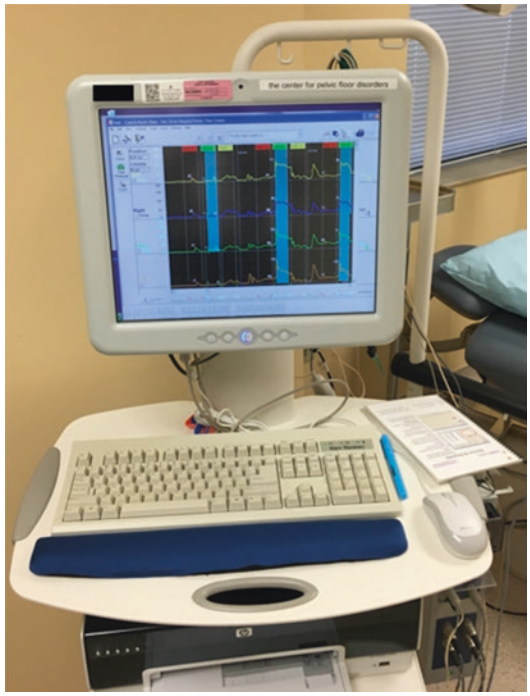


Fig. 3.1 Anal physiology testing system (Mediwatch Duet® Encompass™ System. Mediwatch, West Palm Beach, FL)

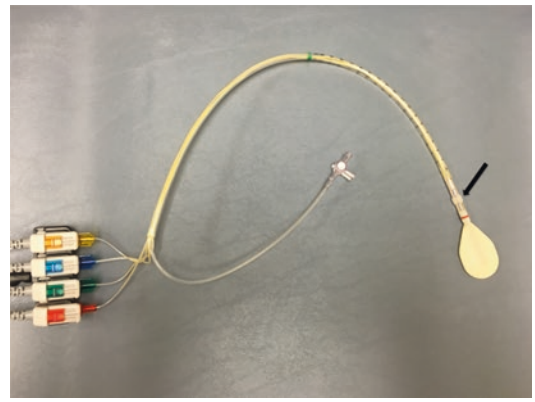


Fig. 3.2 Air charged manometry catheter. Arrow demonstrates the four small balloons used to measure pressures in the anal canal (T-DOC-ARM4 Catheter. T-DOC LLC, Wilmington, DE)

manometry. The vector volume technique involves a continuous pull through in which the system creates vector diagrams, which are used to generate a three dimensional reconstruction of anal canal pressures [19]. As algorithms have improved over the years, fairly accurate representations of anal canal squeeze pressure, resting pressure, length, and symmetry can be reasonably calculated (Fig. 3.4). The results of this technique suffer from a lack of generalizability, as there are a myriad of techniques and algorithms used for vector volume manometry.

Revaluation of standard manometry techniques utilizing a variety of measurement methods (water perfused side hole, water perfused end hole, microtransducer, or microballoon) have demonstrated relatively consistent results across platforms [20]. However, evidence suggests that vector volume manometry may yield higher estimations of anal canal pressures [25]. Yang et al. conducted a prospective analysis comparing vector volume manometry against standard pull through manometry in 50 consecutive patients with fecal incontinence. Their conclusion was that lower pressures may be measured during standard techniques because patients are given more time to rest between squeezes as opposed to the continuous pull through used in the vector volume methods [25]. These data suggest that surgeons need to become comfortable with the data generated by their own manometry system, and be cognizant of the fact that values generated on a given machine may not be directly correlated to external controls. Proponents of the vector volume imaging technique suggest that algorithms have improved over time and there is greater reproducibility in the results [19]. What is less clear is to what degree this technique adds clinical value over standard techniques, and whether it is cost-effective.

Fig. 3.3 Manometry catheter automated withdrawal system (Mediwatch, West Palm Beach, FL)

High-resolution manometry techniques were initially developed to investigate esophageal motility and have been adapted to study anorectal disease. This technique has the potential to generate 3-dimensional maps of pressure gradients throughout the anal canal (Fig. 3.5). Although

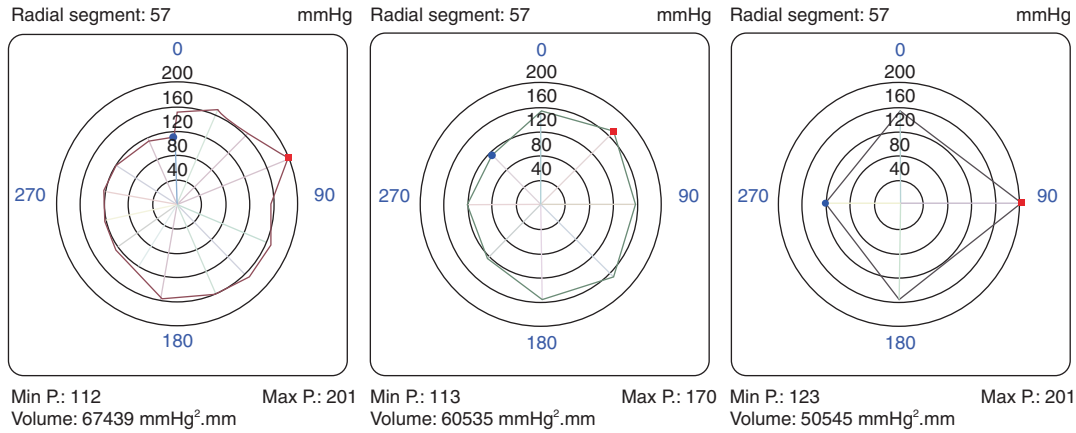


Fig. 3.4 Vector volume manometry. Pressures are measured in multiple planes and vector diagrams are generated. With permission [19] © 2011 Wolters Kluwer

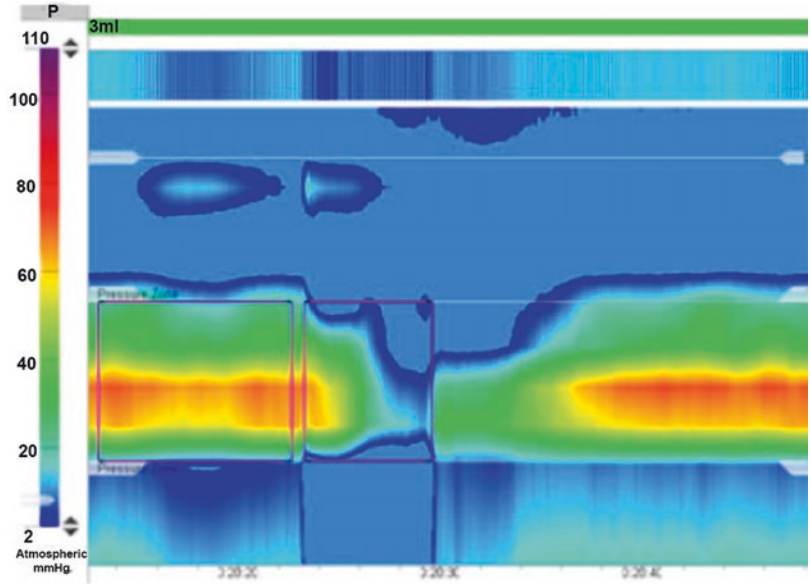


Fig. 3.5 High resolution manometry tracing demonstrating relaxation of the anal sphincter during a pushing maneuver. With permission from [18] © John Wiley and Sons

Table 3.1 Reference values of anal physiologic tests

Resting pressure	40–70 mmHg
Squeeze pressure	100–150 mmHg
Anal canal length	2–3 cm (female)
	2.5–3.5 cm (male)
RAIR	Present
Sensory threshold	10–30 cc
Rectal capacity	100–250 cc
Rectal compliance	5.1–15.7 mL/cm H_2O
Anorectal angle	75–90° at rest
	110–180° at evacuation
Perineal decent	<3 cm with straining

only small pilot studies have examined this technique in the setting of various disease states [17, 26, 27], data is beginning to emerge on the suggested "normal" values of this technique when measured in healthy volunteers [18]. The challenge for future research is to determine whether this technique can offer more useful information than traditional techniques, or whether other techniques such as dynamic distensibility measurements may correlate better with various disease states [28].

Anal resting pressure receives as much as 55–85% of its contribution from the internal sphincter, while squeeze augmentation is mostly from the external sphincter [20, 29–33]. Studies of controls as well as patients with pelvic floor disorders have generated several "normal values" (Table 3.1). Differences have been noted between different gender and age, with generally higher pressures in males and decreased pressures in elderly patients [34]. Pressures are relatively low in the anterior aspect of the upper third of the anal canal, which corresponds to the area not surrounded by the puborectalis sling, and in the posterior aspect of the lower third of the anal canal.

Anal canal length is also assessed by manometric measurement [35]. In many instances, the length of the anal canal has been shown to correlate with sphincter function, and can be predictive of outcomes in disease states such as fecal incontinence [35–37]. Length of the sphincter can almost more be construed as a physiologic, rather than an anatomic length. Many modern systems are now able to reproduce dynamic pressure tracing curves of the anal canal pressures at rest and during maneuvers such as squeeze and push (Figs. 3.6 and 3.7).

Balloon Expulsion

An inexpensive simple test for obstructed defecation is balloon expulsion. Many of the current generation manometry catheters are equipped with a balloon, which can be utilized for this purpose. Though multiple different patient positions and balloon inflation methods have been examined, asking the patient to lay in a supine position and

RAIR (ml)

	1
Volume	N.A.

Resting Duration (s)

6.0 cm	7
5.0 cm	7
4.0 cm	7
3.0 cm	7
2.0 cm	7
1.0 cm	7

Resting Average (mmHg)

	Post	Right	Anter.	Left	Min	Max	Median	Mean
6.0 cm	9	6	5	12	5	12	8	8
5.0 cm	12	7	6	10	6	12	9	9
4.0 cm	26	11	12	20	11	26	16	17
3.0 cm	68	29	29	65	29	68	47	48
2.0 cm	71	29	30	64	29	71	47	48
1.0 cm	75	43	41	78	41	78	59	59

Squeeze Duration (s)

	Post	Right	Anter.	Left	Min	Max	Median	Mean
6.0 cm	6	6	5	6	5	6	6	6
5.0 cm	6	6	6	6	6	6	6	6
4.0 cm	5	5	5	5	5	5	5	5
3.0 cm	6	5	5	6	6	6	6	6
2.0 cm	6	6	6	6	6	6	6	6
1.0 cm	6	6	6	6	6	6	6	6

Squeeze Increase (mmHg)

	Post	Right	Anter.	Left	Min	Max	Median	Mean	HPZ
6.0 cm	14	9	7	34	7	34	11	16	
5.0 cm	45	15	26	50	15	50	35	34	
4.0 cm	87	42	59	76	42	87	68	66	X
3.0 cm	80	53	64	73	53	80	69	68	X
2.0 cm	69	39	53	63	39	69	58	56	
1.0 cm	131	112	132	113	112	132	122	122	X

Fig. 3.6 Sample readout from anal manometry testing

expel a balloon with a 60 mL volume appears to be the most reproducible method (Fig. 3.8) [38]. However, one of the editors (DEB) prefers to place an air or water filled 60 cc Helium type balloon into the anus and have the patient sit on a commode to pass the balloon. This is less embarrassing and more physiologic to the passage of stool [39].

Some investigators have cited this test as a reliable means of ruling out pelvic floor dyssynergia in the setting of constipation [40–43]. Minquez et al. studied two groups of constipated patients (106 with functional constipation, and 24 with pelvic floor dyssynergia based upon manometry and defecography assessments.) Balloon expulsion testing was pathologic in 21 of 24 with pelvic floor dyssynergia and only 12 of 106 with functional constipation [41]. However, a more recent study by Kassis et al., demonstrated a sensitivity of 33% and positive predictive value of 71% of balloon expulsion testing in patients who were diagnosed with pelvic floor dyssynergia suggesting that balloon expulsion is only a complementary test to other modalities in the diagnosis of pelvic floor dyssynergia [40].

Electromyography

Electromyography (EMG) has been used to study both normal anatomy as well as sphincter muscle

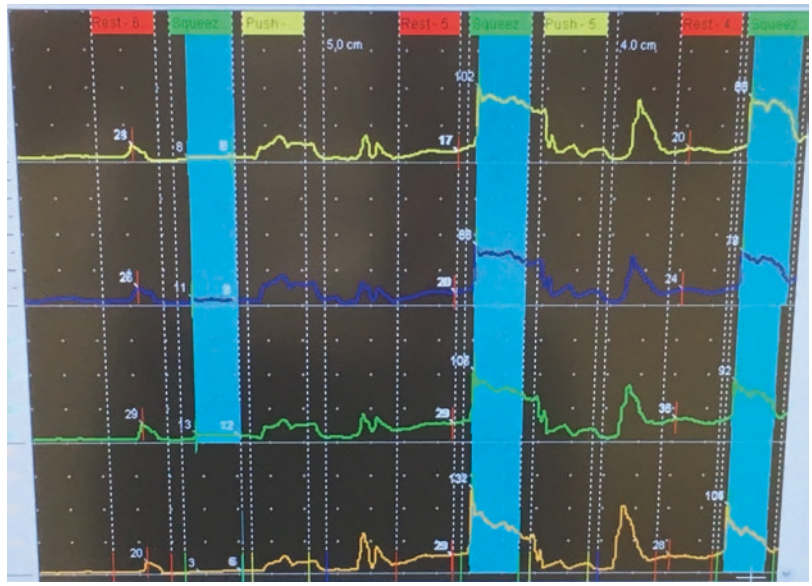


Fig. 3.7 Anal manometry measurements. An increase in pressure is demonstrated as expected during squeeze maneuver. A paradoxical increase in pressure is noted during pushing maneuver

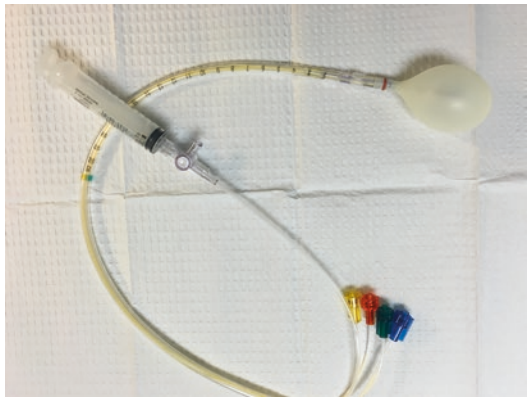


Fig. 3.8 60 cc balloon used for balloon expulsion testing

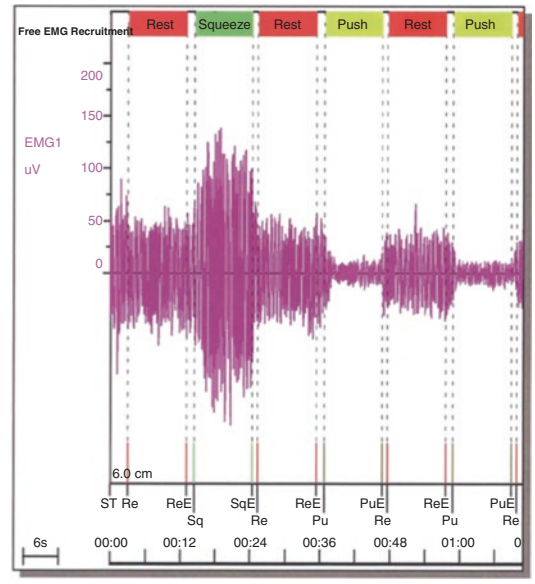


Fig. 3.9 Normal EMG. With permission from [50] © Springer

and pelvic floor muscle in various pathologic states such as fecal incontinence [44–49], paradoxical puborectalis contraction (Figs. 3.9 and 3.10) [51, 52], solitary ulcer syndrome [53], rectal prolapse [48], and perineal descent. One of the difficulties in interpretation of the literature regarding EMG is the multitude of techniques, which have been described. Based on the type of recording electrode used, there are four commonly described techniques available to evaluate pelvic floor muscles. These include concentric needle electrode, monopolar wire electrode, single fiber electrode and surface anal plug, which now include multi-channel devices.

Needle Electrode EMG

Older systems tended to utilize needle electrodes for EMG testing. These included the concentric needle, which is either a bare tipped 0.1 mm diameter steel wire which is introduced into the

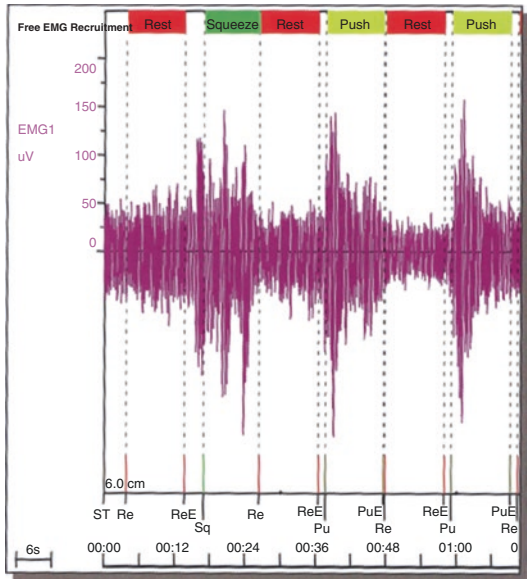


Fig. 3.10 EMG demonstrating a paradoxical increase in activity during push. With permission from [50] © Springer

external anal sphincter to record electrical activity, or the softer monopolar wire EMG electrode, which was thought to give the same information as concentric needle EMG with less patient discomfort. The electrical activity is recorded from each of the four quadrants of the external sphincter complex to ensure accurate sphincter mapping [49, 54–59]. Although accurate measurements may be obtained at the single point that the needle is placed, individual muscle fiber function cannot be reliably tested in this manner. Single fiber electrode techniques improved on this, by providing a representation of the activity of individual muscle fibers within a motor unit. However, the needle EMG techniques are currently less commonly utilized. The most common of these uses was historically, sphincter mapping; however, endoanal ultrasound has largely replaced EMG for this purpose [60–62].

Surface Electrode EMG

Currently, the most common clinical application for EMG is in examining external anal sphincter activity and whether contraction and relaxation is occurring appropriately. This is easily accomplished using a surface electrode EMG. The anal plug consists of two longitudinal or circular silver wires mounted on a plastic or sponge surface. Though surface electrodes have been modified in recent years and can afford more accurate depictions of the morphology of the sphincter complex [44, 63–65], the most common use currently is in the diagnosis of paradoxical puborectalis contraction (anismus), or as a means of demonstrating muscular activity during biofeedback retraining [51]. The incidence of EMG-documented paradoxical puborectalis contraction in chronically constipated patients ranges from between 42 to 100 [66–69]. Patient embarrassment plays a significant role in accurate diagnosis of anismus, and functional testing via cinedefecography may be more accurate.

Rectal Pressure Testing (Manometry)

The role of the rectum in normal, healthy people is to act as social organ. It is a storage reservoir, one that accommodates stool without initiating the urge to defecate and subsequently allows defecation at a socially appropriate time. This is dependent upon the complex interplay between rectal distensibility and complex defecatory reflexes. Basal pressures within the rectum range from between 5 to 25 cm H_2O (or 2–18 mmHg). The initial inflation of an intrarectal balloon is associated with an initial rise in pressure, often followed by a secondary increase in pressure due to rectal contraction. A degree of accommodation then occurs after which the rectal pressure gradually falls to a baseline value. Eventually, as intrarectal pressure increases above a certain threshold, a person will feel an urge to defecate. This threshold is different across individuals and can be affected by conditions, which reduce the capacity of the rectal vault such as low anterior resection [70], or conditions which reduce rectal compliance such as radiation proctitis [71], or ulcerative colitis [72]. The contractile response of the rectum to distention is decreased or absent in patients with spinal cord lesions, suggesting a spinal contribution to this reflex.

Rectal Capacity and Compliance

Rectal capacity determines the frequency of defecation. This is apparent in individuals who have had a low anterior resection for rectal cancer, where increased stool frequency is an expected functional consequence of surgery [73, 74]. Rectal compliance is responsible for the degree of urgency for evacuation. Some of the factors commonly utilized to determine rectal compliance are the rectal volume at first sensation, volume at first urge to defecate, and the maximum tolerable volume (MTV). These measurements are obtained utilizing a balloon attached to the end of the catheter and positioned inside the rectum. Most commonly, the balloon is distended with water and pressure measurements are recorded as cm of H_2O. The water in the balloon is usually maintained at 37 °C, and should not be lower than room temperature, or higher than body core temperature. Prior to injecting water, the patient needs to be instructed on the purpose of the test, and informed of what is being asked of them. Baja et al. demonstrated that a single injection of water can be used with accurate results, and that the technique of multiple injections to permit "conditioning" appear to be unnecessary [75]. Commonly, the volume in the balloon at the first urge to defecate is recorded. Maximum tolerable volume is not often recorded due to patient discomfort. One of the only studies demonstrating utility in maximum tolerable volume demonstrated that patients with a maximum tolerable volume <60 cc had a high incidence of fecal incontinence [76], however, this predictive value was shown to be no better than the predictive value of anal manometry [77], thus, the added patient discomfort of this test is not justified. Rectal compliance, by definition, is 1/slope $\Delta P/\Delta V$. Put simply, compliance measures the response of the rectum (by change of pressure) in response to a change in volume [78–80]. Rectal compliance, measured as mL/cm H_2O have been shown to vary, and normal values ranging from 5.1–15.7 mL/cm H_2O have been reported [80]. Conditions associated with low rectal compliance include radiation proctitis and inflammatory bowel disease, while idiopathic constipation with megarectum may be associated with abnormally high compliance [80]. Recent evidence suggests that patients with impaired continence after anal fistulotomy may have impaired rectal compliance due to scarring in addition to diminished muscle pressures, and this may be an additional mechanism leading to incontinence [81]. Due to the wide range of values reported as normal in the literature, some have suggested that the accuracy of this measurement needs to be interpreted with caution due to limitations with the technique [80]. Other factors have been shown to impact rectal compliance measurements including the contribution of extrarectal tissues to the measurement, as well as differences in rectal size. Newer techniques have been developed to attempt to control for variations in rectal size such as the barostat technique, which uses a large volume bag (with infinite compliance to the limit of its capacity) to test rectal compliance. The proposed advantage of this technique is to attempt to control for variation in capacity. This can hopefully address the issue where a patient with a larger volume rectum will appear more compliant due to the volume of water it can accommodate, as opposed to basing this measurement simply on wall distensibility [78].

The Rectoanal Inhibitory Reflex (RAIR)

One notable aspect of the complex neuromuscular network of the anal canal is the rectoanal inhibitory reflex (RAIR). Distention of the rectum leads to a consequent relaxation of the internal sphincter allowing the rectal contents access to the specialized sensory epithelium lining the upper anal canal. This mechanism allows for sampling and conscious or subconscious discrimination between solid, liquid, or gas contents [82]. Increasing degrees of rectal distention lead to complete internal sphincter inhibition. While the internal sphincter relaxes, the external sphincter contracts to maintain continence. During this episode, there is a small decrease in anal pressure noted: this normal reflex is what defines the RAIR [11, 83]. RAIR is thought to play an important role in maintenance of continence, as it facilitates "sampling" of rectal contents to the specialized sensory apparatus of the anal canal; this is what allows a person to distinguish

between solid, liquid, and gas contents. The RAIR is mediated by nitric oxide and relies on the presence of the interstitial cells of Cajal to mediate its effect [84, 85]. RAIR is noted to be absent in conditions with an impaired myenteric nerve plexus such as Hirschsprung's disease or Chagas' disease, or after surgical resection of the rectum [11, 83, 86, 87].

The test is performed utilizing a balloon catheter. The balloon is placed 2 cm proximal to the anal verge. The expected result is a 50% drop in resting pressure in at least one channel in response to balloon insufflation. The test is interpreted as normal if this condition is met. If the RAIR is absent, this suggests impaired neuromuscular function, and disease states such as Hirschsprung's disease, rectal prolapse, scleroderma, or dermatomyositis should be considered in the proper clinical context [86]. RAIR is also often absent in the setting of chronic rectal prolapse due to a neuropathy induced by chronic stretching of the prolapsed tissue, resulting in continuous stretching of the receptors.

Cinedefecography

Defecography is a technique utilized to assess the process of defecation in a dynamic manner (Fig. 3.11). The primary clinical indication is for the workup of obstructed defecation, or pelvic organ prolapse [88]. Through the past decades the imaging protocols have been modified, but the goal remains to assess the functional interaction of the pelvic floor during the defecatory process.

The patient is placed on the left lateral position, with instillation of 50 mL of liquid barium into the rectum, followed by insufflation of a small quantity of air. In addition, 100–200 mL of barium paste is injected into the rectum [89–91]. Though various other techniques for contrast administration (intravesical [92], oral [93], intravaginal barium soaked tampon [93], or intraperitoneal [94, 95]) have all been described, the most common configuration is rectal barium combined with a vaginal barium paste. This allows for accurate identification of additional pathology such as

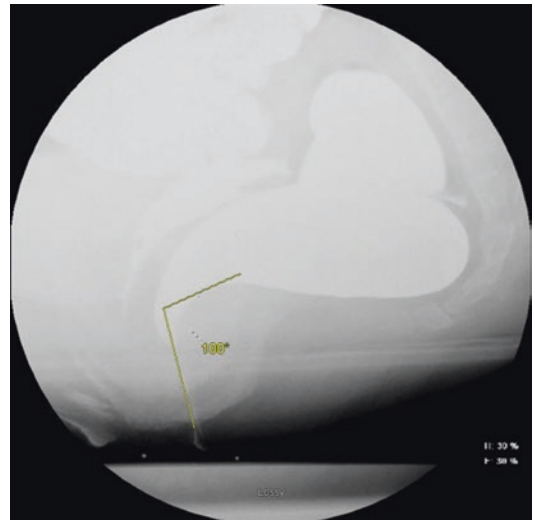


Fig. 3.11 Defecography demonstrating a resting anorectal angle of 100°

enterocele or vaginal vault prolapse, while minimizing patient discomfort and inconvenience [96–98]. Often, a radio-opaque marker is placed on the perineum, which allows measurement of perineal descent.

The patient is then seated on a commode, and lateral radiographs, both static and dynamic are obtained during the process of defecation. The patient is coached to attempt to recreate a normal bowel movement and evacuate the contents of the rectum as completely as possible.

X-ray images are recorded at rest, as well as during squeezing and pushing maneuvers.

Parameters commonly measured are the anorectal angle, degree of perineal descent, and whether paradoxical contraction of the puborectalis is observed [99, 100]. However, many other diagnoses such as internal or complete rectal prolapse, sigmoidocele, enterocele, rectocele, or vaginal vault prolapse may be demonstrated (Figs. 3.12 and 3.13).

The anorectal angle is the angle created between straight lines traversing the anal canal and the rectum. This angle is thought to be largely created by the function of the puborectalis muscle at rest. Normal values have been reported to be 90–110° at rest, and 110–180° at evacuation (Fig. 3.11) [99, 101, 102]. Though the examination of the dynamic change in anorectal angle in

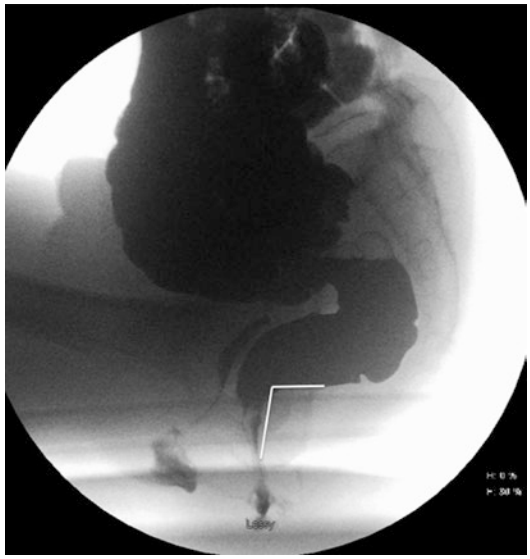


Fig. 3.12 Defecography demonstrating no relaxation of the puborectalis muscle during an attempted defecation

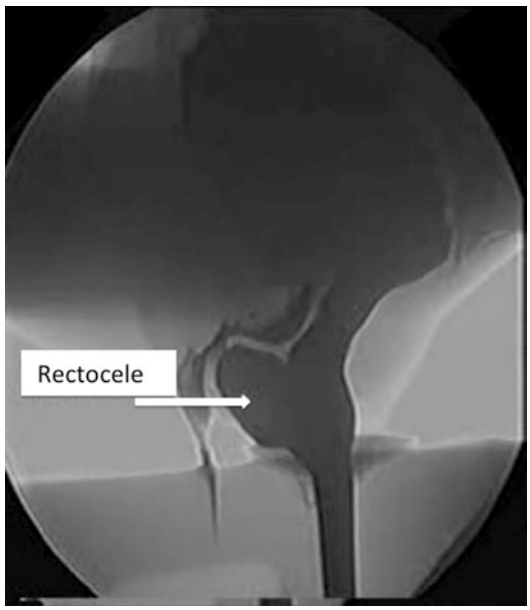


Fig. 3.13 Defecography demonstrating an anterior rectocele with retained contrast during an attempted evacuation

a given patient can be clinically useful, the absolute numbers generated are not very useful because there is disagreement among experts as to the suggested normal values. Though techniques vary, a common reference point for measurement is between the axis of the anal canal and the tangential line of the posterior rectal wall [103].

Perineal decent is measured in relation to a line drawn from the most anterior portion of the symphysis pubis to the coccyx (the pubococcygeal line) [104]. In general, the pelvic floor is observed to rise during squeeze maneuvers and descend with defecation. Perineal descent of more than 3 cm in the resting phase or an increase of more than 3 cm during the pushing phase are the definitions of fixed and dynamic perineal descent, respectively [105, 106]. Additionally, the degree of emptying of the rectum is assessed. Normal rectal emptying should take less than 30 s, and less than 10% of the contrast should remain in the rectum in order for emptying to be read as normal. The degree of emptying should be carefully assessed, as anatomic "abnormalities" can appear on defecography, and correlation of these findings to the patient's symptoms as well as a dynamic analysis of the defecatory process is paramount. Shorvon et al. illustrated that in a mixed gender group of "normal" volunteers, half showed radiological evidence of mucosal prolapse and intussusception. Additionally, 17 of the 21 women studied also had evidence of a rectocele [107]. Other studies have corroborated these findings as well, suggesting that the mere presence of a rectocele on physical examination or defecography is not enough to warrant a repair [108–113]. We would suggest that symptoms of difficult evacuation, need for vaginal splinting to precipitate evacuation, and evidence of non-emptying of the rectocele on defecography should be requisite conditions which should be met prior to consideration of a rectocele repair. We will go into further detail correlating defecography findings to clinical outcomes later in this chapter.

Magnetic Resonance Defecography

More commonly, MRI technology is being utilized in the study of pelvic floor disorders [114–122]. Magnetic resonance (MR) defecography has been proposed as an alternative to fluoroscopic defecography. Proponents of this technique cite

the absence of ionizing radiation and excellent depiction of anatomy. Detractors to this approach cite that the supine patient positioning may alter the normal physiologic process of defecation, which can only be recreated in the upright position. Ideally, an open MRI configuration would be utilized, allowing a patient to sit upright during the examination, however this equipment is not readily available in most institutions. The procedure is typically carried out using a 1.5 T MRI detector, and a body coil is used rather than an endorectal coil. Though fluoroscopic defecography still appears to be the gold standard radiographic test for pelvic floor disorders, a recent study by Vitton et al. demonstrated that MRI techniques are improving. Though the concordance rate of MRI to conventional defecography in diagnosing rectocele (82%), or enterocele (93%) were reasonably good, the concordance of MRI to standard defecography in diagnosing perineal decent was only 57% [123]. This is likely because the supine positioning of MRI is not able to reproduce perineal descent in an accurate manner. There is however, some evidence that MR may be better than cinedefecography at demonstrating internal prolapse [120]. Though MR techniques continue to emerge, the current gold standard modality for assessing pelvic floor function radiographically remains conventional cinedefecography.

Pudendal Nerve Terminal Motor Latency Testing (PNTML)

Pudendal nerve terminal motor latency testing has been performed for the past several decades in an attempt to determine whether the neuromuscular function of the pelvic floor is intact. The technique is accomplished by using a finger-mounted transanally inserted electrode (St. Marks electrode). The fingertip portion of the electrode contains the stimulating portion, while a sensor at the base of the finger measures the response (Figs. 3.14 and 3.15). The clinician places the fingertip on the pudendal nerve as it traverses over the ischial spine. The latency period between pudendal nerve stimulation and

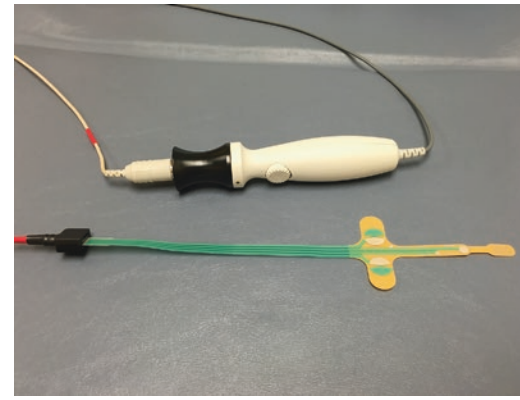


Fig. 3.14 St. Mark's Pudendal Electrode (Alpine Biomed Skovlunde, Denmark)

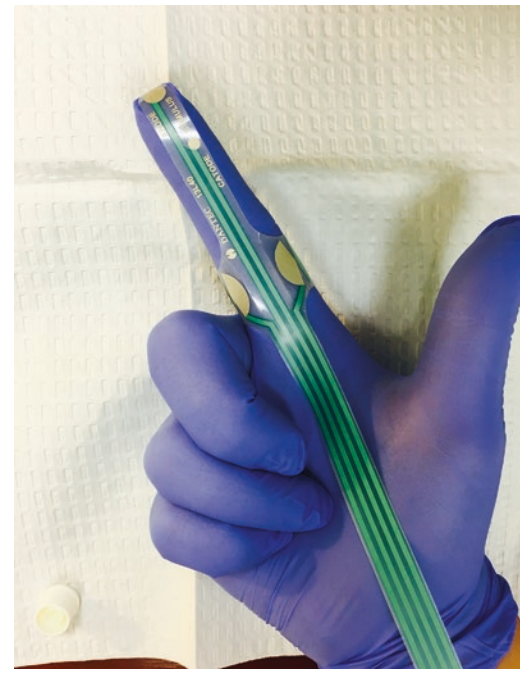


Fig. 3.15 The pudendal electrode is secured to the examiner's finger to allow for pudendal nerve terminal motor latency testing

electromechanical response of the muscle is then measured. Generally, stimulation is checked bilaterally a total of two to three times to be sure that the measurement is reproducible.

Pudendal nerve function has been demonstrated to correlate with age, particularly in women [124–127]. Though it was previously

thought that pudendal neuropathy (PN) correlated with abnormal perineal descent, emerging data suggests that this relationship may be confounded, as both perineal descent and PN are common in older age. PN has been demonstrated to occur in such varied conditions as fecal incontinence [45, 128–130], constipation [131–135], rectal prolapse [133–135], combined fecal and urinary incontinence [133], and low anterior resection syndrome [136, 137]. A study by Lim et al. in 2006 suggested that patients treated with neoadjuvant chemotherapy and radiation for rectal cancer may develop PN after treatment [138, 139]. The authors suggested that this may contribute to the development of low anterior resection syndrome (LARS). More recently, Tomita et al. correlated postoperative PN to soiling and incontinent episodes following low anterior resection. Though PN was thought to be important, the factor most highly predictive of soiling was the height of the anastomosis, with lowest anastomoses producing the most severe symptoms. LARS will be discussed in greater detail below [136]. PN is also associated with traumatic vaginal delivery. Surprisingly, up to, 20% of women who undergo vaginal delivery *without* apparent injury to the external sphincter may also have prolonged pudendal nerve terminal motor latencies. Subsequent recovery occurs approximately in 15% of these patients [139]. Recently, Loganathan et al. also demonstrated that either unilateral, or bilateral PN predicts diminished resting and squeeze tone, even in patients who are found to have an intact internal and external sphincter complex [128].

The technique is interpreted by assessing the amount of time that is taken to elicit a motor response after stimulation of the pudendal nerves. Though different values are reported at different institutions, a normal PNTML is generally considered to be 2 ± 0.2 ms [67, 140]. Though some studies have reported higher "normal" values [1, 124, 141] a surgeon must interpret the results of this test in the context of values typically seen with their own equipment. Pudendal nerve studies are interpreted independently on the left vs. the right side. Additionally, the conduction curve should be examined to be sure that it is reproducible between one test and the next to ensure a reliable measurement of pudendal nerve function.

Clinical Considerations

While a detailed understanding of the various testing modalities is critical to the practice of pelvic floor evaluation, the utility of these tests is best understood in a clinical context. In the following section, we detail several common disease states that may benefit from pelvic floor evaluation. We will review commonly used tests and expected results to help frame the practical utility of pelvic floor testing. A detailed discussion of therapeutic intervention is beyond the scope of this chapter, but will be addressed elsewhere in the text.

Hirschsprung's Disease

Hirschsprung's disease, or congenital aganglionosis of the colon, was first detailed by Dr. Hirschsprung in 1887, when describing a detailed report of constipation in newborns due to dilation and hypertrophy of the colon [142]. In 1948, Zuelzer and Whitehouse identified the pathophysiology as aganglionosis in the rectum and distal bowel, which provided the first scientific basis for intervention [143, 144]. The diagnosis of Hirschsprung's is usually made early after birth, due to the lack of passage of meconium, prompting appropriate surgical intervention. In a small segment of the population, however, with extremely short segment involvement, patients may progress into adulthood, with bowel habits characterized by chronic constipation, and varying degrees of megacolon. Given that the pathophysiology involves a lack of caudal migration of neural crest cells to the distal gut, the end result is aganglionosis, and muscular hypertrophy of the distal rectum and anal canal. Histopathologically, this is characterized by the absence of ganglion cells, and hypertrophied nerve bundles. Functionally, this results in chronic nonrelaxation of the muscular wall of the bowel. Pelvic floor testing is the primary initial step to aid in

diagnosis. The most common finding during physiologic testing is absence of the rectoanal inhibitory reflex. Other than as a result of surgical disruption, there are few other pathophysiologic processes that result in the absence of a RAIR, and in the proper clinical setting, it is considered a proxy for diagnosis [145]. In a patient who presents with a lifelong history of chronic constipation, especially in the face of endoscopic evidence of megacolon, RAIR testing provides the first key piece of evidence towards the diagnosis. Once the absence of a RAIR is confirmed, diagnosis is further made by histologic confirmation. Full-thickness biopsy of the rectal wall is required in order to perform microscopic assessment. Figure 3.16 shows the absence of a RAIR as compared to normal.

Low Anterior Resection Syndrome (LARS)

Low anterior resection syndrome (LARS) refers to the constellation of issues that to 80% of patients who undergo a low anterior resection will experience postoperatively. Symptoms include fecal urgency, frequency, bowel fragmentation, evacuation difficulty and incontinence to name a few. Most patients do regain relatively normal function by 6–12 months after surgery, however symptoms persisting after 1 year, are usually representative of permanent changes. The etiology of LARS is multifactorial, possibly due to sphincter injury, pudendal neuropathy, lumbar plexopathy, and in many cases radiation damage [146]. Diagnosis is primarily clinical, though scoring systems have been developed [74, 147–149]. Pelvic floor testing offers little in the way of predictive value in diagnosis and management since diagnosis is essentially based on symptoms, however after low anastomosis, there are significant decreases in compliance, as well as threshold volume and maximal tolerated volume [87]. To assess the effect of proctectomy on the RAIR, O'Riordain followed a cohort of 46 patients with pelvic floor testing after surgery. Pre-operatively, the RAIR was present in 93%. On the tenth postoperative day, it was only seen in 18%, and after 6–12 months only an additional 3% of patients had regained the reflex [150]. Thus, it is critical that patients are counseled preoperatively about the likelihood of functional changes after proctectomy. Treatment options include dietary management with bulking agents, antidiarrheal

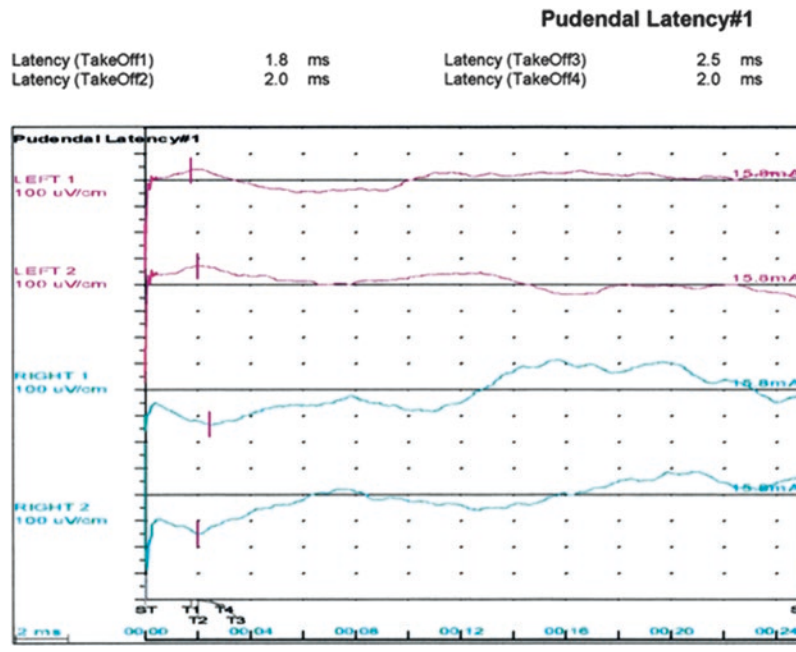


Fig. 3.16 Pudendal nerve tracings. The readings should be repeated two to three times on each side to be sure that similar appearing curves are generated, and that the PNTML values measured are repeatable

agents, daily enema therapy, biofeedback and sacral nerve stimulation [151].

Anismus

Anismus, otherwise known as nonrelaxation, or paradoxical contraction of the puborectalis during defecation is one of the more common etiologies for obstructive defecation syndrome [152]. In the normal state, the puborectalis muscle relaxes during defecation, straightening the anorectal angle, and allowing for unimpeded passage of stool. When this normal reflex is disordered, it is termed anismus. The cause of this dysfunction is unclear. It is felt to be multifactorial, involving both electro myogenic and psychological mechanisms [153–157]. Nonrelaxation of the puborectalis can be diagnosed in the office, both on physical examination as well as with anorectal manometry. Pressure over the puborectalis posteriorly during digital rectal exam while asking the patient to bear down and simulate defecation can reveal abnormal nonrelaxation. This finding can be more objectively confirmed during the "pushing" phase of manometric testing (Fig. 3.6) or EMG testing (Fig. 3.10). However, patient embarrassment during manometric testing may contribute to false positive results. Thus, diagnosis is made not only based on testing but also careful clinical history. The diagnosis is best confirmed by defecography, as the anorectal angle fails to open during defecation (Fig. 3.12). Once diagnosed, anismus may be treated with a variety of approaches including botulinum toxin injection, transanal electrostimulation and pelvic floor physiotherapy.

Rectocele, Sigmoidocele and Enterocele

Rectocele, sigmoidocele, and enterocele are clinical entities, which are often associated with constipation. Though clinical history can be suggestive of these disorders, defecography is the diagnostic modality of choice. Rectocele is an outpouching of the rectal wall during defecation. This is far more commonly found in females due to the relatively thin rectovaginal septum [158–160]. Rectoceles are classified anatomically depending on the location as low mid or high. Etiology is most commonly due to sphincter injury during childbirth, but may also be a result of chronic distention and straining with constipation [161]. The most common symptom of rectocele is a sense of incomplete evacuation, commonly associated with post-defecatory stool loss as the rectocele empties [162]. Rectocele is often a concomitant diagnosis with other pelvic organ prolapse including cystocele, enterocele and sigmoidocele, as well as uterine prolapse. Physical examination yields a prompt diagnosis. Rectoceles are graded relative to the degree of bulging into the vagina. Grade 1 rectocele is mild with little bulging, grade 2 rectocele is defined as bulging to the vaginal introitus, and grade 3 rectocele is bulging outside of the vaginal introitus. Dynamic studies such as defecography provide the most accurate and objective measure of rectocele (Fig. 3.13). A careful distinction must be made regarding the existence of a rectocele and its clinical importance. Studies have found that up to 80% of women have some degree of asymptomatic rectocele [163, 164]. Indication for surgical repair is based not only on symptomatology, but also predictive factors for successful repair. Karlbom found that the most predictive factor related to successful surgical treatment was resolution of obstructive symptoms with digital vaginal or perineal splinting (23/27 in the improved group vs. 3/7 in the non-improved group; $p = 0.04$) whereas a previous hysterectomy, large rectal area on cinedefecography and preoperative use of enemas, motor stimulants or several types of laxatives related to a poor result [165]. Other predictive factors that indicate prior success rates after surgical intervention include barium retention on defecography. Thus, patient selection is critical to successful surgical resolution. Good selection results in success rates of over 80% at 1-year follow-up [159, 164].

Sigmoidocele and enterocele refer to descent of the bowel into a deep rectovaginal sulcus. These are additional etiologies that can contribute to functional pelvic outlet obstruction. Previous hysterectomy is one of the risk factors, with incidences ranging from 6–25% [166]. Obliteration of

the rectovaginal cul-de-sac is the typical approach for enterocele. Like with rectocele, the mere presence of enterocele or sigmoidocele may be an incidental finding on defecography. Only patients with clinically significant obstructive defecation merit consideration for surgical intervention. The pathophysiologic mechanism of obstruction may be multifactorial including collapse of the rectal wall due to extrinsic pressure by the sigmoidocele, as well as obstruction or stasis of the relatively entrapped bowel loop. This process is frequently accompanied by other manifestations of pelvic floor dysfunction including internal rectal prolapse, rectocele and anismus. Jorge and Wexner proposed classification based on the degree of descent of the lowest portion of the sigmoid. First-degree was defined as descent above the pubococcygeal line. Second-degree was descent below the pubococcygeal line and above the ischiococcygeal line, and third-degree was defined as descent below the ischiococcygeal line. In this study, the majority of third-degree sigmoidoceles were treated with sigmoid resection with or without rectopexy. The majority of first and second-degree sigmoidoceles were managed conservatively. In all patients who were treated surgically but in only one third of patients were treated surgically did post treatment symptoms improve [167]. Despite this success rate, surgery is rarely advised as although the anatomic deformity of the sigmoidocele is likely to be corrected, functional symptoms may persist or even be exacerbated.

Perineal Descent

Perineal descent is defined by excessive pelvic floor relaxation, resulting in descent of the perineum relative to the ischial tuberosities. It was first observed by Parks in 1966 in association with chronic constipation [106]. Subsequently it was found to be associated with other anorectal disorders such as incontinence and solitary rectal ulcer syndrome. Excessive perineal descent can force the anterior rectal wall to protrude into the anal canal, which may result in a sensation of incomplete evacuation, and pelvic floor weakening. This may feed forward, causing more straining, further stretching of pelvic floor musculature and further perineal descent. Parks postulated that such chronic straining of the pelvic floor anatomy could result in pudendal neuropathy [48]. Despite this logical association, no reliable correlation has been found between perineal descent and pudendal nerve terminal motor latency prolongation [168]. Perineal descent can be best measured by perineometry or defecography. Typically, during defecography a radio opaque marker is placed on the perineum and the pubococcygeal line is marked on static spot films. During the straining portion of defecography, the degree of descent can be measured directly.

Fecal Incontinence

The evolution of the utility of pelvic floor testing in the management of fecal incontinence has changed dramatically over the last 5 years. Prior to FDA approval in the United States, of sacral nerve stimulation in 2011, management of the majority of fecal incontinence was related to anatomic repair of sphincter injury. As a result, significant attention was paid to pelvic floor imaging and testing techniques. Although the gold standard, sphincter repair has poor long-term functional results. Thus, much attention was paid to identifying predictive factors for success or failure. Endoanal ultrasound is the most effective test for identifying the degree of sphincter injury. More recently, the use of three-dimensional ultrasound has enhanced our ability to image the sphincter and pelvic floor. Pudendal nerve testing showed conflicting results when relating to success after sphincteroplasty. Many investigators, including Barisic, Londono-Schimmer and Gilliland found significant differences in incontinence scores after sphincteroplasty in patients with and without pudendal neuropathy [169–171], however other, contemporaneous studies found no differences [172–174]. Since the advent of sacral nerve stimulation, the role of pelvic floor testing has been further weakened. Ratto and others have demonstrated equivalent efficacy of sacral nerve stimulation in the setting of sphincter injury, thus essentially obviating the need for preopera-

tive endoanal ultrasound [175, 176]. Similarly, pelvic floor manometry has no predictive utility, likely since the overall success rate of sacral nerve stimulation is so high. In Hull's publication on 5-year outcomes of sacral neuromodulation, multiple variables were examined to assess predictive value for success, including presence of sphincter defects and pudendal neuropathy as well as prior pelvic floor pathology, and no predictive values emerged [177]. Further studies have confirmed that manometry pressures, pudendal neuropathy, presence of a sphincter defect, or history of a prior sphincter repair do not predict the success of sacral nerve stimulation [178, 179]. Thus, in the setting of fecal incontinence, clinical judgment is more important than physiologic testing.

Summary

Pelvic floor testing can provide important objective information regarding the function of the pelvic floor. A careful understanding of the clinical significance of the information that can be gleaned aids the clinician in characterization, and in many cases, guides diagnosis and management. It is always important to interpret such data in the relevant clinical context, since only in selected cases, does such data provide clinically useful information.

References

1. Amarenco G, Kerdraon J. Pudendal nerve terminal sensitive latency: technique and normal values. J Urol. 1999;161(1):103–6.
2. Felt-Bersma RJ, Gort G, Meuwissen SG. Normal values in anal manometry and rectal sensation: a problem of range. Hepato-Gastroenterology. 1991;38(5):444–9.
3. Laudano MA, Chughtai B, Lee RK, Seklehner S, Elterman D, Kaplan SA, et al. Use of the bulbocavernosus reflex system in assessing voiding dysfunction. World J Urol. 2013;31(6):1459–62.
4. Granata G, Padua L, Rossi F, De Franco P, Coraci D, Rossi V. Electrophysiological study of the bulbocavernosus reflex: normative data. Funct Neurol. 2013;28(4):293–5.
5. Deffieux X, Raibaut P, Rene-Corail P, Katz R, Perrigot M, Ismael SS, et al. External anal sphincter contraction during cough: not a simple spinal reflex. Neurourol Urodyn. 2006;25(7):782–7.
6. Shafik A. Re: Cough anal reflex: strict relationship between intravesical pressure and pelvic floor muscle electromyographic activity during cough. Urodynamic and electrophysiological study. J Urol. 2005;174(4 Pt 1):1502–3. author reply 3.
7. Amarenco G, Ismael SS, Lagauche D, Raibaut P, Rene-Corail P, Wolff N, et al. Cough anal reflex: strict relationship between intravesical pressure and pelvic floor muscle electromyographic activity during cough. Urodynamic and electrophysiological study. J Urol. 2005;173(1):149–52.
8. Henry MM, Parks AG, Swash M. The anal reflex in idiopathic faecal incontinence: an electrophysiological study. Br J Surg. 1980;67(11):781–3.
9. Sangwan YP, Coller JA, Barrett RC, Murray JJ, Roberts PL, Schoetz DJ Jr. Prospective comparative study of abnormal distal rectoanal excitatory reflex, pudendal nerve terminal motor latency, and single fiber density as markers of pudendal neuropathy. Dis Colon Rectum. 1996;39(7):794–8.
10. Sangwan YP, Coller JA, Barrett RC, Murray JJ, Roberts PL, Schoetz DJ Jr. Distal rectoanal excitatory reflex: a reliable index of pudendal neuropathy? Dis Colon Rectum. 1995;38(9):916–20.
11. Guinet A, Verollet D, Deffontaines Rufin S, Sheikh Ismael S, Raibaut P, Amarenco G. Qualitative and quantitative analysis of rectoanal inhibitory reflex (RAIR) modulation in functional bowel disorders. Int J Color Dis. 2011;26(4):501–5.
12. Xu X, Pasricha PJ, Sallam HS, Ma L, Chen JD. Clinical significance of quantitative assessment of rectoanal inhibitory reflex (RAIR) in patients with constipation. J Clin Gastroenterol. 2008;42(6):692–8.
13. Morais MB, Sdepanian VL, Tahan S, Goshima S, Soares AC, Motta ME, et al. Effectiveness of anorectal manometry using the balloon method to identify the inhibitory recto-anal reflex for diagnosis of Hirschsprung's disease. Rev Assoc Med Bras. 2005;51(6):313–7. discussion 2.
14. Herman RM, Berho M, Murawski M, Nowakowski M, Rys J, Schwarz T, et al. Defining the histopathological changes induced by nonablative radiofrequency treatment of faecal incontinence—a blinded assessment in an animal model. Color Dis. 2015;17(5):433–40.
15. Nikjooy A, Maroufi N, Ebrahimi Takamjani I, Hadizdeh Kharazi H, Mahjoubi B, Azizi R, et al. MR defecography: a diagnostic test for the evaluation of pelvic floor motion in patients with dyssynergic defecation after biofeedback therapy. Med J Islam Repub Iran. 2015;29:188.
16. Brandao AC, Ianez P. MR imaging of the pelvic floor: defecography. Magn Reson Imaging Clin N Am. 2013;21(2):427–45.

17. Heinrich H, Sauter M, Fox M, Weishaupt D, Halama M, Misselwitz B, et al. Assessment of obstructive defecation by high-resolution anorectal manometry compared with magnetic resonance defecography. Clin Gastroenterol Hepatol. 2015;13(7):1310–7.e1.
18. Carrington EV, Brokjaer A, Craven H, Zarate N, Horrocks EJ, Palit S, et al. Traditional measures of normal anal sphincter function using high-resolution anorectal manometry (HRAM) in 115 healthy volunteers. Neurogastroenterol Motil. 2014;26(5):625–35.
19. Schizas AM, Emmanuel AV, Williams AB. Anal canal vector volume manometry. Dis Colon Rectum. 2011;54(6):759–68.
20. Simpson RR, Kennedy ML, Nguyen MH, Dinning PG, Lubowski DZ. Anal manometry: a comparison of techniques. Dis Colon Rectum. 2006;49(7):1033–8.
21. Noelting J, Bharucha AE, Lake DS, Manduca A, Fletcher JG, Riederer SJ, et al. Semi-automated vectorial analysis of anorectal motion by magnetic resonance defecography in healthy subjects and fecal incontinence. Neurogastroenterol Motil. 2012;24(10):e467–75.
22. Nazir M, Carlsen E, Nesheim BI. Do occult anal sphincter injuries, vector volume manometry and delivery variables have any predictive value for bowel symptoms after first time vaginal delivery without third and fourth degree rupture? A prospective study. Acta Obstet Gynecol Scand. 2002;81(8):720–6.
23. Kroesen AJ. Extended anal sphincter assessment by vector manometry. Int J Color Dis. 2000;15(5–6):311–2.
24. Zbar AP, Kmiot WA, Aslam M, Williams A, Hider A, Audisio RA, et al. Use of vector volume manometry and endoanal magnetic resonance imaging in the adult female for assessment of anal sphincter dysfunction. Dis Colon Rectum. 1999;42(11):1411–8.
25. Yang YK, Wexner SD. Anal pressure vectography is of no apparent benefit for sphincter evaluation. Int J Color Dis. 1994;9(2):92–5.
26. Vitton V, Ben Hadj Amor W, Baumstarck K, Behr M, Bouvier M, Grimaud JC. Comparison of three-dimensional high-resolution manometry and endoanal ultrasound in the diagnosis of anal sphincter defects. Color Dis. 2013;15(10):e607–11.
27. Lee TH, Lee JS. High-resolution anorectal manometry and anal endosonographic findings in the evaluation of fecal incontinence. J Neurogastroenterol Motil. 2012;18(4):450–1.
28. Gourcerol G, Granier S, Bridoux V, Menard JF, Ducrotte P, Leroi AM. Do endoflip assessments of anal sphincter distensibility provide more information on patients with fecal incontinence than high-resolution anal manometry? Neurogastroenterol Motil. 2016;28(3):399–409.
29. Felt-Bersma RJ, Meuwissen SG. Anal manometry. Int J Color Dis. 1990;5(3):170–3.
30. Dreznik Z, Bat L. Value of anal manometry in anorectal diseases. Harefuah. 1989;117(7–8):196–8.
31. Kuypers JH. Anal manometry, its applications and indications. Neth J Surg. 1982;34(4):153–8.
32. Frenckner B, Euler CV. Influence of pudendal block on the function of the anal sphincters. Gut. 1975;16(6):482–9.
33. Lestar B, Penninckx F, Kerremans R. The composition of anal basal pressure. An in vivo and in vitro study in man. Int J Color Dis. 1989;4(2):118–22.
34. Wexner SD. Re: Manometric tests of anorectal function in the management of defecation disorders. Am J Gastroenterol. 1997;92(8):1400.
35. Nivatvongs S, Stern HS, Fryd DS. The length of the anal canal. Dis Colon Rectum. 1981;24(8):600–1.
36. Rajasekaran MR, Jiang Y, Bhargava V, Lieber RL, Mittal RK. Novel applications of external anal sphincter muscle sarcomere length to enhance the anal canal function. Neurogastroenterol Motil. 2011;23(1):70–5.e7.
37. Rajasekaran MR, Jiang Y, Bhargava V, Littlefield R, Lee A, Lieber RL, et al. Length-tension relationship of the external anal sphincter muscle: implications for the anal canal function. Am J Physiol Gastrointest Liver Physiol. 2008;295(2):G367–73.
38. Seong MK. Clinical utility of balloon expulsion test for functional defecation disorders. Ann Surg Treat Res. 2016;90(2):89–94.
39. Beck DE. A simplified balloon expulsion test. Dis Colon Rectum. 1992;35:597–8.
40. Kassis NC, Wo JM, James-Stevenson TN, Maglinte DD, Heit MH, Hale DS. Balloon expulsion testing for the diagnosis of dyssynergic defecation in women with chronic constipation. Int Urogynecol J. 2015;26(9):1385–90.
41. Minguez M, Herreros B, Sanchiz V, Hernandez V, Almela P, Anon R, et al. Predictive value of the balloon expulsion test for excluding the diagnosis of pelvic floor dyssynergia in constipation. Gastroenterology. 2004;126(1):57–62.
42. Fleshman JW, Dreznik Z, Cohen E, Fry RD, Kodner IJ. Balloon expulsion test facilitates diagnosis of pelvic floor outlet obstruction due to nonrelaxing puborectalis muscle. Dis Colon Rectum. 1992;35(11):1019–25.
43. Barnes PR, Lennard-Jones JE. Balloon expulsion from the rectum in constipation of different types. Gut. 1985;26(10):1049–52.
44. Cescon C, Riva D, Zacesta V, Drusany-Staric K, Martsidis K, Protsepko O, et al. Effect of vaginal delivery on the external anal sphincter muscle innervation pattern evaluated by multichannel surface EMG: results of the multicentre study TASI-2. Int Urogynecol J. 2014;25(11):1491–9.
45. Thomas C, Lefaucheur JP, Galula G, de Parades V, Bourguignon J, Atienza P. Respective value of pudendal nerve terminal motor latency and anal sphincter electromyography in neurogenic fecal incontinence. Neurophysiol Clin. 2002;32(1):85–90.
46. Neill ME, Swash M. Increased motor unit fibre density in the external anal sphincter muscle in ano-rectal incontinence: a single fibre EMG study. J Neurol Neurosurg Psychiatry. 1980;43(4):343–7.

47. Penninckx F, Kerremans R. Objective evaluation of anorectal function in fecal incontinence. Acta Chir Belg. 1985;85(5):335–40.
48. Parks AG, Swash M, Urich H. Sphincter denervation in anorectal incontinence and rectal prolapse. Gut. 1977;18(8):656–65.
49. Cheong DM, Vaccaro CA, Salanga VD, Wexner SD, Phillips RC, Hanson MR, et al. Electrodiagnostic evaluation of fecal incontinence. Muscle Nerve. 1995;18(6):612–9.
50. Mellgren A, editor. Physiologic testing. New York: Springer; 2011.
51. Glia A, Gylin M, Gullberg K, Lindberg G. Biofeedback retraining in patients with functional constipation and paradoxical puborectalis contraction: comparison of anal manometry and sphincter electromyography for feedback. Dis Colon Rectum. 1997;40(8):889–95.
52. Rutter KR. Electromyographic changes in certain pelvic floor abnormalities. Proc R Soc Med. 1974;67(1):53–6.
53. Rutter KR, Riddell RH. The solitary ulcer syndrome of the rectum. Clin Gastroenterol. 1975;4(3):505–30.
54. Wiesner A, Jost WH. EMG of the external anal sphincter: needle is superior to surface electrode. Dis Colon Rectum. 2000;43(1):116–8.
55. Podnar S, Vodusek DB. Standardisation of anal sphincter EMG: high and low threshold motor units. Clin Neurophysiol. 1999;110(8):1488–91.
56. Podnar S, Rodi Z, Lukanovic A, Trsinar B, Vodusek DB. Standardization of anal sphincter EMG: technique of needle examination. Muscle Nerve. 1999;22(3):400–3.
57. Binnie NR, Kawimbe BM, Papachrysostomou M, Clare N, Smith AN. The importance of the orientation of the electrode plates in recording the external anal sphincter EMG by non-invasive anal plug electrodes. Int J Color Dis. 1991;6(1):5–8.
58. Claes G. EMG study of the external anal sphincter: current diagnostic aids. Acta Belg Med Phys. 1990;13(2):79–83.
59. Strijers RL, Felt-Bersma RJ, Visser SL, Meuwissen SG. Anal sphincter EMG in anorectal disorders. Electromyogr Clin Neurophysiol. 1989;29(7–8):405–8.
60. Enck P, von Giesen HJ, Schafer A, Heyer T, Gantke B, Flesch S, et al. Comparison of anal sonography with conventional needle electromyography in the evaluation of anal sphincter defects. Am J Gastroenterol. 1996;91(12):2539–43.
61. Law PJ, Kamm MA, Bartram CI. A comparison between electromyography and anal endosonography in mapping external anal sphincter defects. Dis Colon Rectum. 1990;33(5):370–3.
62. Tjandra JJ, Milsom JW, Schroeder T, Fazio VW. Endoluminal ultrasound is preferable to electromyography in mapping anal sphincteric defects. Dis Colon Rectum. 1993;36(7):689–92.
63. Cescon C, Mesin L, Nowakowski M, Merletti R. Geometry assessment of anal sphincter muscle based on monopolar multichannel surface EMG signals. J Electromyogr Kinesiol. 2011;21(2):394–401.
64. Gregory WT, Clark AL, Simmons K, Lou JS. Determining the shape of the turns-amplitude cloud during anal sphincter quantitative EMG. Int Urogynecol J Pelvic Floor Dysfunct. 2008;19(7):971–6.
65. Merletti R, Bottin A, Cescon C, Farina D, Gazzoni M, Martina S, et al. Multichannel surface EMG for the non-invasive assessment of the anal sphincter muscle. Digestion. 2004;69(2):112–22.
66. Preston DM, Lennard-Jones JE. Anismus in chronic constipation. Dig Dis Sci. 1985;30(5):413–8.
67. Jorge JM, Wexner SD, Ger GC, Salanga VD, Nogueras JJ, Jagelman DG. Cinedefecography and electromyography in the diagnosis of nonrelaxing puborectalis syndrome. Dis Colon Rectum. 1993;36(7):668–76.
68. Jones PN, Lubowski DZ, Swash M, Henry MM. Is paradoxical contraction of puborectalis muscle of functional importance? Dis Colon Rectum. 1987;30(9):667–70.
69. Womack NR, Williams NS, Holmfield JH, Morrison JF, Simpkins KC. New method for the dynamic assessment of anorectal function in constipation. Br J Surg. 1985;72(12):994–8.
70. Suzuki H, Matsumoto K, Amano S, Fujioka M, Honzumi M. Anorectal pressure and rectal compliance after low anterior resection. Br J Surg. 1980;67(9):655–7.
71. Varma JS, Smith AN, Busuttil A. Correlation of clinical and manometric abnormalities of rectal function following chronic radiation injury. Br J Surg. 1985;72(11):875–8.
72. Suzuki H, Fujioka M. Rectal pressure and rectal compliance in ulcerative colitis. Jpn J Surg. 1982;12(1):79–81.
73. Bregendahl S, Emmertsen KJ, Lous J, Laurberg S. Bowel dysfunction after low anterior resection with and without neoadjuvant therapy for rectal cancer: a population-based cross-sectional study. Color Dis. 2013;15(9):1130–9.
74. Emmertsen KJ, Laurberg S. Low anterior resection syndrome score: development and validation of a symptom-based scoring system for bowel dysfunction after low anterior resection for rectal cancer. Ann Surg. 2012;255(5):922–8.
75. Bajwa A, Thiruppathy K, Emmanuel A. The utility of conditioning sequences in barostat protocols for the measurement of rectal compliance. Color Dis. 2013;15(6):715–8.
76. Felt-Bersma RJ, Sloots CE, Poen AC, Cuesta MA, Meuwissen SG. Rectal compliance as a routine measurement: extreme volumes have direct clinical impact and normal volumes exclude rectum as a problem. Dis Colon Rectum. 2000;43(12):1732–8.
77. Rasmussen OO, Ronholt C, Alstrup N, Christiansen J. Anorectal pressure gradient and rectal compliance in fecal incontinence. Int J Color Dis. 1998;13(4):157–9.

78. Fox M, Thumshirn M, Fried M, Schwizer W. Barostat measurement of rectal compliance and capacity. Dis Colon Rectum. 2006;49(3):360–70.
79. Krogh K, Ryhammer AM, Lundby L, Gregersen H, Laurberg TS. Comparison of methods used for measurement of rectal compliance. Dis Colon Rectum. 2001;44(2):199–206.
80. Madoff RD, Orrom WJ, Rothenberger DA, Goldberg SM. Rectal compliance: a critical reappraisal. Int J Color Dis. 1990;5(1):37–40.
81. Awad RA, Camacho S, Flores F, Altamirano E, Garcia MA. Rectal tone and compliance affected in patients with fecal incontinence after fistulotomy. World J Gastroenterol. 2015;21(13):4000–5.
82. Gang Y. What is the desirable stimulus to induce the rectoanal inhibitory reflex? Dis Colon Rectum. 1995;38(1):60–3.
83. Yin S, Zhao K. Research progress of rectoanal inhibitory reflex. Zhonghua Wei Chang Wai Ke Za Zhi. 2015;18(12):1284–7.
84. de Lorijn F, de Jonge WJ, Wedel T, Vanderwinden JM, Benninga MA, Boeckxstaens GE. Interstitial cells of Cajal are involved in the afferent limb of the rectoanal inhibitory reflex. Gut. 2005;54(8):1107–13.
85. Rattan S, Sarkar A, Chakder S. Nitric oxide pathway in rectoanal inhibitory reflex of opossum internal anal sphincter. Gastroenterology. 1992;103(1):43–50.
86. Zbar AP, Jonnalagadda R. Parameters of the rectoanal inhibitory reflex in different anorectal disorders. Dis Colon Rectum. 2003;46(4):557. author reply -8.
87. Carmona JA, Ortiz H, Perez-Cabanas I. Alterations in anorectal function after anterior resection for cancer of the rectum. Int J Color Dis. 1991;6(2):108–10.
88. Bozkurt MA, Kocatas A, Surek A, Kankaya B, Kalayci MU, Alis H. The importance of defecography in the assessment of the etiology of chronic constipation: an analysis of 630 patients. Ulus Cerrahi Derg. 2014;30(4):183–5.
89. Peznanski AK. The use of a semisolid contrast medium in a defecography. Radiology. 1970;97(1):82.
90. Ikenberry S, Lappas JC, Hana MP, Rex DK. Defecography in healthy subjects: comparison of three contrast media. Radiology. 1996;201(1):233–8.
91. Goei R. Defecography: principles of technique and interpretation. Radiologe. 1993;33(6):356–60.
92. Altringer WE, Saclarides TJ, Dominguez JM, Brubaker LT, Smith CS. Four-contrast defecography: pelvic "floor-oscopy". Dis Colon Rectum. 1995;38(7):695–9.
93. Saclarides TJ, Brubaker LT, Altringer WE, Smith CS, Dominguez JM. Clarifying the technique of four-contrast defecography. Dis Colon Rectum. 1996;39(7):826.
94. Bremmer S, Mellgren A, Holmstrom B, Lopez A, Uden R. Peritoneocele: visualization with defecography and peritoneography performed simultaneously. Radiology. 1997;202(2):373–7.
95. Bremmer S, Ahlback SO, Uden R, Mellgren A. Simultaneous defecography and peritoneography in defecation disorders. Dis Colon Rectum. 1995;38(9):969–73.
96. Faccioli N, Comai A, Mainardi P, Perandini S, Moore F, Pozzi-Mucelli R. Defecography: a practical approach. Diagn Interv Radiol. 2010;16(3):209–16.
97. Low VH, Ho LM, Freed KS. Vaginal opacification during defecography: direction of vaginal migration aids in diagnosis of pelvic floor pathology. Abdom Imaging. 1999;24(6):565–8.
98. Ho LM, Low VH, Freed KS. Vaginal opacification during defecography: utility of placing a folded gauze square at the introitus. Abdom Imaging. 1999;24(6):562–4.
99. Kim AY. How to interpret a functional or motility test—defecography. J Neurogastroenterol Motil. 2011;17(4):416–20.
100. Brennan D, Williams G, Kruskal J. Practical performance of defecography for the evaluation of constipation and incontinence. Semin Ultrasound CT MR. 2008;29(6):420–6.
101. Mellgren A, Bremmer S, Johansson C, Dolk A, Uden R, Ahlback SO, et al. Defecography. Results of investigations in 2,816 patients. Dis Colon Rectum. 1994;37(11):1133–41.
102. Poon FW, Lauder JC, Finlay IG. Technical report: evacuating proctography—a simplified technique. Clin Radiol. 1991;44(2):113–6.
103. Mellgren A, Bremmer S. Defecography and its clinical significance. Increased use of an "old" technique. Lakartidningen. 1995;92(47):4416–21.
104. Jorge JM, Ger GC, Gonzalez L, Wexner SD. Patient position during cinedefecography. Influence on perineal descent and other measurements. Dis Colon Rectum. 1994;37(9):927–31.
105. Henry MM, Parks AG, Swash M. The pelvic floor musculature in the descending perineum syndrome. Br J Surg. 1982;69(8):470–2.
106. Parks AG, Porter NH, Hardcastle J. The syndrome of the descending perineum. Proc R Soc Med. 1966;59(6):477–82.
107. Shorvon PJ, McHugh S, Diamant NE, Somers S, Stevenson GW. Defecography in normal volunteers: results and implications. Gut. 1989;30(12):1737–49.
108. Chen HH, Iroatulam A, Alabaz O, Weiss EG, Nogueras JJ, Wexner SD. Associations of defecography and physiologic findings in male patients with rectocele. Tech Coloproctol. 2001;5(3):157–61.
109. Delemarre JB, Kruyt RH, Doornbos J, Buyze-Westerweel M, Trimbos JB, Hermans J, et al. Anterior rectocele: assessment with radiographic defecography, dynamic magnetic resonance imaging, and physical examination. Dis Colon Rectum. 1994;37(3):249–59.
110. Kaiser A, Buchmann P, Bruhlmann W. The value of defecography for diagnosis of rectocele and rectal prolapse. Helv Chir Acta. 1994;60(5):697–700.
111. Piloni V, Pomerri F, Platania E, Pieri L, Pinto F, Gasparini G, et al. The National Workshop on

Defecography: anorectal deformities with a functional origin (prolapse, intussusception, rectocele). Radiol Med. 1994;87(6):789–95.
112. Soares FA, Regadas FS, Murad-Regadas SM, Rodrigues LV, Silva FR, Escalante RD, et al. Role of age, bowel function and parity on anorectocele pathogenesis according to cinedefecography and anal manometry evaluation. Color Dis. 2009;11(9):947–50.
113. van Dam JH, Ginai AZ, Gosselink MJ, Huisman WM, Bonjer HJ, Hop WC, et al. Role of defecography in predicting clinical outcome of rectocele repair. Dis Colon Rectum. 1997;40(2):201–7.
114. Thapar RB, Patankar RV, Kamat RD, Thapar RR, Chemburkar V. MR defecography for obstructed defecation syndrome. Indian J Radiol Imaging. 2015;25(1):25–30.
115. Reginelli A, Di Grezia G, Gatta G, Iacobellis F, Rossi C, Giganti M, et al. Role of conventional radiology and MRi defecography of pelvic floor hernias. BMC Surg. 2013;13(Suppl 2):S53.
116. Piloni V, Tosi P, Vernelli M. MR-defecography in obstructed defecation syndrome (ODS): technique, diagnostic criteria and grading. Tech Coloproctol. 2013;17(5):501–10.
117. Cappabianca S, Reginelli A, Iacobellis F, Granata V, Urciuoli L, Alabiso ME, et al. Dynamic MRI defecography vs. entero-colpo-cysto-defecography in the evaluation of midline pelvic floor hernias in female pelvic floor disorders. Int J Color Dis. 2011;26(9):1191–6.
118. Mortele KJ, Fairhurst J. Dynamic MR defecography of the posterior compartment: indications, techniques and MRI features. Eur J Radiol. 2007;61(3):462–72.
119. Hetzer FH, Andreisek G, Tsagari C, Sahrbacher U, Weishaupt D. MR defecography in patients with fecal incontinence: imaging findings and their effect on surgical management. Radiology. 2006;240(2):449–57.
120. Roos JE, Weishaupt D, Wildermuth S, Willmann JK, Marincek B, Hilfiker PR. Experience of 4 years with open MR defecography: pictorial review of anorectal anatomy and disease. Radiographics. 2002;22(4):817–32.
121. Paetzel C, Strotzer M, Furst A, Rentsch M, Lenhart M, Feuerbach S. Dynamic MR defecography for diagnosis of combined functional disorders of the pelvic floor in proctology. Rofo. 2001;173(5):410–5.
122. Hilfiker PR, Debatin JF, Schwizer W, Schoenenberger AW, Fried M, Marincek B. MR defecography: depiction of anorectal anatomy and pathology. J Comput Assist Tomogr. 1998;22(5):749–55.
123. Vitton V, Vignally P, Barthet M, Cohen V, Durieux O, Bouvier M, et al. Dynamic anal endosonography and MRI defecography in diagnosis of pelvic floor disorders: comparison with conventional defecography. Dis Colon Rectum. 2011;54(11):1398–404.
124. Pradal-Prat D, Mares P, Peray P, Lopez S, Gagnard-Landra C. Pudendal nerve motor latency correlation by age and sex. Electromyogr Clin Neurophysiol. 1998;38(8):491–6.
125. Laurberg S, Swash M. Effects of aging on the anorectal sphincters and their innervation. Dis Colon Rectum. 1989;32(9):737–42.
126. Vernava AM 3rd, Longo WE, Daniel GL. Pudendal neuropathy and the importance of EMG evaluation of fecal incontinence. Dis Colon Rectum. 1993;36(1):23–7.
127. Vaccaro CA, Cheong DM, Wexner SD, Nogueras JJ, Salanga VD, Hanson MR, et al. Pudendal neuropathy in evacuatory disorders. Dis Colon Rectum. 1995;38(2):166–71.
128. Loganathan A, Schloithe AC, Hakendorf P, Liyanage CM, Costa M, Wattchow D. Prolonged pudendal nerve terminal motor latency is associated with decreased resting and squeeze pressures in the intact anal sphincter. Color Dis. 2013;15(11):1410–5.
129. Suilleabhain CB, Horgan AF, McEnroe L, Poon FW, Anderson JH, Finlay IG, et al. The relationship of pudendal nerve terminal motor latency to squeeze pressure in patients with idiopathic fecal incontinence. Dis Colon Rectum. 2001;44(5):666–71.
130. Chen AS, Luchtefeld MA, Senagore AJ, Mackeigan JM, Hoyt C. Pudendal nerve latency. Does it predict outcome of anal sphincter repair? Dis Colon Rectum. 1998;41(8):1005–9.
131. Vaccaro CA, Cheong DM, Wexner SD, Salanga VD, Phillips RC, Hanson MR. Role of pudendal nerve terminal motor latency assessment in constipated patients. Dis Colon Rectum. 1994;37(12):1250–4.
132. Lubowski DZ, Swash M, Nicholls RJ, Henry MM. Increase in pudendal nerve terminal motor latency with defaecation straining. Br J Surg. 1988;75(11):1095–7.
133. Rakas P, Liapis A, Karandreas A, Creatsas G. Pudendal nerve terminal motor latency in women with genuine stress incontinence and prolapse. Gynecol Obstet Investig. 2001;51(3):187–90.
134. Pfeifer J, Salanga VD, Agachan F, Weiss EG, Wexner SD. Variation in pudendal nerve terminal motor latency according to disease. Dis Colon Rectum. 1997;40(1):79–83.
135. Birnbaum EH, Stamm L, Rafferty JF, Fry RD, Kodner IJ, Fleshman JW. Pudendal nerve terminal motor latency influences surgical outcome in treatment of rectal prolapse. Dis Colon Rectum. 1996;39(11):1215–21.
136. Tomita R, Igarashi S, Ikeda T, Koshinaga T, Fujisaki S, Tanjoh K. Pudendal nerve terminal motor latency in patients with or without soiling 5 years or more after low anterior resection for lower rectal cancer. World J Surg. 2007;31(2):403–8.
137. Matsuoka H, Masaki T, Sugiyama M, Atomi Y. Pudendal nerve terminal motor latency in evaluation of evacuatory disorder following low anterior resection for rectal carcinoma. Hepato-Gastroenterology. 2007;54(77):1426–9.
138. Lim JF, Tjandra JJ, Hiscock R, Chao MW, Gibbs P. Preoperative chemoradiation for rectal cancer

causes prolonged pudendal nerve terminal motor latency. Dis Colon Rectum. 2006;49(1):12–9.
139. Snooks SJ, Setchell M, Swash M, Henry MM. Injury to innervation of pelvic floor sphincter musculature in childbirth. Lancet. 1984;2(8402):546–50.
140. Wexner SD, Marchetti F, Salanga VD, Corredor C, Jagelman DG. Neurophysiologic assessment of the anal sphincters. Dis Colon Rectum. 1991;34(7):606–12.
141. Lefaucheur J, Yiou R, Thomas C. Pudendal nerve terminal motor latency: age effects and technical considerations. Clin Neurophysiol. 2001;112(3):472–6.
142. Tam PK. Hirschsprung's disease: a bridge for science and surgery. J Pediatr Surg. 2016;51(1):18–22.
143. Zuelzer WW, Wilson JL. Functional intestinal obstruction on a congenital neurogenic basis in infancy. Am J Dis Child. 1948;75(1):40–64.
144. Whitehouse FR, Kernohan JW. Myenteric plexus in congenital megacolon; study of 11 cases. Arch Intern Med (Chic). 1948;82(1):75–111.
145. Tang YF, Chen JG, An HJ, Jin P, Yang L, Dai ZF, et al. High-resolution anorectal manometry in newborns: normative values and diagnostic utility in Hirschsprung disease. Neurogastroenterol Motil. 2014;26(11):1565–72.
146. Martellucci J. Low anterior resection syndrome: a treatment algorithm. Dis Colon Rectum. 2016;59(1):79–82.
147. Carrillo A, Enriquez-Navascues JM, Rodriguez A, Placer C, Mugica JA, Saralegui Y, et al. Incidence and characterization of the anterior resection syndrome through the use of the LARS scale (low anterior resection score). Cir Esp. 2016;94(3):137–43.
148. Hou XT, Pang D, Lu Q, Yang P, Jin SL, Zhou YJ, et al. Validation of the Chinese version of the low anterior resection syndrome score for measuring bowel dysfunction after sphincter-preserving surgery among rectal cancer patients. Eur J Oncol Nurs. 2015;19(5):495–501.
149. Samalavicius NE, Dulskas A, Lasinskas M, Smailyte G. Validity and reliability of a Lithuanian version of low anterior resection syndrome score. Tech Coloproctol. 2016;20:215–20.
150. O'Riordain MG, Molloy RG, Gillen P, Horgan A, Kirwan WO. Rectoanal inhibitory reflex following low stapled anterior resection of the rectum. Dis Colon Rectum. 1992;35(9):874–8.
151. Bleier JI, Maykel JA. Outcomes following proctectomy. Surg Clin North Am. 2013;93(1):89–106.
152. Podzemny V, Pescatori LC, Pescatori M. Management of obstructed defecation. World J Gastroenterol. 2015;21(4):1053–60.
153. Mathers SE, Kempster PA, Swash M, Lees AJ. Constipation and paradoxical puborectalis contraction in anismus and Parkinson's disease: a dystonic phenomenon? J Neurol Neurosurg Psychiatry. 1988;51(12):1503–7.
154. Kuijpers HC, Bleijenberg G. The spastic pelvic floor syndrome. A cause of constipation. Dis Colon Rectum. 1985;28(9):669–72.
155. Kuijpers HC, Bleijenberg G, de Morree H. The spastic pelvic floor syndrome. Large bowel outlet obstruction caused by pelvic floor dysfunction: a radiological study. Int J Color Dis. 1986;1(1):44–8.
156. MacDonald A, Shearer M, Paterson PJ, Finlay IG. Relationship between outlet obstruction constipation and obstructed urinary flow. Br J Surg. 1991;78(6):693–5.
157. Heymen S, Wexner SD, Gulledge AD. MMPI assessment of patients with functional bowel disorders. Dis Colon Rectum. 1993;36(6):593–6.
158. Sullivan ES, Leaverton GH, Hardwick CE. Transrectal perineal repair: an adjunct to improved function after anorectal surgery. Dis Colon Rectum. 1968;11(2):106–14.
159. Khubchandani IT, Sheets JA, Stasik JJ, Hakki AR. Endorectal repair of rectocele. Dis Colon Rectum. 1983;26(12):792–6.
160. Sehapayak S. Transrectal repair of rectocele: an extended armamentarium of colorectal surgeons. A report of 355 cases. Dis Colon Rectum. 1985;28(6):422–33.
161. Picirillo MTT, Yoon K, Patino Paul R, Lucas J, Wexner S. Rectoceles: the incidence and clinical significance. Tech Coloproctol. 1996;2:75–9.
162. Block IR. Transrectal repair of rectocele using obliterative suture. Dis Colon Rectum. 1986;29(11):707–11.
163. Karasick S, Karasick D, Karasick SR. Functional disorders of the anus and rectum: findings on defecography. AJR Am J Roentgenol. 1993;160(4):777–82.
164. Siproudhis L, Ropert A, Lucas J, Raoul JL, Heresbach D, Bretagne JF, et al. Defecatory disorders, anorectal and pelvic floor dysfunction: a polygamy? Radiologic and manometric studies in 41 patients. Int J Color Dis. 1992;7(2):102–7.
165. Karlbom U, Graf W, Nilsson S, Pahlman L. Does surgical repair of a rectocele improve rectal emptying? Dis Colon Rectum. 1996;39(11):1296–302.
166. Hawksworth W, Roux JP. Vaginal hysterectomy. J Obstet Gynaecol Br Emp. 1958;65(2):214–28.
167. Jorge JM, Yang YK, Wexner SD. Incidence and clinical significance of sigmoidoceles as determined by a new classification system. Dis Colon Rectum. 1994;37(11):1112–7.
168. Jorge JM, Wexner SD, Ehrenpreis ED, Nogueras JJ, Jagelman DG. Does perineal descent correlate with pudendal neuropathy? Dis Colon Rectum. 1993;36(5):475–83.
169. Barisic GI, Krivokapic ZV, Markovic VA, Popovic MA. Outcome of overlapping anal sphincter repair after 3 months and after a mean of 80 months. Int J Color Dis. 2006;21(1):52–6.
170. Gilliland R, Altomare DF, Moreira H Jr, Oliveira L, Gilliland JE, Wexner SD. Pudendal neuropathy is predictive of failure following anterior overlapping sphincteroplasty. Dis Colon Rectum. 1998;41(12):1516–22.
171. Londono-Schimmer EE, Garcia-Duperly R, Nicholls RJ, Ritchie JK, Hawley PR, Thomson

JP. Overlapping anal sphincter repair for faecal incontinence due to sphincter trauma: five year follow-up functional results. Int J Color Dis. 1994;9(2):110–3.
172. Bravo Gutierrez A, Madoff RD, Lowry AC, Parker SC, Buie WD, Baxter NN. Long-term results of anterior sphincteroplasty. Dis Colon Rectum. 2004;47(5):727–31. discussion 31–2
173. Karoui S, Leroi AM, Koning E, Menard JF, Michot F, Denis P. Results of sphincteroplasty in 86 patients with anal incontinence. Dis Colon Rectum. 2000;43(6):813–20.
174. Malouf AJ, Norton CS, Engel AF, Nicholls RJ, Kamm MA. Long-term results of overlapping anterior anal-sphincter repair for obstetric trauma. Lancet. 2000;355(9200):260–5.
175. Ratto C, Litta F, Parello A, Donisi L, De Simone V, Zaccone G. Sacral nerve stimulation in faecal incontinence associated with an anal sphincter lesion: a systematic review. Color Dis. 2012;14(6):e297–304.
176. Johnson BL 3rd, Abodeely A, Ferguson MA, Davis BR, Rafferty JF, Paquette IM. Is sacral neuromodulation here to stay? Clinical outcomes of a new treatment for fecal incontinence. J Gastrointest Surg. 2015;19(1):15–9. discussion 9–20.
177. Hull T, Giese C, Wexner SD, Mellgren A, Devroede G, Madoff RD, et al. Long-term durability of sacral nerve stimulation therapy for chronic fecal incontinence. Dis Colon Rectum. 2013;56(2):234–45.
178. Quezada Y, Whiteside JL, Rice T, Karram M, Rafferty JF, Paquette IM. Does preoperative anal physiology testing or ultrasonography predict clinical outcome with sacral neuromodulation for fecal incontinence? Int Urogynecol J. 2015;26(11):1613–7.
179. Brouwer R, Duthie G. Sacral nerve neuromodulation is effective treatment for fecal incontinence in the presence of a sphincter defect, pudendal neuropathy, or previous sphincter repair. Dis Colon Rectum. 2010;53(3):273–8.

Congenital and Pediatric Anorectal Conditions

4

Anne Kim Mackow

Abbreviations

HAEC	Hirschsprung's associated enterocolitis
LAARP	Laparoscopic-assisted anorectoplasty
PSARP	Posterior sagittal anorectoplasty
RAIR	Recto-anal inhibitory reflex
SRUS	Solitary rectal ulcer syndrome
VACTERL	Vertebral, anorectal, cardiac, tracheo-esophageal, renal, limb anomalies

Introduction

An understanding of the common pediatric anorectal problems is important for the practicing surgeon. Although some adult conditions such as anal fissure and prolapse occur in children, the presentation and management may be quite different. Patients with the more unusual problems such as Hirschsprung's disease and imperforate anus may have difficulties well into adulthood. Indeed, some patients with Hirschsprung's disease may not present until adulthood. Awareness of these problems assists in appropriate management.

A. K. Mackow (✉)
Division of Pediatric Surgery, Rainbow Babies and Children's Hospital, University Hospitals, Case Medical Center, Cleveland, OH, USA
e-mail: Anne.kim@uhhospitals.org

Anorectal Malformations

Following an extensive report of the embryology and anatomy of patients with anorectal malformations by Ladd and Gross in 1934 [1], there was an effort made in 1970 to classify anorectal malformations as low, intermediate, or high based on the position of the distal end of bowel with respect to the puborectalis or levator sling [2]. Their initial work has been further elucidated over time, with these malformations being most easily understood by the presence of a fistula and its connection to the genitourinary tract or perineum. The location of the fistulous connection has important implications on the presence of associated congenital anomalies and long-term outcomes in terms of continence and constipation [3, 4]. The overall incidence of anorectal malformations has been reported as 1 in 5000 live births [5].

Classification

Anorectal malformations encompass a wide spectrum of anomalies, including rectal atresia or stenosis, imperforate anus without a fistula and perineal fistulas (Table 4.1), which occur in both males and females. In rectal atresia (~1% of malformations), the anus appears normal externally, but there may be a narrowing or atresia noted on attempt to pass a probe for rectal tem-

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_4

Table 4.1 Classifications of anorectal malformations

Male	Female
Perineal fistula	
Rectourethral fistula	Rectovestibular fistula
Rectobulbar Rectoprostatic	Cloaca Common channel <3 cm Common channel >3 cm
Rectobladder neck fistula	
Imperforate anus without fistula	
Rectal atresia	
Complex defects	

Modified from [6]

perature measurement [3]. Patients with imperforate anus without a fistula (~5% of malformations), have a blind end of rectum, which is generally located within 2 cm of the perineum. There appears to be an association between this particular malformation (5–10% of anorectal malformations overall) and trisomy 21—although 2% of patients with anorectal malformations have trisomy 21, 95% of them have an imperforate anus without a fistula [7, 8]. Finally, perineal fistulas are usually thought to be an anteriorly-displaced anus. On examination, there is a small perineal opening that is stenotic and appears to be anterior to the center of the sphincter. Because these openings are obstructively small and are not centered within the sphincteric complex, these are best thought of as a fistula to the perineum rather than a true displacement of the anus itself.

In males (Fig. 4.1), anorectal malformations may involve fistulas between the rectum and the urethra at the level of the bulbar or prostatic portions of the urethra, or the bladder neck. The most common male defect is the rectourethral bulbar fistula, a connection of the rectum to the lower portion of the urethra; this occurs in up to 50% of male cases [3]. Fortunately, these also tend to have good prognoses with respect to continence and sphincteric function. In contrast, those fistulas that open into the prostatic, or upper portion of the urethra, tend to have more problems with sacral anomalies and poor sphincter control. About 10% of males with anorectal malformations have bladder neck fistulas and these tend to follow suit with the rectoprostatic fistulas. In general, management of these patients is surgically staged, utilizing an initial colostomy and later definitive repair of the fistula.

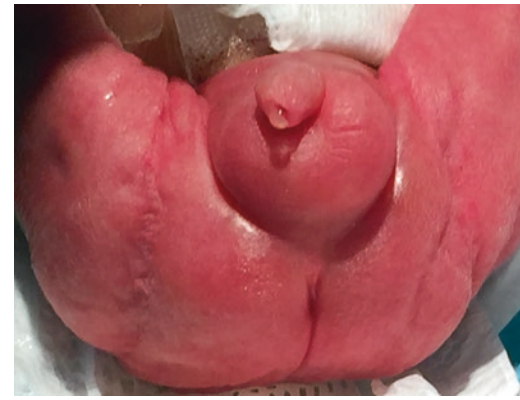


Fig. 4.1 Male anorectal malformation—the perineal raphe is prominent and the gluteal cleft less pronounced than usual. The lack of an anus in this child should prompt examination for meconium along the raphe during the first 24 h of life

Females generally have two types of fistulas—either a rectovestibular fistula (Fig. 4.2a) with an abnormal connection of the rectum to the posterior aspect of the vaginal introitus or a cloacal anomaly (Fig. 4.2b). Although the term rectovaginal is used freely with respect to these fistulas, the actual incidence of these anomalies is only 1% [9]. This is an important distinction because when the anomaly is not clearly rectovestibular, there may be an assumption that the anomaly is rectovaginal in nature, when it is actually a cloaca—a common, often small, orifice that empties the urinary, vaginal and intestinal tracts. The conjoined openings of the urinary, genital and colorectal systems may cause obstruction of any of these outlets such that urinary or vaginal ostomies need to be created, potentially with a concomitant colostomy and mucous fistula for initial diversion. Eventual detailing of the anatomy requires a combination of contrast studies to evaluate the shape and connection of the genitourinary tracts and distal colostomy, as well as cystoscopy and exam under anesthesia to evaluate the length of the common channel. The incorrect initial assumption that a cloaca is a rectovaginal fistula will lead to the need to address the urogenital sinus at a later point.

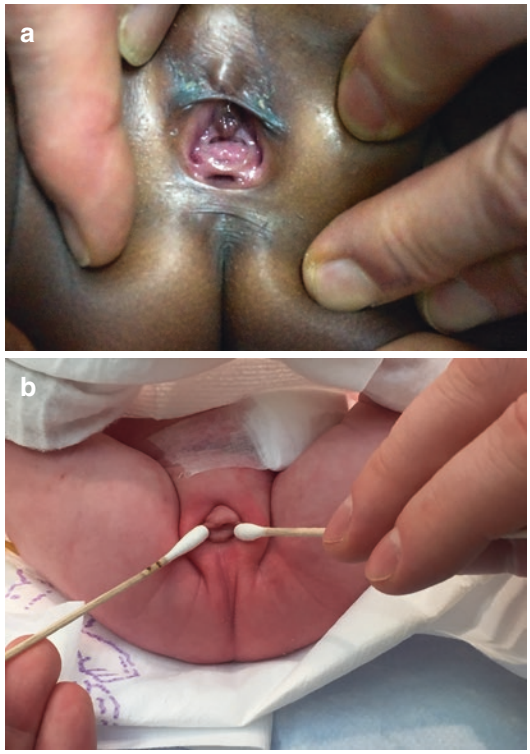


Fig. 4.2 Female anorectal malformations. (**a**) Rectovestibular fistula in an older child, with the rectal opening visualized within the posterior aspect of the introitus. (**b**) Cloaca with diminutive external orifice

Rectovestibular fistulas, because they offer ready egress for stool, allow for a broader range of management, as neonates may be able to stool through a fistula if it is large enough. If the patient is relatively small or systemically ill, and their fistula can be dilated, they may be able to have definitive surgical treatment delayed.

Embryology

During the third week of gestation, a common cavity connects the allantois (which may give rise to the bladder), the mesonephric ducts (eventually giving rise to the ureter and gonads) and the hindgut, which are bound by the cloacal membrane. Although the exact process of septation between the anorectal and genitourinary tracts is still under investigation [10], the prevailing thought has supported the presence of a urorectal septum that arises craniocaudally and migrates toward the cloacal membrane, as well as the ingrowth of lateral (Rathke) folds before the cloacal membrane ruptures during the seventh week [6]. The muscles of the levator and sphincteric complex form between weeks 6–9, but the sphincteric complex is matured by the end of the third month of gestation [10, 11]. The development of the external genitalia is ongoing after this point and not included in this discussion.

Associated Anomalies

Anorectal malformations are part of the range of anomalies associated with the VACTERL sequence (vertebral, anorectal, cardiac, tracheoesophageal, renal, limb anomalies). The evaluation for these involves sacral x-rays to evaluate for sacral and spinal defects such as spina bifida, and an eventual sacral ultrasound or MRI (if older than 3 months of age) to rule out the presence of a tethered cord, which can be found in 24% of these patients (11% of those with rectovestibular fistula and 29% of those with cloaca), depending on the severity of their defect [12]. Smaller ratios of the coccygeal-sacroiliac distance to the sacroiliac-iliac crest distance are predictive of the severity of the malformation and presence of tethered cord [3, 12]. Sacral ultrasound has been reported to be 80% sensitive and 89% specific for the presence of tethered cord, and can be confirmed with MRI [13]. Cardiac defects should be evaluated with an echocardiogram. Tracheoesophageal fistula is generally clinically apparent at birth if esophageal atresia is present, but may be challenging to identify until later in life if it involves an H-type defect with an intact esophagus. Renal or genitourinary malformations are comprised primarily of renal agenesis and vesicoureteral reflux that do not generally necessitate immediate intervention at birth. Limb anomalies can be evaluated and treated on an elective basis by a pediatric orthopedist.

Of these anomalies, genitourinary (in almost 50%) and sacral (in almost 30%) defects are far more likely in patients with higher fistulas with respect to the perineum [4]. As seen in Table 4.2,

Table 4.2 Fistula level as related to associated anomalies and functional outcomes

Fistula level	% GU anomaly	%GU anomaly if also has spinal anomaly	% voluntary BM	% total fecal continence	% soiling	% constipation	% urinary incontinence
Rectal atresia	–	–	100	100	0	40	0
Perineal	0	00	100	100	0	29	0
Vestibular	30	80	93	66	30	61	5
Bulbar	25	55	81	34	65	55	0
No fistula	–	–	77	52	39	50	0
Vaginal	72	83	75	0	100	25	0
Cloaca	88	82	71	37	68	28	19–64[a]
Prostatic	66	79	67	26	74	41	7
Bladder neck	92	93	16	0	83	18	10

Data from [3, 4]

N.B. Data taken as percentages from below references to show trends of outcomes and presence of anomalies based on fistula level.

[a]As determined by common channel length shorter or longer than 3 cm

patients with sacral defects are even more likely to have genitourinary defects. In addition, functional outcomes for these patients tend to be poorer if the fistula is higher, with rates of voluntary bowel movement control and fecal continence being far better and rates of soiling far less in patients with lower fistulas. In contrast, the rates of constipation tend to be higher in patients with relatively lower fistulas. Urinary incontinence was primarily seen in patients with higher fistulas, such as to the bladder neck, and in cloacal anomalies with a longer common channel (defined as greater than 3 cm) [3].

An interesting association between anorectal anomalies, sacral defects and presacral mass was first described by Currarino in 1981 [14]. Presacral masses may represent teratoma, meningocele or enteric cysts. Interestingly, when associated with Currarino syndrome, these masses are less likely to undergo malignant transformation than are sacrococcygeal teratomas presenting in isolation [15].

Presentation

Patients with these anomalies generally present early in the neonatal period, and depending on the level of their fistula, may have abdominal distention related to obstruction. After the recognition of a lack of an anus, further evaluation differs depending on what is noted on perineal exam. As stated previously, if a patient has features that correspond to trisomy 21 or a known diagnosis, and have an imperforate anus, they are more likely to have no fistula. Male infants with a perineal fistula may have green, white or dark meconium noted along the midline raphe of the penis or scrotum, or what is termed a "bucket handle deformity" overlying the anus (Fig. 4.1). If meconium can be expressed from the urethral meatus, that is a clear indication of some fistulous connection of the rectum to some portion of the urinary tract.

As for female infants, the lack of an anal opening should prompt evaluation of the introitus. This is best effected by placing outward manual traction on the labia. If there is a rectovestibular fistula, it will be noted in the posterior aspect of the vestibule (Fig. 4.2). If there is a true rectovaginal fistula, it may be noted above the level of the hymenal opening. However, the likelihood of identifying this in a neonate, given its size, is very low. As for cloacal anomalies, these may present in a number of ways. Beyond the abdominal distention that would be caused by the inability to effectively pass stool, the neonate may present with a lower abdominal mass that is comprised of either a distended bladder or vagina (hydrocolpos). The urinary tract obstruction is generally a

result of a back-filling of the vagina from the urinary tract, which can accumulate so much fluid that it obstructs the urethra. It is of critical importance to ensure adequate decompression of the urinary system, either via intermittent catheterization of the cloacal opening or by urgent surgical intervention, often with the use of a suprapubic or vaginostomy tube. Initial intraoperative assessment of these patients involves careful endoscopic evaluation to evaluate the anatomy of the various tracts and to measure the length of the common channel as this predicts the need for abdominal approach and the anticipated complexity of such a repair. Vaginal and uterine duplication may be present to varying extents, sometimes with a vaginal septum in a single vaginal opening [9, 13].

Management

Immediate management of the patient, once it has been established that they have adequate urinary drainage and resuscitation, should involve workup for potentially life-threatening associated anomalies, obtaining echocardiography and passing a nasogastric tube to establish esophageal continuity. If the patient is stable, sacral anomalies can be assessed with a sacral x-ray, and ultrasound of the sacrum and abdomen can be obtained to assess for tethered cord or renal anomalies. In addition, abdominal ultrasound can help demonstrate hydrocolpos or bladder distention if not clinically evident.

If no obvious fistula is noted, an "invertogram" can be taken after 16–24 h, keeping the patient with the perineum elevated to evaluate the bowel gas pattern to determine the level of the distalmost rectum and measure its distance to the perineum (Fig. 4.3a). If performed too early, it is possible that not enough air will have accumulated in the GI tract to allow for satisfactory delineation of the rectum [1, 6]. Additionally, it may take 20–24 h for meconium to have been forced into the fistula to become obvious in the urine or along the perineum [6].

By 24 h of age, the surgeon should have accumulated enough information to determine if they should proceed with a colostomy and staged procedure, or whether primary repair is reasonable [6, 16]. The decision about staging depends on the ability to initially identify the level of the fistula. If the distal pouch is sufficiently low or if the fistula is perineal or rectovestibular in nature, it is reasonable to perform a primary repair with anoplasty or limited sagittal anorectoplasty. If the fistula is higher or the rectal pouch is above the coccyx on the invertogram, a divided colostomy should be created in the left lower quadrant of the abdomen.

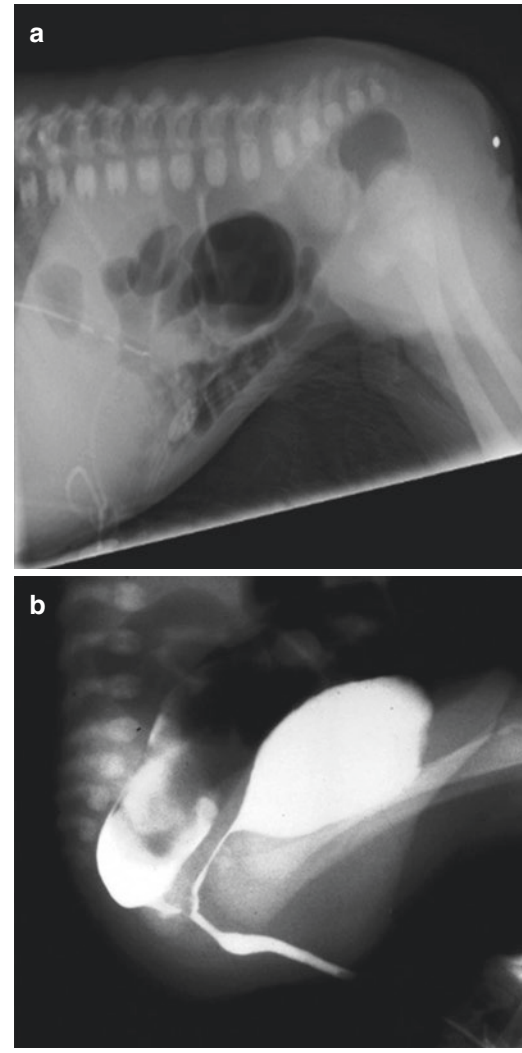


Fig. 4.3 Diagnostic imaging for operative planning for repair of anorectal malformations: (**a**) Cross-table lateral radiograph, high rectum. (**b**) Distal colostogram showing a rectourethral bulbar fistula. Reprinted with permission from [6] © 2012 Elsevier

Divided Colostomy

Peña describes creating a divided colostomy using an oblique left lower quadrant incision with maturation of a descending colostomy at one end of the incision, and a smaller, skin level mucous fistula at the other end of the incision [17]. These recommendations came from their experience with ostomy complications in patients cared for at other institutions, with notable complications including mislocation of the stoma and stomal prolapse. Problems related to location of the stoma involved stomas that were too close together, allowing for fecal contamination of the distal limb, and with fecal impaction in that distal limb causing problems during the eventual anoplasty. Another problem relates to bringing up the proximal ostomy such that there is too short an intervening segment to allow for a tension-free anoplasty at the time of definitive repair. This is obviated by maintaining the retroperitoneal attachments of the descending colon where the stoma is created, which also helps to prevent mistaking the proximal for the distal colon. In addition, the relative fixation of the colon at this point would help prevent prolapse of the colostomy by maturing a non-mobile segment of bowel. Preventing stoma prolapse for the mucous fistula is aided by tacking part of the mobile bowel to the anterior abdominal wall approximately 6–7 cm from the stoma and creating a small, skin-level stoma [17].

The goal of temporary diversion is to allow the passage of stool and provide for eventual anorectoplasty with the protective nature of this colostomy. The anorectoplasty will be less complicated if there is no need to take down the colostomy, as well as by assuring that the distal colon is adequately clean of stool before creation of the mucous fistula. If the distal colon becomes impacted with stool, the anorectoplasty will be made difficult by the dilation of this portion of the colon. In addition, part of the importance of creating a good distal colostomy would be the eventual performance of a high-pressure distal colostogram (Fig. 4.3b), in which a balloon-based urinary catheter could be introduced into the distal colostomy, held on some tension so that the balloon occluded the external tract, and then contrast applied under pressure to help delineate the distal rectum and fistula to whichever portion of the urinary tract that it involved [18]. This is often done 6–8 weeks after the initial colostomy creation.

Posterior Sagittal Anorectoplasty

Definitive repair of these malformations is affected by posterior sagittal anorectoplasty (PSARP) as described by Peña in 1982 [19]. Prior to this time, different techniques had been tried, ranging from cruciate perforation of a thin distal membrane to joint abdominoperineal approaches to attempting to pull the rectum through the puborectalis sling, with varying success [1, 20, 21]. Interestingly, Ladd and Gross described a midline dissection undertaken with the patient in lithotomy position, resulting in a similar exposure and placement of the rectum within the center of the sphincter complex in a similar manner to that of the PSARP, but with more discouraging results at the time of their report [1]. In the PSARP technique, the patient is positioned prone and an electrical stimulator is used to identify the sphincter muscle components before the structures are divided in the midline from the coccyx to the perineum. The midline dissection allows for a relatively bloodless field and the identification of the fascia surrounding the rectum once the anal sphincteric and levator muscular complexes have been divided. It is of critical importance to avoid rectal ischemia by maintaining the dissection on the surface of the rectum but not damaging the rich intramural blood supply.

In males, the rectum should be opened to identify the fistula within the tract (Fig. 4.4); fine silk sutures are placed to provide uniform traction on the rectal wall as it is opened. Once the fistula is identified, a submucosal dissection should be undertaken to separate the urethral wall from the fistula. The fistula is then divided close to the urethra and the site marked for eventual closure with absorbable suture. The rectum is then circumferentially dissected, with the anterior dissection undertaken once the majority of the posterolateral dissection has been completed, as the plane between the rectum and seminal vesicles is very

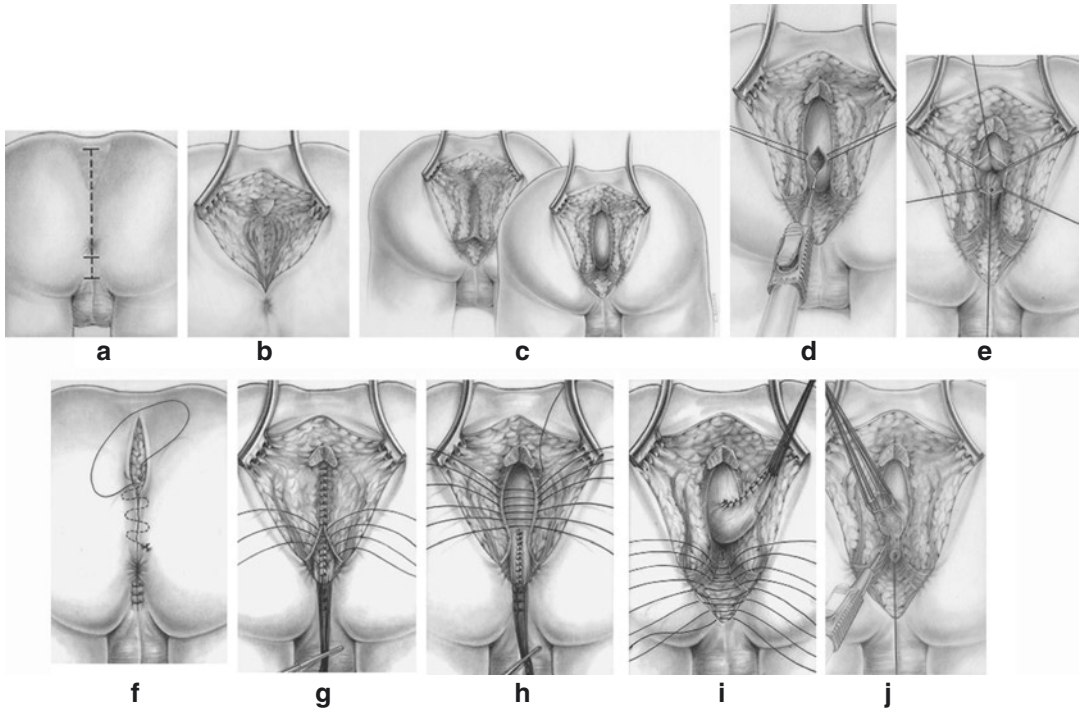


Fig. 4.4 Essential steps for posterior sagittal anorectoplasty in male patients—(**a**) Planned posterior sagittal incision. (**b**) Posterior sagittal approach with the parasagittal fibers and ischiorectal fat split in the midline. (**c**) Posterior rectal wall exposed. (**d**) Posterior rectal wall opened in the midline. (**e**) Posterior rectal wall opened going anteriorly until the rectourethral fistula is identified. (**f**) Separation of the rectum from the posterior urethra with dissection above the fistula. (**g**) The rectum fully mobilized and in this case tapered. Sutures are placed anteriorly to close the perineal body. (**h**) The rectum pulled though and placed within the limits of the sphincter mechanism. (**i**) Closure of the levator and tacking of the posterior edge of the muscle complex to the posterior rectal wall. (**j**) Closure of the posterior sagittal incision and completed anoplasty. Reprinted with permission from [6] © 2012 Elsevier

thin-walled. Once the rectum has been separated from the urinary tract and fully mobilized, the fistula is closed with absorbable suture and the perineal body closed in layers. The rectum is then situated within the sphincter complex. The levator ani is then closed posterior to the rectum, taking care to incorporate some sutures to the rectal wall to help prevent prolapse. The skin is then closed in midline and the anoplasty completed with circumferential, interrupted long-term absorbable suture [6, 19].

If the fistula is perineal, uniform traction can be initiated and maintained by using fine silk sutures through the edges of the fistula as it is dissected away from the surrounding tissue, but the remainder of the procedure is the same, with the exception of having to close a urinary fistula. For higher rectal pouches, as to the bladder neck, length is obtained by an abdominal approach with ligation of the arterial branches close to the wall of the rectum so that the distal rectum continues to rely on its intramural blood supply as supplied by the main trunk of the inferior mesenteric artery [6, 19].

In females with rectovestibular fistulas, the rectal wall is identified within the base of the midline wound and dissection proceeds with use of fine silk sutures to mark the edges of the fistula and separate it from the introitus. As mentioned above, the anterior dissection requires careful attention to separate the rectum from the very thin vaginal wall.

Cloacal anomalies, because of the involvement of the entire urogenital tract, are even more

complex and require careful endoscopic evaluation, as well as contrast studies, to evaluate the urinary and genital tracts in addition to the distal colostomy. Following separation of the rectum from the urogenital sinus, the entire urogenital tract is mobilized away from the clitoris and the common channel is divided in the midline to create flaps to help create the neovagina and reconstruct the introitus (Fig. 4.5). For patients with a longer common channel, this total urogenital sinus mobilization will be insufficient to achieve sufficient length for reconstruction. These infants should receive a total body preparation because they will require a laparotomy to mobilize the genital tract. This dissection is exceedingly complex and may require cystotomy with cannulation of the ureters, as these reside in the long common wall between the bladder and vagina. Depending on the anatomy of the genital tract, vaginal reconstruction may then be undertaken with the use of a duplicated hemivagina (called the vaginal switch maneuver by Peña) or portions of the gastrointestinal tract. If the distal rectum is wide enough, it is possible that a well-vascularized segment of the distal rectum can be separated (for use as a vaginal replacement) from the remainder

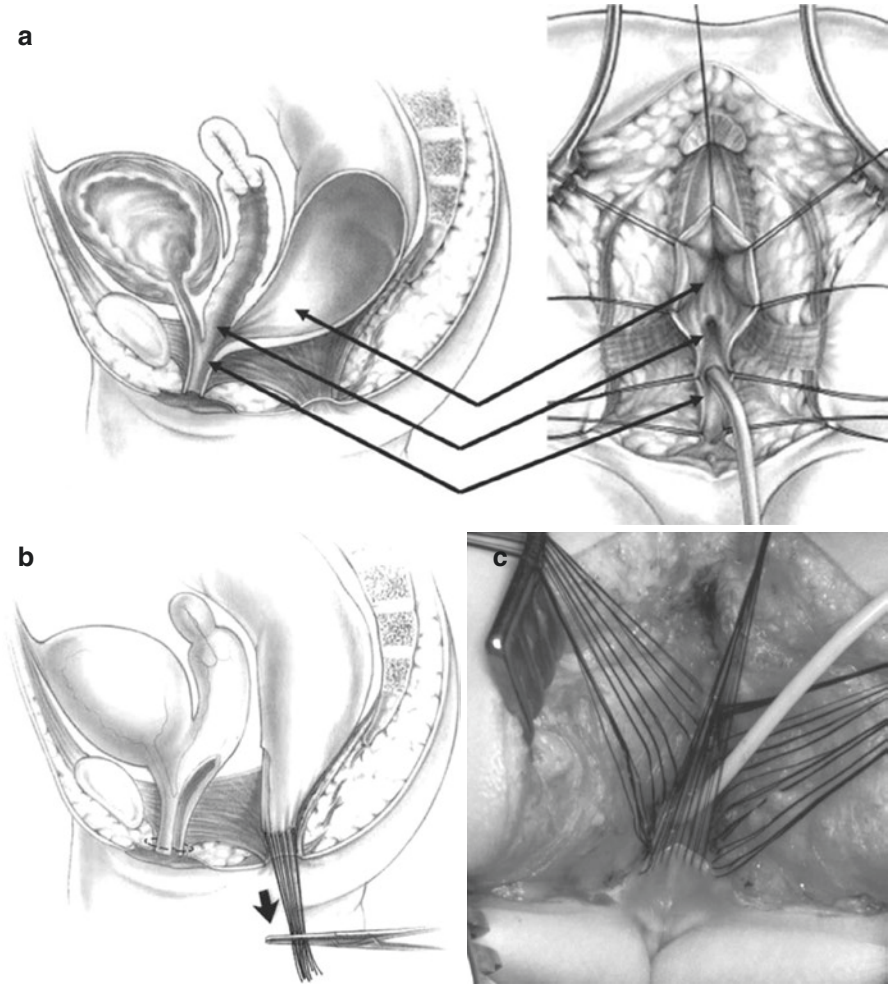


Fig. 4.5 Illustration of operative steps to repair cloacal malformation—(**a**) Total urogenital sinus mobilization (cloaca with a short common channel, <3 cm). (**b**) The rectum is separated from the urogenital sinus. (**c**) Sutures are placed around the urogenital complex for uniform traction to facilitate mobilization of the urogenital sinus. Reprinted with permission from [6] © 2012 Elsevier

of the rectum tapered for use in the anorectoplasty. If this is not possible, using a portion of the mobile rectosigmoid or even the distal colostomy can be considered, with the small bowel used as the least favorable option. If the vaginal tract opens directly into the bladder neck or trigone, a vesicostomy should be created, with consideration for eventual continent urinary diversion vs a bladder neck reconstruction; vaginal replacement can be done as otherwise described [6].

Laparoscopic-Associated Anorectoplasty (LAARP)

The laparoscopic approach has been mainly applied to the higher anorectal malformations (such as rectobladder neck or rectoprotatic fistulas, or even cloacal anomalies) [20–27]. Georgeson described this technique in 2000, as he initially developed the technique of a laparoscopic pull-through for Hirschsprung's disease and then applied it to anorectal malformations [22]. The dissection is undertaken at the level of the peritoneal reflection to identify and divide the mesorectum, staying on the rectal wall until the fistula can be clipped and divided. The rectum is then retracted out of the pelvis to reveal the pelvic musculature. Approaching the perineum externally, with use of an electrical stimulator to identify the sphincter complex, an 8 mm incision is made over the complex. Gentle blunt dissection in the midline is undertaken, guided by the intrapelvic light from the laparoscope. Following this, a Veress needle, with a sheath for a 10 mm radially-dilating port, is introduced through the midline of the sphincter complex under direct visualization. Once the needle is optimally positioned, the port can be introduced through the sheath and the end of the rectum brought out as the port is removed. The anorectoplasty is then fashioned and the rectum tacked to the presacral fascia under laparoscopic guidance [22].

Direct comparison of the LAARP and PSARP has been attempted in several instances, with the suggestion that outcomes are comparable [23, 26, 27]. Ming reported that there were more morbidities for the PSARP, including wound infection and recurrent fistula, but that rectal prolapse occurred in 7.5% of the patients undergoing LAARP [23]. Another study reports a higher incidence of posterior urethral diverticula with LAARP [26], while a different study reported more surgical complications (including damage to the vas deferens and urethra) with LAARP [27]. Perhaps the greatest challenge in comparing the two procedures, however, is a lack of specificity in the description of the LAARP technique and a lack of standardization in comparing results of the two procedures [26].

Bowel Management

Although constipation can be a major issue for some patients, the issue that is considered most important to most patients and families is that of long-term bowel control or continence. When evaluating a patient with fecal incontinence, of primary importance is the distinction to be made between patients with pseudoincontinence and true incontinence. Pseudoincontinence refers to fecal impaction with overflow incontinence, which requires disimpaction followed by a regimen of laxatives. Patients who fall into this group tend to be patients with anorectal malformations with a good prognosis for continence (perineal fistulas, rectovestibular or rectobulbar fistulas, cloacas with common channel <3 cm and imperforate anus without fistulas), as well as some patients with Hirschsprung's with ongoing with constipation. These patients will need to be kept on a laxative regimen (e.g., senna-based), sometimes requiring the aid of a bulking agent to make stool more formed before it is passed [28, 29].

Patients with true fecal incontinence have no potential for bowel control, having been born with anorectal malformations with poorer prognosis for continence (bladder neck fistulas, cloacas with longer common channel, an abnormal sacrum, large sacrococcygeal teratoma, spina bifida, or Hirschsprung's disease in which the dentate line was not preserved during the pull-through). Relying on the fact that colon transit takes up to 24 h, a bowel management program uses daily enemas to empty the descending colon and rectosigmoid in order to maintain patient cleanliness. The type of enema relies on

whether the colon appears dilated or nondilated on initial contrast enema, as the latter suggests a hypermotile colon that may require loperamide and a bulking diet to prevent small amounts of stool to be emitted in between enemas. The former type of colon will require a larger volume enema that can be graduated in concentration from normal saline to an enema containing soap or Fleets phosphosoda [28, 29]. A well-established method of determining the right amount and concentration of this enema was first demonstrated by the group at Cincinnati Children's Colorectal Center, utilizing a week-long trial, with daily assessment utilizing abdominal films to titrate the enemas.

The enemas as described above, are administered utilizing a Foley balloon to allow full administration of the enema over 5 min, followed by a "dwell time" of 10 min, then 45 min of sitting on the toilet to allow for evacuation. The enema concentration and volume are adjusted based on whether the enema achieves evacuation of the full stool burden, and whether the patient is having "accidents" between enema administrations [28]. Once the enemas have been established as an effective maneuver for maintaining cleanliness, and when the child is of sufficient age and ability to cooperate, the patients may be offered an appendicostomy or cecostomy to facilitate self-administration of antegrade enemas. These may be accomplished through use of a tube appendicostomy (such as a Chait tube) that can be created laparoscopically [30], or a continent appendicostomy brought up through the umbilicus utilizing a cecopexy to create a valve mechanism allowing administration of the flush without backflow of the enema [31].

Hirschsprung's Disease

Harald Hirschsprung, a Danish pediatrician, is credited with the most complete, although not the first, description of two children with what he termed as congenital megacolon [32, 33], Although his report described the outward appearance of the dilated bowel and non-dilated rectum in both of these patients, he did not recognize the pathologic significance of these differences. The understanding that this was related to a lack of ganglion cells in the myenteric and submucosal plexuses of the bowel was not recognized until 1948, despite an apt description of the lack of nerve cells in the myenteric plexus by Tittel in 1901 [33].

Hirschsprung's disease is diagnosed in approximately one out of every 4400 patients [34, 35]. Hirschsprung's incidence has been thought to be relatively low in premature infants, reported from 4 to 8% [36]. However, Baxter's review revealed a rate of 19% in 132 pre-term patients [37], who were more likely to be diagnosed after 30 days of age, undergo staged procedures and have presentations with Hirschsprung's associated enterocolitis (HAEC) than their full-term counterparts. The reason for delay in diagnosis may be related to the usual development and onset of function of the enteric nervous system—although the craniocaudal neural crest cell migration may be complete within the first 13 weeks of gestation, the activity of this system does not start until late in gestation [38].

As with anorectal malformations, there is an association between Hirschsprung's and Down's syndrome, or Trisomy 21. Over time, there has been increasing recognition of this association, as 2.7% of children with Down's also have Hirschsprung's disease [39], and the overall incidence of Down's in the Hirschsprung's population has been estimated from below 3% to up to 16% [39–41]. These patients tend to have more severe disease—long segment involvement, more episodes of Hirschsprung's associated enterocolitis and worse outcomes with respect to long-term constipation [41]. In addition to Down's syndrome, Hirschsprung's is associated with congenital heart disease, and congenital central hypoventilation syndrome (Ondine's curse) [42].

Pathophysiology

The characteristic pathologic finding is a lack of ganglion cells in the submucosal (Meissner) and myenteric (Auerbach) plexus [33, 43], associated with an increase in hypertrophied nerve trunks

[44]. It appears that the lack of ganglion cells leads to an excess of acetylcholinesterase activity in the lamina propria and muscularis mucosae [45], which has been well-demonstrated by pathologic staining. The aganglionic segment involves the distal-most colon and extends proximally; notably, 75–80% involve the rectum and sigmoid colon [40, 46]. The lack of normal neural transmission in the distal bowel causes an inability of that segment to undergo normal peristalsis, resulting in functional obstruction and dilation of the normal bowel proximal to this point.

Presentation

Neonatal Obstruction

The classic teaching is that the vast majority of Hirschsprung's patients fail to pass meconium within the first 24 h, but this is does not necessarily correlate with a high incidence of diagnosis during the initial newborn period [40, 42, 46]. Despite the incidence of presentation with failure to pass meconium within 24 h (90%), abdominal distention (92%) and bilious emesis (75%), in Grosfeld's experience [46], only 38% were diagnosed as neonates, while 36% were infants (22 days to 2 years) and 26% children (2–18 years). Over time, recognition of Hirschsprung's in the early neonatal period has improved to the point that the average age of diagnosis decreased from almost 18.8 months of age in the 1960s to 2.6 months in the 1980s [36]. Multicenter outcomes data in 2003 suggested that ~60% of neonates are diagnosed with Hirschsprung's within the first month of life [47]; more recent studies utilizing the National Inpatient Sample suggest that presentation within the first week is rare (6.5%) and grows to 60% by a year of age [48].

Childhood Constipation

Workup for constipation in the pediatric population should include rectal biopsy and barium enema. Per Swenson, these children generally present with abdominal distention and, depending on the length of affected intestine, either an empty rectum if they have long segment disease or palpable stool and fecal impaction if a shorter segment was involved [40]. Klein's report also corroborated that 80% of those presenting outside the newborn period had abdominal distention [36].

Hirschsprung's-Associated Enterocolitis (HAEC)

A severe form of enterocolitis that presents specifically in Hirschsprung's disease was well-characterized by Bill in 1962, when they described severe, explosive, watery diarrhea that could be fatal [49]. Patents may present with enterocolitis in 6–29%, while 5–42% may develop post-pull-through enterocolitis [47, 50]. HAEC is theorized to be related to a partial obstruction leading to stasis and mucosal ischemia in the ganglionic segment, eventual bacterial translocation and severe systemic inflammatory response [50]. Teitelbaum characterized the primary risk factors as being presentation after 1 week of age and Down's syndrome [47]. When present, HAEC requires prompt attention to effecting stool egress with rectal irrigations (10–20 mL/kg), use of intravenous fluids for resuscitation and antibiotics. Metronidazole has become the antibiotic of choice and can be used by mouth or intravenously, as warranted by the clinical presentation. The life-saving potential of irrigations or colostomy to halt the systemic insult cannot be underscored enough.

Diagnosis

Contrast Enema

When abdominal x-ray suggests the diagnosis with dilated loops of bowel, or air-fluid levels in the rectum, these findings are generally corroborated with an unprepped contrast enema. The study is considered diagnostic with demonstration of a transition between dilation of normal bowel proximal to the aganglionic segment (Fig. 4.6). However, the radiographic transition point has a reported sensitivity of 65–80% and specificity of 60–76% [51, 52], and does not always correlate with the pathologically-determined level [53].

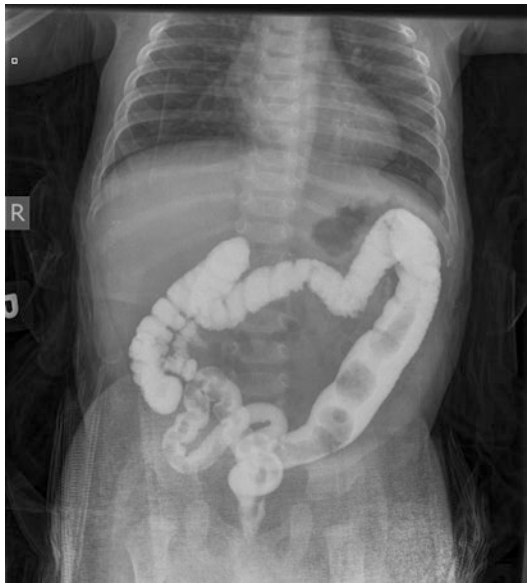


Fig. 4.6 Contrast enema in patients with Hirschsprung's disease with transition zone between descending and sigmoid colon

Another diagnostic sign is reversal of the normal recto-sigmoid ratio—the caliber of the rectum should be larger at rest than that of the sigmoid, as the rectum acts as a reservoir, distending until defecation occurs. However, the reliability of contrast enema with respect to both transition zone and rectosigmoid ratio has been shown to be age specific, with a higher sensitivity and specificity shown in infants and older children than in neonates [54]. Another helpful adjunct is that of the retention of rectal contrast on a 24-h delayed film, with a specificity of 85% for Hirschsprung's disease [55].

Anorectal Manometry

Manometric evaluation of the anorectum was first undertaken by Swenson in 1949, with the characteristic finding of higher anorectal resting tone and loss of the usual recto-anal inhibitory reflex (RAIR) displayed when stool presents to a rectum not yet filled for defecation [56]. Interestingly, although loss of RAIR is characteristic of Hirschsprung's disease, anorectal manometry can also present false negative results. Anorectal manometry is therefore considered more effective at ruling out the diagnosis in constipated children than in making a definitive diagnosis itself [56].

Rectal Biopsy

Suction vs. Full-Thickness

The gold standard of diagnosis is rectal biopsy. Work done on characterizing these pathologic specimens showed that the paucity of ganglion cells extended further caudally in the submucosal plexus than in the myenteric plexus [43], which validates the diagnostic ability of suction rectal biopsy [57]. Introduction of a suction biopsy device per rectum relies on the application of sufficient negative pressure to provide standardized pieces of mucosa and underlying submucosa. Biopsies should be undertaken at least 1–2 cm proximal to the dentate line as there is a normal "anal transition zone" in which there are no ganglion cells present [43]. Additional diagnostic confirmation is provided by identification of hypertrophied nerve trunks [44], and acetylcholinesterase staining showing heightened activity in the lamina propria and muscularis mucosae [45].

Such biopsies can be accomplished at bedside, with centimeter markings along the barrel of the device facilitating proper levels—at least 2 cm from the anal verge for newborns. Generally speaking, these should be taken at 3 points, posteriorly; specimens may require careful separation from the device using a fine hypodermic needle, before placement into separate formalin containers for pathologic analysis.

In older children, suction rectal biopsy cannot provide adequate sampling of the submucosa. These children are taken for a rectal examination under anesthesia, with the child in lithotomy position, using a nasal speculum to visualize placement of separate 3-0 or 4-0 absorbable sutures at 2, 4 and 6 cm from the dentate line to provide traction exposure. The intervening mucosa can be biopsied down to the muscularis in wedge-shaped fashion, placed on a non-adherent material and sent separately in formalin; the proximal suture to the biopsy can then used to close the mucosal defect.

Management

The principal of definitive operative management of these patients is to bring the normal ganglionic

bowel to the anus while preserving sphincteric function. Swenson first proposed this in 1949 as a full thickness resection of the aganglionic bowel starting 2.5–3 cm proximal to the dentate line [58]. Prior to this, other management strategies had been proposed, including resection of the dilated bowel leaving a normal-appearing rectum in place, and attempts at sympathectomy because physiologic studies suggested increased sympathetic tone in the affected bowel. Once Swenson noted that colon function and size normalized after colostomy creation, he suggested bringing normal bowel down to the anus in order to bypass a functional obstruction in the rectosigmoid colon [58]. Initial experience with the Swenson technique intimated that mortality was higher in the neonatal population, and due to this and other morbidities [59], other techniques were proposed in the next 15–20 years: a retrorectal pull-through by Duhamel [60] and a submucosal pull-through by Soave [61]. These techniques have all been modified over time, with some of the primary innovations including the initiation of primary pull-throughs in the neonatal population to obviate the need for a colostomy, starting in 1980 [62] and confirmed to be a safe alternative to staged procedures by Teitelbaum in his report in 2000 [63]. Following this, Georgeson's described a laparoscopic pull-through in 1995 [64] and a completely transanal dissection was proposed by Langer in 1999 [65]. Current practice among pediatric surgeons tends to favor the completely transanal or laparoscopic-assisted transanal approach to an endorectal pull-through of either the Soave or Swenson technique [66, 67].

Surgical Approaches

Swenson

The classic description by Swenson began as a closed division of bowel 12 cm proximal to the visible transition zone via laparotomy, with mobilization of the normal bowel to a tension-free anastomosis. Following this, he everted the distal end through the anus and divided the aganglionic bowel 2.5 cm proximal to the sphincter, completing the pull-through in two layers after gently pulling through the end of the normal bowel (Fig. 4.7a) [58, 59].

Duhamel

Duhamel considered his pull-through to be a modification of Swenson's technique. The purpose of the modification was to avoid potential urinary and sexual dysfunction that could result from the full thickness dissection of the rectum in the pelvis, and some complications related to the end-to-end anastomosis, such as structuring. He detailed his technique as resecting the aganglionic segment at the level of the peritoneal reflection, leaving a Hartman's pouch of aganglionic bowel. The proximal bowel was mobilized and the retro-rectal space dissected to pass the normal colon posterior to the aganglionic segment. He then turned to the perineal dissection, utilizing a posterior incision at the anocutaneous junction to dissect in the plane between the anal mucosa and the external sphincters until the pull-through segment could be sutured to the anal mucosa cranial to the external sphincter. Two Kocher clamps were then applied to the apposed walls of the aganglionic native rectum anteriorly and the pull-through segment posteriorly, creating a crush-clamp anastomosis (Fig. 4.7b) [60]. Currently, a stapler is used to complete the anastomosis. This technique is often used as a "rescue" for a failed Swenson or Soave pull-through and is thought to cause problems with constipation [69].

Soave

Soave's technique was initiated with hydrodissection, injecting lidocaine into the seromuscular layer to facilitate its separation from the mucosal layer, from the level of the peritoneal reflection. The subsequent perineal dissection was undertaken after dilation of the anus, followed by circumferential incision of the mucosa 1 cm proximal to the dentate line, proceeding proximally until the two planes of dissection were joined. The normal colon was then pulled down to the level of the mucosal dissection and the cut seromuscular edge sewn to the proximal colonic wall after a pelvic Penrose drain was introduced

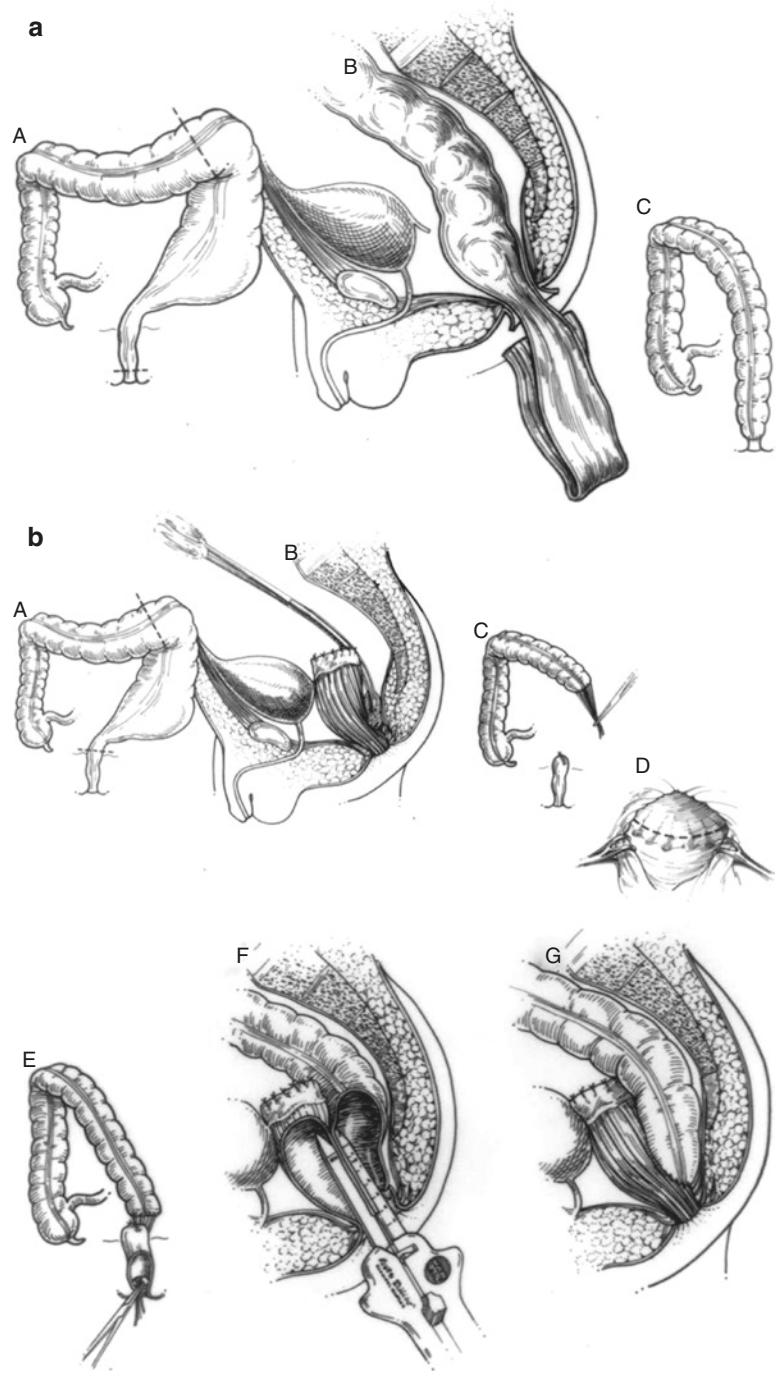


Fig. 4.7 Depiction of three main pull-through types: (**a**) Swenson pull-through—a: Resection of the aganglionic and dilated bowel. b: Pull-through of normal ganglionic bowel. c: Operation finished. (**b**) Duhamel pull-through—a: Resection of dilated portion and part of the aganglionic segment. b: Presacral, rectorectal dissection. c: Pull-through of normal ganglionic bowel. d: Incision of the posterior rectal wall. e: Pull-through of normal ganglionic bowel through the window in the posterior rectal wall. f: Creating a wide anastomosis between normal ganglionic and aganglionic segment. g: Finished operation. (**c**) Soave pull-through—A: Resection of dilated colon plus intraperitoneal aganglionic segment. B: Endorectal intrapelvic dissection. C: Resection of the mucosal aganglionic segment down to the pectinate line. D: Pull-through of normal ganglionic bowel through the muscle cuff and anastomosis 1 cm above the pectinate line. Reprinted with permission [68] © 2006 Springer

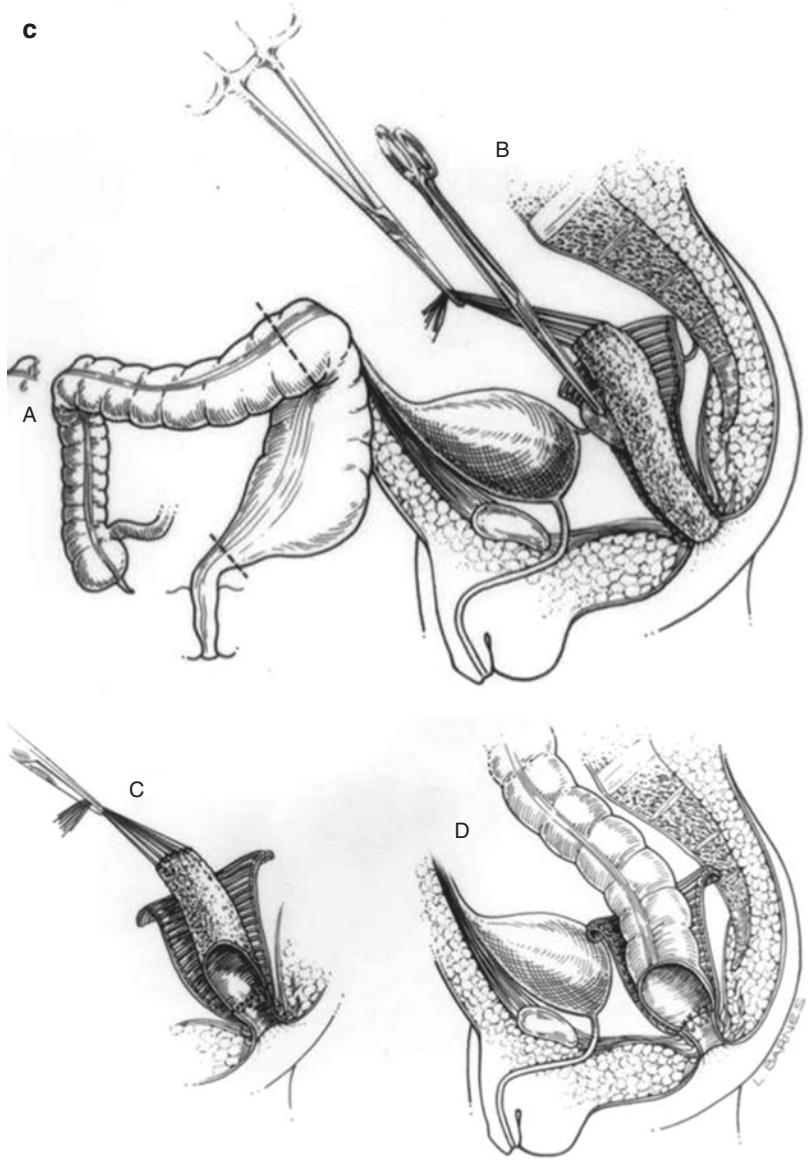


Fig. 4.7 (continued)

between layers. He left the pull-through segment exteriorized and completed the anastomosis in delayed fashion, using a rectal tube for post-operative decompression until normal function was regained. After several weeks, daily dilations would then be undertaken for several postoperative months (Fig. 4.7c) [61].

Modern modification of this technique has led to splitting the posterior muscular cuff, immediate completion of the anastomosis, and adoption of a totally transanal approach for rectosigmoid and short segment disease [65, 67].

Modern Approach

Georgeson proposed a laparoscopic procedure combined with a submucosal transanal dissection. Laparoscopy was undertaken initially, with mobilization of the colon and rectal dissection

into the pelvis. Transanal approach was then facilitated by hydrodissection [64]. Langer's modification initiated the dissection transanally, taking intraoperative frozen sections to confirm the level of aganglionosis before completing resection and pull-through of a segment several centimeters proximal to the transition zone [65]. An initial evaluation of long-term outcomes of the Soave showed concerning findings that a transanal approach had worsened outcomes with continence, but lower rates of HAEC than the transabdominal approach [70]. However, further evaluation with a multicenter trial showed that the transanal pull-through had fewer initial complications and no difference in terms of continence or stooling patterns [71].

Generally, preoperative preparation includes rectal irrigations (10–20 mL/kg of normal saline), and often enteral neomycin and erythromycin. In the operating room, laparoscopy can be utilized to obtain intraoperative frozen sections if desired for assistance of the transanal dissection. Biopsies are generally taken at the transition point and proximally; while pathology is being evaluated, the mesentery is divided and the proximal segment mobilized. Indeed, transanal dissection can also be initiated if the transition zone appears quite obvious, but may interfere with the maintenance of pneumoperitoneum for further biopsies and mobilization if necessary.

Long-Segment Disease

Long-segment or total colonic disease occurs in 2–13% of patients and present a particular diagnostic and treatment challenge [72]. The aganglionosis may even extend into the small bowel, which may result in treatment for intestinal failure requiring total parental nutrition and a proximal stoma, with all the concomitant risks [42]. Operative treatment may involve modification of Duhamel to utilize a longer segment of aganglionic bowel to take advantage of the increased motility of the small bowel and the reservoir function of the retained aganglionic rectum [42, 73]. These patients have a high-risk of preoperative (20%) and postoperative HAEC (55%), but have surprisingly reasonable long-term outcomes [73].

Complications

Post-operative complications from a pull-through can be grouped into the following three categories—incontinence, constipation and HAEC.

Incontinence

The major diagnostic dilemma is determining whether the incontinence is a true incontinence due to lack of rectal sensation or overflow incontinence deriving from fecal impaction. If a pull-through is performed too close to the dentate line, the removal of the native rectal mucosa—able to sample rectal contents and determine whether they are solid, liquid or gas—leads to incontinence that must be treated with a bowel management program. If, however, the problem is related to fecal impaction, then more workup ought be undertaken [69].

In long-term studies, incontinence does appear to be a significant issue in 12–32% of Hirschsprung's patients [74, 75], with a larger number of patients experiencing "incomplete continence," or a worsened stooling pattern compared to age-matched normal patients in 71–75% [74]. These outcomes appear to improve over time as shown by a study of long-term outcomes in 107 patients over 22 years—48% of patients under 5 years old reported problems with continence, compared to 8% in patients over 15 years old [76], These results were corroborated by Aworanti based on continence scores in a cohort followed after pull-through [77].

Constipation

Persistent problems with stooling occur in 10–13% of patients overall [74], do not seem to improve as much as continence [76, 77]. Some of the problems are anatomic, such as anastomotic stricture, a "spur" following Duhamel—which may require reoperation—or a tight muscular cuff following a Soave [69, 78, 79] Some patients, particularly those with longer segment disease, may have motility issues affecting the proximal bowel (based on a "Sitz" marker study) that lead to a diagnosis of intestinal neuronal dysplasia [79]. Other issues may be related to an inadequate pull-through due to acquired or retained aganglionosis that require redo pull-through [69]. Internal anal sphincteric achalasia, if preset, has a

reasonable response to botulinum toxin A (Botox®) injection [79, 80]. A final category, diagnosed by exclusion, is that of functional megacolon, characterized as stool-holding behavior unresponsive to botulinum toxin injection and requires long-term bowel management [69, 79].

HAEC

As noted above, HAEC may be present at initial diagnosis, or occur post-operatively in 5–42% [47, 81]. Postoperative HAEC may lead to anastomotic stricture with treatment including dilations, or even a redo pull-through if recalcitrant to dilation alone. HAEC may respond to botulinum toxin injections to relax the internal anal sphincter or with posterior myectomy if the episodes become recurrent. Although prevention is the best treatment for HAEC, a randomized controlled trial of the use of post-pull-through probiotics did not show it to be effective in decreasing its incidence [82].

Reoperation

There are different reoperative algorithms for patients with ongoing issues following pull-through (Fig. 4.8) [69]. The least invasive is progressive serial anal dilation, as for strictures; if the stricture proves unresponsive, a limited stricturoplasty or redo pull-through would be the next step. Botulinum toxin can be used as an intersphincteric injection of 3–5 mg/kg in divided doses, and may require multiple reapplications, as effects may only last 3–6 months. Posterior myotomy or myectomy may be employed in the presence of recurrent enterocolitis or severe constipation with a normal rectal biopsy, or potentially selectively with a shorter retained segment of aganglionic bowel [69, 81]. A redo pull-through requires careful planning and evaluation, as it is fraught with greater risks due to obscured planes from previous dissection and scarring, as well as an increased risk of bleeding and other morbidity (Fig. 4.9) [69].

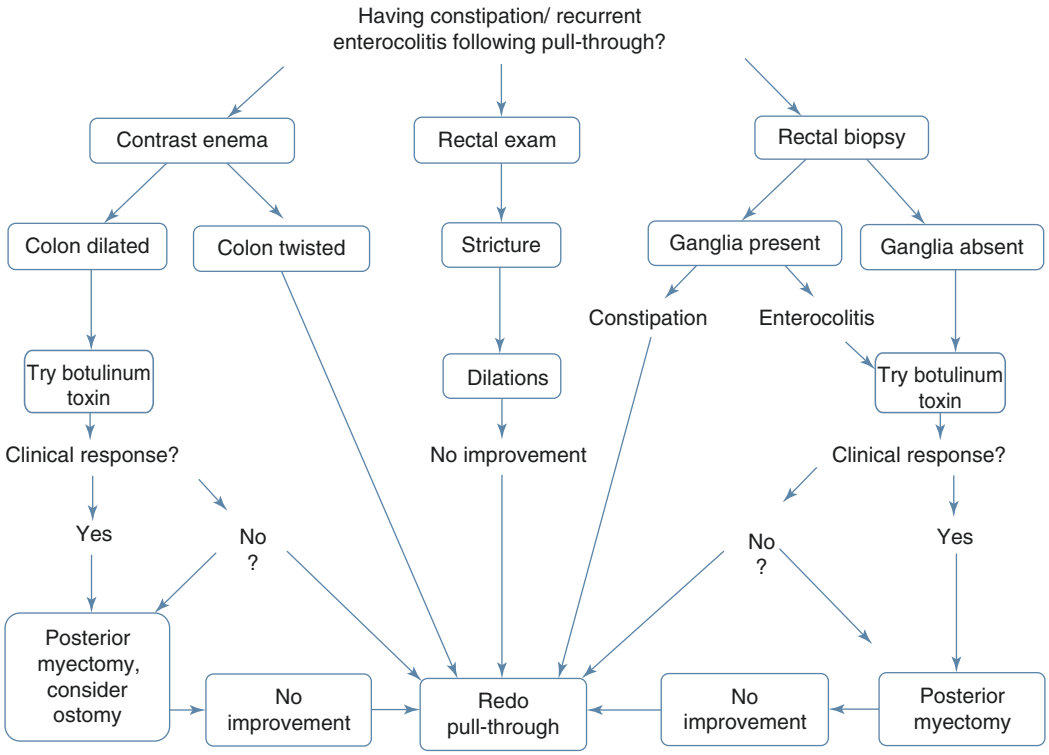


Fig. 4.8 Algorithm for treatment of post-pull-through complications. Modified from [69]

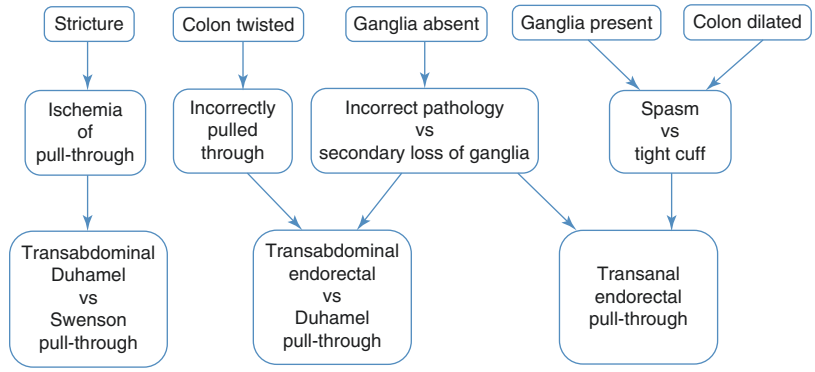


Fig. 4.9 Algorithm for redo-pull-through type. Modified from [69]

Fistula-in-ano/Perianal Abscess

Perianal abscesses occur most frequently in male neonates and are thought to be due to inflammation of relatively "deep" crypts leading to abscess formation, predisposed by androgen excess (Fig. 4.10) [83]. Fistula-in-ano may occur in 20–85% of these patients [83–85]. Although these abscesses may drain spontaneously, incision and drainage with careful wound care may prevent the formation of fistula-in-ano. Watanabe reported that only 34% of 97 patients treated nonoperatively developed a fistula-in-ano [85]. Rosen's report of 18 patients with perianal abscess revealed that the 14 treated nonoperatively all developed a fistula-in-ano [84]. Despite the potential for development of fistula-in-ano, the debate over whether to intervene operatively centers around that fact that these may heal spontaneously—Watanabe reported 42% resolved after a single episode and Rosen reported 100% resolution within 6 months [84, 85]. However, Watanabe did report up to 3 or 4 recurrences of fistula-in-ano leading to eventual operative intervention in 6 out of 33 patients [85]. Another report by Oh favors operative treatment, because although one-third of 18 patients with fistula-in-ano treated conservatively were followed for a year without further inflammatory sequelae, compared to 12 with recurrent inflammation, they ultimately all underwent fistulotomy to achieve complete resolution of the fistulae, with no recurrence reported after 2 year followup on average [86]. MacDonald further reported that recurrence was seen in only 3 of 31 patients undergoing operative treatment of fistulaes; all 3 had Crohn's disease [83].

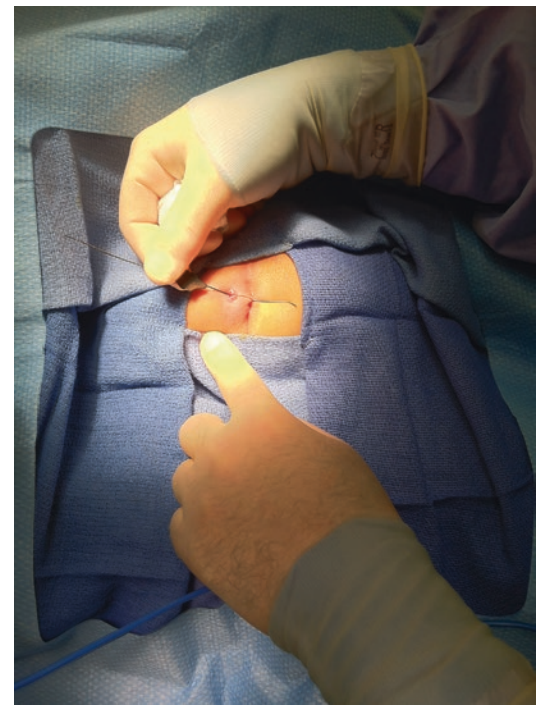


Fig. 4.10 Fistula-in-ano with lacrimal duct probe through fistulous tract

Perianal abscesses do not necessitate use of oral antibiotics, and as diarrhea may predispose to worsened problems with recurrent abscess and fistula-in-ano formation, should be avoided in the absence of signs of immunosuppression [84, 85].

Anal Fissure

The pathophysiology of anal fissures is initiated by mucosal tearing from the passage of hard stool, potentially in the face of high resting anal canal tone. The initial trauma leads to pain with defecation, which may lead to withholding stool, increasing absorption of water from the stool, resulting in a greater stool burden, aggravating the potential for repetitive trauma to the anal mucosa. Over time, this builds up granulation tissue that results in "piles" or perianal skin tags that signify the presence of constipation [87]. On history, the child may be reported to cry when passing stools, or have streaks of blood on the outside of the stools. Physical examination may reveal rectal bleeding, visible anal fissure or perianal skin tags; anal stenosis should be ruled out, as dilation might be necessary. Treatment generally commences with use of laxatives with close follow-up, but may escalate to use of topical agents such as EMLA or nitroglycerin, though the results have been variable [88, 89]. Other treatment modalities have been used with varying success, including botulinum toxin injection [90] or even lateral internal sphincterotomy [91]. Once the fissure has healed, perianal skin tags should eventually resolve.

Rectal Prolapse

This is a problematic, though relatively rare condition that is most frequently related to chronic constipation, though other associated conditions may predispose to prolapse, such as cystic fibrosis, Hirschsprung disease or other gastrointestinal and connective tissue disorders [91]. There is a high correlation of behavioral and psychiatric disorders with prolapse—54% of patients without concomitant predisposing conditions [92]. Three types of prolapse are possible—mucosal, full-thickness and a sliding hernia of the anterior wall of the rectum [93]. It is commonly self-limited, in that treatment of the underlying cause of constipation may relieve straining, which in turn decreases the episodes of prolapse. Treatment ranges from use of laxatives and dietary changes to limit use of dairy and increase fiber, physical therapy to focus on strengthening the pelvic floor, and behavioral therapy to improve compliance with various components of therapy and ensuring adequate sit times for stooling [92]. When surgical intervention is needed, this may range from sclerosant injection or mucosal cauterization to submucosal suture placement to rectopexy (either laparoscopic [94] or open [95]) or perineal resection. Complications following these procedures may include mucosal or full-thickness prolapse or worsening constipation.

Solitary Rectal Ulcer Syndrome (SRUS)

Though infrequent in children, SRUS seems to be associated with constipation or rectal prolapse [96], which corresponds to the purported ischemic nature of these lesions from chronic trauma. These patients present with rectal bleeding and anorectal pain with excessive mucous discharge, with ulceration often noted of the anterior rectal wall, with histology showing an obliteration of the lamina propria and hypertrophy and disordered growth of the smooth muscle into that layer [96, 97]. These symptoms generally resolve with use of laxatives and a high-fiber diet, although these patients may require use of rectal sulfasalazine or steroids and on occasion, rectopexy [97].

Sexual Abuse

In the mid 1980s, two British pediatricians published their findings from diagnosing several hundred children with sexual abuse. Among their chief findings were that 83% of boys and 25% of girls diagnosed with sexual abuse showed anal tears and obvious trauma in over half as well as reflex anal dilatation—a dynamic relaxation of the internal and external anal sphincters when the buttocks are spread, such that the examiner could see into the rectum—in over 40% [98]. Over time, concerns have been raised about whether reflex anal dilatation might been too nonspecific a sign of sexual abuse [99–101],

with the suggestion made that it may be seen in children with chronic constipation [100] or neurologic diseases associated with constipation or need for a bowel management regimen [101]. Interestingly, although a study of children with chronic constipation showed that 20–66% of children with varying levels of fecal loading showed a visibly relaxed external sphincter on examination, there were still a significant number (109 of 129) of these children who did not show any sphincteric dilation on examination [100]. In fact, evaluation of a cohort of patients presenting with a need for ano-genital examination showed that 6% of 232 patients showed signs of reflex anal dilatation, but only 1% showed this sign without predisposing factors to suggest chronic constipation (primarily based on history of constipation and use of suppositories or enemas). When Hobbs compared sexually abused patients to physically abused patients, he showed that reduced anal tone, fissures and scars as well as perineal venous congestion, especially when there was more than one of these signs, were far more prevalent in children found to have sustained sexual abuse [99].

References

1. Ladd WE, Gross R. Congenital malformations of anus and rectum: report of 162 cases. Am J Surg. 1934;23(1):167–83.
2. Santulli TV, Kieswetter WB, Bill AH. Anorectal anomalies: a suggested international classification. J Pediatr Surg. 1970;5(3):281–7.
3. Peña A. Anorectal malformations. Semin Pediatr Surg. 1995;4(1):35–47.
4. Rich MA, Brock WA, Peña A. Spectrum of genitourinary malformations in patients with imperforate anus. Pediatr Surg Int. 1988;3(2–3):110–3.
5. Brenner E. Congenital defects of the anus and rectum. Surg Gynecol Obstet. 1915;20:579–98.
6. Levitt MA, Peña A. Anorectal malformations. In: Coran A, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, Caldamone AA, editors. Pediatric surgery. Philadelphia: WB Saunders; 2012.
7. Torres R, Levitt MA, Tovilla JM, Rodriguez G, Peña A. Anorectal malformations and Down's syndrome. J Pediatr Surg. 1998;33(2):194–7.
8. Black CT, Sherman JO. The association of low imperforate anus and Down's syndrome. J Pediatr Surg. 1989;24(1):92–4.
9. Rosen NG, Hong AR, Soffer SZ, Rodriguez G, Peña A. Rectovaginal fistula: a common diagnostic error with significant consequences in girls with anorectal malformations. J Pediatr Surg. 2002;37(7):961–5.
10. Kluth D. Embryology of anorectal malformations. Semin Pediatr Surg. 2010;19(3):201–8.
11. Levi AC, Borghi F, Garavoglia M. Development of the anal canal muscles. Dis Colon Rectum. 1991;34(3):262–6.
12. Levitt MA, Patel M, Rodriguez G, Gaylin DS, Peña A. The tethered spinal cord in patients with anorectal malformations. J Pediatr Surg. 1997;32(3):462–8.
13. Van den Hondel D, Sloots C, de Jong THR, Lequin M, Wijnen R. Screening and treatment of tethered spinal cord in anorectal malformation patients. Eur J Pediatr Surg. 2016;26(1):22–8.
14. Currarino G, Coln D, Votteler T. Triad of anorectal, sacral, and presacral anomalies. AJR. 1981;137(2):395–8.
15. Dirix M, van Becelaere T, Berkenbosch L, van Baren R, Wijnen RM, Wijnen MH, et al. Malignant transformation in sacrococcygeal teratoma and in presacral teratoma associated with Currarino syndrome: a comparative study. J Pediatr Surg. 2015;50(3):462–4.
16. Bischoff A, Levitt MA, Peña A. Update on the management of anorectal malformations. Pediatr Surg Int. 2013;29(9):899–904.
17. Peña A, Migotto-Krieger M, Levitt MA. Colostomy in anorectal malformations: a procedure with serious but preventable complications. J Pediatr Surg. 2006;41(4):748–56.
18. Gross GW, Wolfson PJ, Peña A. Augmented-pressure colostogram in imperforate anus with fistula. Pediatr Radiol. 1991;21(8):560–2.
19. Devries PA, Peña A. Posterior sagittal anorectoplasty. J Pediatr Surg. 1982;17(5):638–43.
20. Rhoads JE, Pipes RL, Randall JP. A simultaneous abdominal and perineal approach in operations for imperforate anus with atresia of the rectum and rectosigmoid. Ann Surg. 1948;127(3):552–6.
21. Stephens FD. Congenital imperforated rectum, recto-urethral and recto-vaginal fistulae. Aust N Z J Surg. 1953;22(3):161–72.
22. Georgeson KE, Inge TH, Albanese CT. Laparoscopically assisted anorectal pull-through for high imperforate anus—a new technique. J Pediatr Surg. 2000;35(6):927–31.
23. Ming AX, Li L, Diao M, Wang HB, Liu Y, Ye M, et al. Long term outcomes of laparoscopic-assisted anorectoplasty: a comparison study with posterior sagittal anorectoplasty. J Pediatr Surg. 2014;49(4):560–3.
24. Wang C, Li L, Cheng W, Liu S, Diao M, Li X, et al. A new approach for persistent cloaca: laparoscopically assisted anorectoplasty and modified repair of urogenital sinus. J Pediatr Surg. 2015;50(7):1236–40.
25. Bischoff A, Martinez-Leo B, Peña A. Laparoscopic approach in the management of anorectal malformations. Pediatr Surg Int. 2015;31(5):431–7.
26. Japanese Multicenter Study Group on Male High Imperforate Anus. Multicenter retrospective

comparative study of laparoscopically assisted and conventional anorectoplasty for male infants with rectoprostatic urethral fistula. J Pediatr Surg. 2013;48(12):2363–88.
27. De Vos C, Arnold M, Sidler D, Moore SW. A comparison of laparoscopic-assisted (LAARP) and posterior sagittal (PSARP) anorectoplasty in the outcome of intermediate and high anorectal malformations. S Afr J Surg. 2011;49(1):39–43.
28. Bischoff A, Tovilla M. A practical approach to the management of pediatric fecal incontinence. Semin Pediatr Surg. 2010;19(2):154–9.
29. Levitt M, Peña A. Update on paediatric faecal incontinence. Eur J Pediatr Surg. 2009;19(1):1–9.
30. Stanton MP, Shin YM, Hutson JM. Laparoscopic placement of the Chait cecostomy device via appendicostomy. J Pediatr Surg. 2002;37(12):1766–7.
31. Levitt MA, Soffer SZ, Peña A. Continent appendicostomy in the bowel management of fecally incontinent children. J Pediatr Surg. 1997;32(11):1630–3.
32. Hirschsprung H. Classic articles in colonic and rectal surgery: constipation in the newborn as a result of dilation and hypertrophy of the colon: Harald Hirschsprung, Jahrbuch für Kinderheilkunde, 1888. Dis Colon Rectum. 1981;24(5):408–10.
33. Whitehouse FR, Kernohan JW. Myenteric plexus in congenital megacolon; study of 11 cases. Arch Intern Med. 1948;82(1):75–111.
34. Orr JD, Scobie WG. Presentation and incidence of Hirschsprung's disease. Br Med J. 1983;287(6406):1671.
35. Spouge D, Baird PA. Hirschsprung disease in a large birth cohort. Teratology. 1985;32(2):171–7.
36. Klein MD, Philippart AI. Hirschsprung's disease: three decade's experience at a single institution. J Pediatr Surg. 1993;28(10):1291–4.
37. Baxter KJ, Bhatia AM. Hirschsprung's disease in the preterm infant: implications for diagnosis and outcome. Am Surg. 2013;79(7):734–8.
38. Kenny SE, Tam PK, Garcia-Barcelo M. Hirschsprung's disease. Semin Pediatr Surg. 2010;19(3):194–200.
39. Caniano DA, Teitelbaum DH, Qualman SJ. Management of Hirschsprung's disease in children with trisomy 21. Am J Surg. 1990;19:402–4.
40. Swenson O, Sherman JO, Fisher JH. Diagnosis of congenital megacolon: an analysis of 501 patients. J Pediatr Surg. 1973;8(5):587–94.
41. Friedmacher F, Puri P. Hirschsprung's disease associated with Down syndrome: a meta-analysis of incidence, functional outcomes and mortality. Pediatr Surg Int. 2013;29(9):936–46.
42. Langer JC. Hirschsprung disease. In: Coran A, Adzick NS, Krummel TM, Laberge JM, Shamberger RC, Caldamone AA, editors. Pediatric surgery. Philadelphia: WB Saunders; 2012.
43. Aldridge RT, Campbell PE. Ganglion cell distribution in the normal rectum and anal canal. A basis for the diagnosis of Hirschsprung's disease by anorectal biopsy. J Pediatr Surg. 1968;3(4):475–90.
44. Monforte-Munoz H, Gonzalez-Gomez I, Rowland JM, Landing BH. Increased submucosal nerve trunk caliber in aganglionosis: a "positive" and objective finding in suction biopsies and segmental resections in Hirschsprung's disease. Arch Pathol Lab Med. 1998;122(8):721–5.
45. Meier-Ruge W, Lutterbeck PM, Herzog B, Morger R, Moser R, Schärli A. Acetylcholinesterase activity in suction biopsies of the rectum in the diagnosis of Hirschsprung's disease. J Pediatr Surg. 1972;7(1):11–7.
46. Grosfeld JL, Ballantine TV, Csicsko JF. A critical evaluation of the Duhamel operation for Hirschsprung's disease. Arch Surg. 1978;113(4):454–60.
47. Teitelbaum DH, Qualman SJ, Caniano DA. Hirschsprung's disease: identification of risk factors for enterocolitis. Ann Surg. 1988;207(3):240–4.
48. Aboagye J, Goldstein SD, Salazar JH, Papandria D, Okoye MT, et al. Age at presentation of common pediatric surgical conditions: reexamining dogma. J Pediatr Surg. 2014;49(6):995–9.
49. Bill AH, Chapman ND. The enterocolitis of Hirschsprung's disease: its natural history and treatment. Am J Surg. 1962;103:70–6.
50. Demehri FR, Halaweish IF, Coran AG, Teitelbaum DH. Hirschsprung-associated enterocolitis: pathogenesis, treatment and prevention. Pediatr Surg Int. 2013;29(9):873–81.
51. Taxman TL, Yulish BS, Rothstein FC. How useful is the barium enema in the diagnosis of infantile Hirschsprung's disease? Am J Dis Child. 1986;140(9):881–4.
52. O'Donovan AN, Habra G, Somers S, Malone DE, Rees A, Winthrop AL. Diagnosis of Hirschsprung's disease. AJR. 1996;167(2):517–20.
53. Proctor ML, Traubici J, Langer JC, Gibbs DL, Ein SH, Daneman A, et al. Correlation between radiographic transition zone and level of aganglionosis in Hirschsprung's disease: implications for surgical approach. J Pediatr Surg. 2003;38(5):775–8.
54. Garcia R, Arcement C, Hormaza L, Haymon MH, Ward K, Velasco C, et al. Use of the recto-sigmoid index to diagnose Hirschsprung's disease. Clin Pediatr. 2007;46(1):59–63.
55. Wong CW, Lau CT, Chung PH, Lam M, Wong KK, Tam PK. The value of the 24-h delayed abdominal radiograph of barium enema in the diagnosis of Hirschsprung's disease. Pediatr Surg Int. 2015;31(1):11–5.
56. Suzuki H, Watanabe K, Kasai M. Manometric and cineradiographic studies on anorectal motility in Hirschsprung's disease before and after surgical operation. Tohoku J Exp Med. 1970;102(1):69–80.
57. Noblett HR. A rectal suction biopsy tube for use in the diagnosis of Hirschsprung's disease. J Pediatr Surg. 1969;4(4):406–9.
58. Swenson O, Segnitz RH, Shedd RH. Hirschsprung's disease: new surgical treatment. Am J Surg. 1951;81(3):341–7.

59. Swenson O, Sherman JO, Fisher JH, Cohen E. The treatment and postoperative complications of congenital megacolon: a 25 year followup. Ann Surg. 1975;182(3):266–73.
60. Duhamel B. A new operation for the treatment of Hirschsprung's disease. Arch Dis Child. 1960;35:38–9.
61. Soave F. Hirschsprung's disease: a new surgical technique. Arch Dis Child. 1964;39:116–24.
62. So HB, Schwartz DL, Becker JM, Daum F, Schneider KM. Endorectal "pull-through" without preliminary colostomy in neonates with Hirschsprung's disease. J Pediatr Surg. 1980;15(4):470–1.
63. Teitelbaum DH, Cilley RE, Sherman NJ, Bliss D, Uitvlugt ND, Renaud EJ, et al. A decade of experience with the primary pull-through for Hirschsprung disease in the newborn period: a multicenter analysis of outcomes. Ann Surg. 2000;232(3):372–80.
64. Georgeson KE, Fuenfer MM, Hardin WD. Primary laparoscopic pull-through for Hirschsprung's disease in infants and children. J Pediatr Surg. 1995;30(7):1017–22.
65. Langer JC, Minkes RK, Mazziotti MV, Skinner MA, Winthrop AL. Transanal one-stage soave procedure for infants with Hirschsprung's disease. J Pediatr Surg. 1999;34(1):148–52.
66. Thomson D, Allin B, Long AM, Bradnock T, Walker G, Knight M. Laparoscopic assistance for primary transanal pull-through in Hirschsprung's disease: a systematic review and meta-analysis. BMJ Open. 2015;5(3):1–7.
67. Chen Y, Nah SA, Narasimhan KL, Ong CC, Chua JH, Jacobsen A, et al. Transanal endorectal pull-through versus transabdominal approach for Hirschsprung's disease: a systematic review and meta-analysis. J Pediatr Surg. 2013;48(3):642–51.
68. Peña A, Levitt M. Surgical treatment of Hirschsprung's disease. In: Wexner SD, Duthie GS, editors. Constipation: etiology, evaluation and management. 2nd ed. London: Springer; 2006. p. 221–34.
69. Ralls MW, Coran AG, Teitelbaum DH. Reoperative surgery for Hirschsprung disease. Semin Pediatr Surg. 2012;21(4):354–63.
70. El-Sawaf MI, Drongowski RA, Chamberlain JN, Coran AG, Teitelbaum DH. Are the long-term results of the transanal pull-through equal to those of the transabdominal pull-through? A comparison of the 2 approaches for Hirschsprung disease. J Pediatr Surg. 2007;42(1):41–7.
71. Kim AC, Langer JC, Pastor AC, Zhang L, Sloots CE, Hamilton NA, et al. Endorectal pull-through for Hirschsprung's disease—a multicenter, long-term comparison of results: transanal vs transabdominal approach. J Pediatr Surg. 2010;45(6):1213–20.
72. Moore SW. Total colonic aganglionosis in Hirschsprung disease. Semin Pediatr Surg. 2012;21(4):302–9.
73. Wildhaber BE, Teitelbaum DH, Coran AG. Total colonic Hirschsprung's disease: a 28-year experience. J Pediatr Surg. 2005;40(1):203–7.
74. Aworanti OM, McDowell DT, Martin IM, Hung J, Quinn F. Comparative review of functional outcomes post surgery for Hirschsprung's disease utilizing the paediatric incontinence and constipation scoring system. Pediatr Surg Int. 2012;28(11):1071–8.
75. Marty TL, Seo T, Matlak ME, Sullivan JJ, Black RE, Johnson DG. Gastrointestinal function after surgical correction of Hirschsprung's disease: long-term follow-up in 135 patients. J Pediatr Surg. 1995;30(5):655–8.
76. Yanchar NL, Soucy P. Long-term outcome after Hirschsprung's disease: patients' perspectives. J Pediatr Surg. 1999;34(7):1152–60.
77. Aworanti OM, McDowell DT, Martin IM, Quinn F. Does functional outcome improve with time postsurgery for Hirschsprung disease? Eur J Pediatr Surg. 2016;26(2):192–9. Epub 2015 Feb 2.
78. Wildhaber BE, Pakarinen M, Rintala RJ, Coran AG, Teitelbaum DH. Posterior myotomy/ myectomy for persistent stooling problems in Hirschsprung's disease. J Pediatr Surg. 2004;39(6):920–6.
79. Langer JC. Persistent obstructive symptoms after surgery for Hirschsprung's disease: development of a diagnostic and therapeutic algorithm. J Pediatr Surg. 2004;39(10):1458–62.
80. Patrus B, Nasr A, Langer JC, Gerstle T. Intrasphincteric botulinum toxin decreases the rate of hospitalization for postoperative obstructive symptoms in children with Hirschsprung disease. J Pediatr Surg. 2011;46(1):184–7.
81. Frykman PK, Short SS. Hirschsprung-associated enterocolitis: prevention and therapy. Semin Pediatr Surg. 2012;21(4):328–35.
82. El-Sawaf M, Siddiqui S, Mahmoud M, Drongowski R, Teitelbaum DH. Probiotic prophylaxis after pull-through for Hirschsprung disease to reduce incidence of enterocolitis: a prospective, randomized, double-blind, placebo-controlled, multicenter trial. J Pediatr Surg. 2013;48(1):111–7.
83. MacDonald A, Wilson-Storey D, Munro F. Treatment of perianal abscess and *fistula-in-ano* in children. Br J Surg. 2003;90(2):220–1.
84. Rosen NG, Gibbs DL, Soffer SZ, Hong A, Sher M, Peña A. The nonoperative management of fistula-in-ano. J Pediatr Surg. 2000;35(6):938–9.
85. Watanabe Y, Todani T, Yamamoto S. Conservative management of fistula in ano in infants. Pediatr Surg Int. 1998;13(4):274–6.
86. Oh JT, Han A, Han SJ, Choi SH, Hwang EH. Fistula-in-ano in infants: is nonoperative management effective? J Pediatr Surg. 2001;36(9):1367–9.
87. Beaty JS, Shashidharan M. Anal fissure. Clin Colon Rectal Surg. 2016;29(1):30–7.
88. Kenny SE, Irvine T, Driver C, Nunn AT, Losty PD, Jones MO, et al. Double blind randomized controlled trial of topical glyceryl trinitrate in anal fissure. Arch Dis Child. 2001;85(5):404–7.
89. Sonmez K, Demirogullari B, Ekingen G, Turkyilmaz Z, Karabulut R, Basaklar AC, et al. Randomized, placebo-controlled treatment of anal fissure by lido-

caine, EMLA and GTN in children. J Pediatr Surg. 2002;37(9):1313–6.
90. Husberg B, Malborg P, Strigard K. Treatment with botulinum toxin in children with chronic anal fissure. Eur J Pediatr Surg. 2009;19(5):290–2.
91. Cohen A, Dehn TC. Lateral subcutaneous sphincterotomy for treatment of anal fissure in children. Br J Surg. 1995;82(10):1341–2.
92. Hill SR, Ehrlich PF, Felt B, Dore-Stites D, Erickson K, Teitelbaum DH. Rectal prolapse in older children associated with behavioral and psychiatric disorders. Pediatr Surg Int. 2015;31(8):19–24.
93. Altemeier WA, Culbertson WR, Alexander JW. One-stage perineal repair of rectal prolapse. Twelve year's experience. Arch Surg. 1964;89:6–16.
94. Potter DD, Bruny JL, Allshouse MJ, Narkewicz MR, Soden JS, Partrick DA. Laparoscopic suture rectopexy for full-thickness anorectal prolapse in children: an effective outpatient procedure. J Pediatr Surg. 2010;45(10):2103–7.
95. Ashcraft KW, Garred JL, Holder TM, Amoury RA, Sharp RJ, Murphy JP. Rectal prolapse: 17-year experience with the posterior repair and suspension. J Pediatr Surg. 1990;25(9):992–4.
96. Figueroa-Colon R, Younoszai MK, Mitros FA. Solitary ulcer syndrome of the rectum in children. J Pediatr Gastroenterol Nutr. 1989;8(3):408–12.
97. Ertem D, Acar Y, Karaa EK, Pehlivanoglu E. A rare and often unrecognized cause of hematochezia and tenesmus in childhood; solitary rectal ulcer syndrome. Pediatrics. 2002;110(6):e79.
98. Hobbs CJ, Wynne JM. Child sexual abuse—an increasing rate of diagnosis. Lancet. 1987;2(8563):837–41.
99. Hobbs CJ, Wright CM. Anal signs of child sexual abuse: a case-control study. BMC Pediatr. 2014;14:128.
100. Clayden GS. Reflex anal dilatation associated with severe chronic constipation in children. Arch Dis Child. 1988;63(7):832–6.
101. Sfriso F, Masiero S, Mardegan V, Bressan S, Aprile A. Reflex anal dilatation: an observational study on non-abused children. Forensic Sci Int. 2014;238:22–5.

Perioperative Management

5

Sean Joseph Langenfeld

Introduction

Thirty-five years ago, a patient undergoing anorectal surgery could expect to spend several days in the hospital recovering afterward. In the modern era, more than 90% of anorectal surgeries are performed in the ambulatory setting [1]. In order to ensure excellent outcomes from outpatient surgery, it is essential that the surgeon employ a thoughtful approach to the patient's perioperative care. This process starts with the detailed office evaluation of patient-reported symptoms, moves on to the decision to operate with a thorough preoperative assessment, and continues through the patient's surgery and recovery.

This chapter contains an in-depth discussion of important considerations for the perioperative care of patients undergoing anorectal surgery, including a review of the supporting evidence and ongoing controversies. The aim of this chapter is to provide the surgeon with a framework to guide perioperative decision-making. Further reading can also be found within the American Society of Colon and Rectal Surgeons (ASCRS) practice guidelines for ambulatory anorectal surgery [2]. Of note, Chap. 6 contains a separate discussion of operative care including patient positioning and options for anesthesia.

Preoperative Care

When caring for patients with anorectal disease, the first step occurs in the office setting, where the surgeon must perform a thorough history and physical examination. This includes an in-depth review of the patient's medications, past medical and surgical history, and lifestyle issues, which may be contributing to the current pathology. A detailed anorectal examination should be performed in the office, including an external inspection, digital exam, anoscopy, and rigid proctoscopy when appropriate.

Patient Education

Once the patient's problem has been identified and a decision has been made to proceed with anorectal surgery, the next step is preparing the patient for a safe and effective surgery. Important considerations will be listed below, but this process begins by helping patients understand their disease process and treatment

S. J. Langenfeld (✉)
Department of Surgery,
University of Nebraska Medical Center,
Omaha, NE, USA
e-mail: sean.langenfeld@unmc.edu

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_5

options. This education often includes pictures, diagrams, and a summary of findings using layperson's terminology. The planned intervention should then be explained in detail, including what the patient should expect regarding the day of surgery, the associated pain, recovery time, activity restrictions, and potential time off from school or work. This process is often aided by handouts, which can be individually produced by the surgeon (Table 5.1) or purchased from the ASCRS [3].

Table 5.1 Patient handout on anal condyloma

Condyloma Acuminata Condyloma Acuminata or "anal warts" occur outside the anal opening as well as inside the anal canal. They vary in size and quantity, but can become large and extensive over time if left untreated. They are caused by the Human Papilloma Virus (HPV), and are the result of direct sexual contact with an infected individual. They also occur in the genital area, and can sometimes spread to the anal area from the groin. Anal intercourse is not necessary to develop anal warts
Symptoms These lesions are often non-tender, and can go unnoticed by the infected individual. The most common symptoms are itching, anal irritation, and mild bleeding. If the lesions are large enough, there may be palpable lumps. Please see the attached photo, which illustrates a common appearance of these warts
Treatment All anal warts require removal to prevent progression. If the lesions are small and external, they may be treated medically in the doctor's office with several different topical medications. They often require multiple treatments over time to eradicate. If the warts are extensive and/or present in the anal canal, they may require surgery. The most common approach is to fulgurate the warts. This is an outpatient procedure involving electrocautery that requires regional or general anesthesia
Follow up The doctor will need to see the patient at regular intervals for several months to eradicate any remaining or recurrent warts, as well as document wart resolution
Resolution/recurrence Recurrent condyloma is common, and can be frustrating for the patient. The Human Papilloma Virus can lay dormant for extended periods of time. Infected skin may appear normal, but still has the potential to cause future problems. We recommend that patients practice safe sex, and abstain from sexual contact with infected individuals. We also recommend that sexual partners be evaluated for warts, even if they are not experiencing symptoms

Fitness for Surgery

An assessment of patient risk begins with a review of the patient's medical history. Specific health concerns include a history of cardiopulmonary disease, liver and kidney disease, functional limitations, and significant obesity. To help with risk assessment, the American Society of Anesthesiologists (ASA) Score is typically employed (Table 5.2) [4]. While the ASA score is helpful, it should not be used alone to determine fitness for surgery, but in conjunction with more patient-specific information.

Historically, routine preoperative labs were obtained in preparation for surgery, including

Table 5.2 American Society of Anesthesiologists Physical Status Classification System

ASA PS Classification	Definition	Examples, including, but not limited to:
ASA I	A normal healthy patient	Healthy, non-smoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Examples include (but not limited to): current smoker, social alcohol drinker, pregnancy, obesity (30 < BMI < 40), well-controlled DM/HTN, mild lung disease
ASA III	A patient with severe systemic disease	Substantive functional limitations; One or more moderate to severe diseases. Examples include (but not limited to): poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA <60 weeks, history (>3 months) of MI, CVA, TIA, or CAD/stents

Table 5.2 (continued)

ASA PS Classification	Definition	Examples, including, but not limited to:
ASA IV	A patient with severe systemic disease that is a constant threat to life	Examples include (but not limited to): recent (<3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis
ASA V	A moribund patient who is not expected to survive without the operation	Examples include (but not limited to): ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	

electrolytes, a complete blood count, and coagulation studies. In addition, physicians ordered routine chest X-rays and electrocardiograms for older patients. These tests were quite costly, and often did very little to improve the safety and risk stratification of the patient. Currently, the ASA and the ASCRS both recommend the avoidance of routine labs and imaging, instead tailoring the scheduling of these tests to the individual patient's risk profile [4, 5]. Several studies show that this selective approach is safe, and results in significant cost savings [6, 7].

Choosing a Location for Surgery

As mentioned in the introduction, most anorectal surgery can be performed in the ambulatory setting, either within a hospital-based operating room or at an outpatient surgery center. Most ASA I and II patients can undergo ambulatory surgery with high levels of safety and efficacy, along with select ASA III patients [2, 8, 9]. It should be noted, however, that many ambulatory surgery centers have restrictions related to patient age and ASA scores of 3 or higher, so some patients will be required to undergo surgery in the hospital setting even if the plan is for same-day dismissal.

Other factors specific to the patient must also be considered, including the presence of a difficult airway, financial constraints, and the patient's social support structure. Procedure-specific factors including equipment availability and case complexity must also be considered [2].

Management of Home Medications

A detailed review of the patient's medication list, including prescriptions, over-the-counter medications, and herbal supplements should be performed. Most medications can be continued through surgery at the patient's normal dose and interval, including beta-blockers and oral steroids. In general, it is not necessary to provide supplemental beta-blockade in addition to the patient's home dose. Similarly, there is no proven benefit to supplemental "stress-dose" steroids, and continuation of the patient's regular dose of Prednisone is adequate.

For diabetic patients, consideration must be given to the risk of lactic acidosis associated with perioperative metformin use. This problem is rare in the absence of renal impairment [10], but the product's website advises against perioperative use [11], and metformin is typically held for 48 h prior to surgery.

Anticoagulants and anti-platelet agents must be judiciously managed based on the risk associated with drug cessation and the anticipated degree of surgical bleeding. In general, warfarin is held for 5–7 days prior to surgery, without a need to routinely check INR on the day of surgery. Clopidogrel is also typically held for 7 days prior to surgery. Of note, it is not safe to hold clopidogrel if the patient has experienced a myocardial infarction within the last 6 months, or placement of a drug-eluting stent within the last

year [12]. In these cases, the surgeon has the option of delaying non-urgent surgery or proceeding on clopidogrel with great caution.

Aspirin Use

Aspirin (81 mg) deserves specific mention, as is taken by many patients for primary and secondary prevention of cardiovascular disease, pre-existing disease, or indwelling cardiac stents. Traditionally, it has been held for 7 days when possible, and selectively continued for patients who have had recent myocardial infarctions or cardiac stents. In this latter population, cessation is associated with high rates of stent thrombosis and sudden cardiac death [12].

The safety and efficacy of aspirin use during abdominal surgery and urologic procedures have been extensively evaluated, but most studies were either retrospective or underpowered to detect bleeding complications [13–16]. In general, these studies concluded that continuing aspirin during the perioperative period was safe, and discontinuation could lead to a prothrombotic state [17, 18].

The 2014 POISE II trial was a large multicenter randomized controlled trial focused on the perioperative initiation or continuation of aspirin in major non-cardiac surgery [19]. It concluded that aspirin use did not improve death, myocardial infarction, or stroke rates when compared to placebo, but it did result in a higher risk of major bleeding (4.6% vs. 3.8%, HR 1.23; P = 0.04). Of note, patients with recent bare-metal stents or drug-eluting stents within the last year were excluded, and the dose of 200 mg exceeds what most patients take for primary or secondary prevention. In addition, a 0.8% absolute difference in major bleeding may not be clinically relevant to a patient undergoing hemorrhoidectomy.

Unfortunately, there is no high-quality literature specific to aspirin-related bleeding in anorectal surgery. Therefore, it can be held based on surgeon's preference for a week prior to surgery. For patients with bare metal or drug eluting cardiac stents, regardless of how long the stents have been in place, aspirin therapy should be continued through the perioperative period, which is generally safe but can be associated with a slightly higher risk of bleeding.

Bowel Preparation

The use of oral antibiotics (OBP) and/or mechanical bowel prep (MBP) for abdominal and pelvic surgery is a topic of hot debate among colorectal experts. At the time of this publication, the pendulum has swung back in favor of a combined OBP/MBP for colectomies, but the issue remains unsettled, and conflicting reports continue to arise within the literature.

For anorectal surgery, there is no evidence regarding the proper bowel preparation. Previous textbooks recommended full mechanical bowel prep prior to complex anorectal surgeries [20, 21], and this issue is continuously debated without consensus. It is the author's preference to have patients self-administer enemas on the evening prior to surgery, and again on the morning of surgery, using either tap water or commercially available enemas. This measure is taken not with the intent of decreasing surgical site infection, but rather to eliminate stool from the operative field and improve visualization. If patients are unable or unwilling to perform enemas, they can often be performed in the operating room, or completely omitted depending on the proposed procedure.

Editor's note: It is one of the editor's (SDW) preference to use full mechanical cathartic preparation prior to circumferential sleeve advancement procedures, and other select complex operations. Another editor (DEB) uses a limited mechanical preparation for TAMIS and other complex anorectal procedures.

Perioperative Care

Chapter 6 will discuss operative and anesthetic techniques, including patient positioning, options for anesthesia, and the use of short and long-acting local agents. This section will focus on the other elements of the operation, including the use of antibiotics, prevention of deep vein thrombosis (DVT), and management of intravenous fluids.

Antibiotic Prophylaxis

The proper use of perioperative antibiotics to prevent surgical site infection (SSI) is certainly important. However, a shallow glance at anorectal surgery from anesthesiologists or hospital administrators may result in a large overestimation of the risk for surgical site infection. When such cases are lumped in with abdominal surgery under the "colorectal" umbrella, or when the incision's location leads to a focus on the "contaminated" or "dirty/infected" wound classification, surgeons may feel external pressures to order antibiotics even when there is no actual benefit to the patient.

Despite its location within a contaminated field, the rate of surgical site infection after anorectal surgery is very low. Patients develop transient bacteremia in roughly 8% of hemorrhoidectomies [22, 23], but this rarely translates into a clinically relevant infection. There are surprisingly few studies evaluating SSI after anorectal surgery. A 2014 study retrospectively reviewed over 852 patients undergoing hemorrhoidectomy, and reported a 1.4% incidence of SSI, with routine perioperative antibiotics showing no benefit [24]. A 2014 randomized controlled trial of 100 patients undergoing hemorrhoidectomy also showed no benefit to perioperative antibiotics in regards to pain or wound healing [25].

The exact reason for such low rates of infection are not entirely known, but presumably due to the area's excellent blood supply along with the tendency of many sutured wounds to open up over time, allowing adequate drainage. Currently, there is no evidence that intravenous antibiotics should be given in the perioperative period for routine anorectal surgery. However, antibiotics may be appropriate in select patients at increased risk of SSI, including those with poorly controlled diabetes or other immunocompromised states.

Deep Vein Thrombosis (DVT) Prophylaxis

Venous thromboembolism (VTE) is a dreaded complication of surgery, not only because it can be fatal, but also because it is often preventable through the proper use of DVT prophylaxis. For abdominopelvic surgery, patients will typically receive chemoprophylaxis with unfractionated or low molecular weight heparin, along with mechanical prophylaxis from sequential compression devices (SCDs).

The risk of DVT following ambulatory anorectal surgery is exceptionally low, with only a single case reported in the literature [8]. In that case series, the rate was 0.1% (1/969 patients), and it occurred in a "calf vein" of a patient who underwent drainage of an anal abscess 2 weeks after colectomy, so one could easily argue that the anorectal surgery was not to blame for the thrombosis. In general, the DVT risk following ambulatory surgical operations remains quite low across all procedures at 0.15%, with high variation between low risk and high-risk procedures (0.06% vs. 1.18%) [26].

To the author's knowledge, there is nothing in the existing literature directly addressing the risk of VTE after ambulatory anorectal surgery. The ASCRS guidelines recommend that the choice for DVT prophylaxis be catered to the patient's individual level of risk and the anticipated length of procedure [2]. In general, chemoprophylaxis can be safely omitted, and the use of SCDs left at the discretion of the operating surgeon.

Perioperative Intravenous Fluids

Urinary retention has been reported in up to 34% of patients undergoing anorectal surgery, with the incidence being higher in male patients and in surgeries that include multi-quadrant suturing [27–29]. The result may be high rates of unplanned postoperative catheterization [30], an unpleasant experience requiring a visit to the office or emergency room.

Urinary retention after anorectal surgery is believed to be secondary to muscle spasm and swelling. When such spasm occurs, aggressive intravenous fluid administration can lead to accumulation of high volumes of urine within the bladder, causing overdistention and atony. In order to avoid this problem, the surgeon must

establish well-defined fluid protocols and educate other members of the surgery team on the dangers of aggressive fluid administration. It is also important that the surgeon maintain open communication with the anesthesia team and the perioperative nurses. One avenue to accomplish this goal is to discuss the plan for fluid restriction during the surgical time out.

Current ASCRS guidelines cite level 1b evidence that urinary retention can be reduced by the restriction of perioperative fluid administration [2]. In general, oral and intravenous fluids should be restricted to less than 1000 mL until the patient has voided. Some expert groups recommend restricting fluids even further to 250 mL, with low subsequent rates of retention [30, 31]. It is easier to safely limit intravenous fluid administration when a preoperative oral cathartic bowel prep has been avoided.

Postoperative Care

Once the patient has undergone successful anorectal surgery, the next step is to ensure a quick and uncomplicated recovery. In general, a proactive approach is more effective than a reactive one, and many issues can be avoided by anticipating problems before they occur.

Enhanced Recovery

While the concept of "fast track" surgery or Enhanced Recovery After Surgery (ERAS) typically refers to abdominopelvic colorectal surgery, many of the same principles apply to anorectal surgery as well. The concepts of preoperative patient education, omission of bowel prep, and limited intraoperative fluids have already been discussed. Many parallels to ERAS exist within the postoperative care as well, where the surgeon relies on multi-modal pain control to minimize narcotics, and maintains a focus on early return to normal activities and work.

Patient Education

As discussed earlier, patient education is of paramount importance, and this is central in the recovery period. Due to anesthesia and narcotics, most patients will not remember postoperative interactions with adequate clarity. Friends and family members who accompany the patient may not have the necessary details of the patient's pathology, or the understanding and recall to be reliable messengers. Therefore, it is helpful for the surgeon to once again provide diagrams and printed handouts so that the patient will know what to expect during the recovery period (Table 5.3). Such an approach will reduce patient confusion, eliminate phone calls, and generally lead to a higher rate of patient and surgeon satisfaction. Currently, the use of electronic medical records allows for standardized templates and "smart phrases" to be used for patient education, which can greatly enhance the speed and reproducibility of the process.

Antibiotics

Much like in the perioperative setting, antibiotics do not have a role in the routine postoperative care of anorectal surgery patients. The use of postoperative oral antibiotics after incision and drainage of anal abscess was studied in a 2011 randomized controlled trial [32]. This study determined that antibiotics did not result in lower rates of infection or subsequent fistula formation compared to placebo.

Oral metronidazole has not only been used for control of postoperative infection, but also for alleviation of postoperative pain. A small randomized controlled trial in 1998 showed improved analgesia with metronidazole when compared to placebo [33], but subsequent randomized trials have failed to show benefit for postoperative pain [34, 35]. Currently there is no clear role for oral metronidazole in the postoperative period.

Table 5.3 Postoperative instructions

Today, you underwent the following procedure:_____
During the recovery period, you should take the following medications in addition to your regular home medications: 1. **Docusate sodium 100 mg**: 1 pill to be taken twice daily. This is a stool softener to avoid constipation. It is available over the counter. 2. **Ibuprofen 200 mg**: 4 pills (800 mg) to be taken three times per day for 5 days, then up to three times per day as needed after that. This is a pain medicine to help with anal discomfort. This should be taken with a small snack to avoid stomach upset. 3. **Hydrocodone/Acetaminophen 5/325 mg**: 1–2 pills every 6–8 h as needed for pain. This is a narcotic, and will cause constipation when used. A prescription will be sent home with you. 4. **Additional new medications**: _____ _____
Sitz baths should be performed three times per day, using warm water and soaking for 20 min at a time. This will decrease pain and help keep the wound clean. Epsom salts is not necessary. A bathtub can be used for the Sitz baths, or a small plastic Sitz bath can be purchased from the pharmacy. Sitz baths can be performed more frequently if desired
If unable to urinate, fill the bathtub above the waist with warm water to see if this allows you to void. If not, please call the office immediately for further assistance
Some bleeding is normal after anal surgery. If the bleeding is copious or getting worse, please call the office for assistance
It is essential that you keep your bowel movements soft and easy to pass. Hard or large stools will cause increased discomfort and may traumatize your new wound. Please take the stool softeners as directed, drink plenty of water, and maintain a high fiber diet (20–25 g/day). If hard stools persist, start taking polyethylene glycol 17 g (one capful) mixed in 8 ounces of water one to two times per day
An appointment has been made for you to follow up in the surgeon's office on the following date: _____. Please call if you are unable to make that appointment, or if you wish to be seen sooner
Please call with any questions or concerns about your postoperative care. Your surgery team is available 24 h per day at the following number: _____

Sitz Baths

To help with pain and wound care, patients often undergo scheduled "Sitz baths" after anorectal surgery, which consists of soaking the anus in warm water three to four times per day for 20–30 min at a time. It is typically recommended that the patients utilize very warm water, but avoid temperatures that can damage the wound. No additive agents are necessary, and the use of "Epsom salts" (Magnesium Sulfate compounds) should be avoided. Patients can use a bathtub, or can purchase a commercially available plastic Sitz bath (Fig. 5.1), which can be easily found at local pharmacies and medical supply stores. Hospital wards can usually purchase Sitz baths for less than $1, but they are typically in excess of $15 in retail locations [36, 37].

While utilization of the absorbable fistula plug for treatment of complex anal fistulas is becoming an increasingly rare procedure, the plug's instructions should be read carefully, as Sitz baths are often contraindicated in patients with indwelling plugs.

Fig. 5.1 Sitz bath. Photo courtesy of Sean Langenfeld, MD

The evidence that Sitz baths reduce pain after anorectal surgery is quite modest [38, 39], but they are known to reduce intra-anal resting pressures [40], which is of hypothetical benefit to the patient. In addition, the intervention is cheap and easy with little known side effects, so it remains as a common element of most recovery algorithms.

Wound Care

Wounds that exist within or above the anal canal do not typically require postoperative care, and attempts at special care may lead to unnecessary wound trauma and patient discomfort. Open or closed wounds at the anal verge or on the anal margin can typically be managed with Sitz baths alone, or in conjunction with a gauze pad to control drainage. Special ointments to assist wound healing will be discussed shortly, but are typically not necessary. Antibiotic ointments for anorectal wounds have not been well studied, and are generally unnecessary.

In general, serial or repeated packing of open anal wounds causes significant discomfort without patient benefit. If packing is placed at surgery to control bleeding or to stent the incision open, this packing can be removed during the patient's first Sitz bath, and does not require replacement. If repeated packing is necessary to keep a wound open after an incision and drainage of an anorectal abscess, it is likely that the surgeon made an inadequate incision at the time of surgery.

The choice of suture for anorectal surgery is left at the surgeon's discretion, but this choice does affect postoperative care. Absorbable suture such as chromic or polyglycolic acid is preferred, as postoperative suture removal is generally both difficult and painful.

It is quite common for anal suture lines to separate over time, which is normal and typically does not negatively impact surgical outcomes. If slower-absorbing sutures and running suture lines are employed, patients may contact or come to the office with complaints of hanging sutures. Patients should be coached to avoid pulling on these sutures in an attempt for removal, and they should instead be instructed to either ignore the strands, or gently cut them off at the skin level.

When more complex anorectal surgeries are performed, including sphincteroplasties, anoplasties, and endorectal advancement flaps, patients are often instructed to avoid sitting directly on their incisions to help prevent wound breakdown or flap disruption. While this seems intuitive, the author is unaware of any literature that supports or negates these recommendations.

Activity and Work Restrictions

There are no universal rules regarding whether or not patients should limit their activities after anorectal surgery. For simpler procedures such as sphincterotomy, fistulotomy, and abscess drainage, patients can perform normal activities without restriction. For the more complex cases including local excision of rectal tumors, sphincteroplasty, anoplasty, and endorectal advancement flaps, it is reasonable to have the patient avoid strenuous exercise and heavy lifting for 2–3 weeks after surgery to prevent undue tension on flaps and suture lines.

Work restrictions are similarly vague, and typically depend on the patient's occupation and the amount of anticipated postoperative pain. Some patients will only require 1–2 days off from work after surgery, while others will have sufficient pain to warrant 1 or 2 weeks away from work. Patients should be allowed up to 2 weeks off of work if desired, especially if they undergo hemorrhoidectomy or other procedures known to be associated with significant postoperative pain.

Diet

There are no meaningful data in support of a specific diet after anorectal surgery. High fiber diets are often recommended to help prevent postoperative constipation, but there are no specific restrictions that require adherence. Once they are voiding easily, it is also important that patients drink plenty of water, as dehydration is common in the postoperative period, which contributes to fatigue and constipation.

Bowel Regimen

Constipation is common after anorectal surgery for many reasons, including dehydration, narcotic intake, and the functional constipation that occurs from the patient's fear of a painful bowel movement. Efforts should be made to avoid postoperative constipation, as hard stools often

exacerbate pain and can put unnecessary stress on surgical wounds.

No specific bowel regimen is superior, but most surgeons recommend a combination of increased fiber intake, increased water intake, and a scheduled stool softener such as Docusate Sodium or Polyethylene Glycol to prevent large or hard stools. Other stimulant laxatives such as senna, bisacodyl, magnesium citrate, and milk of magnesia may also be used temporarily as a rescue therapy, but they are often associated with more diarrhea and cramping, can be habit-forming, and should be avoided if possible in the long term.

Pain Management

Anorectal surgery is often very painful, and poor pain control can lead to a multitude of problems including urinary retention, constipation, emergency room visits, and readmissions. ASCRS guidelines recommend a multi-modal approach to postoperative analgesia (Table 5.4) [2]. This protocol begins in the operating room with the use of local analgesia in the form of traditional or long-acting (liposomal) bupivacaine, and also includes the above-mentioned Sitz baths and bowel regimens.

Oral and IV Analgesia

Most patients receive a prescription for an oral narcotic such as hydrocodone or oxycodone combined with acetaminophen. These compounds should be used with discretion, as constipation is nearly universal and dependence can occur with prolonged use.

Nonsteroidal anti-inflammatory drugs (NSAIDs) are typically used in the postoperative period to improve analgesia and limit narcotic consumption. Over-the-counter ibuprofen at a dose of 600 or 800 mg can be extremely effective for analgesia. Ketorolac has also shown efficacy with several methods of delivery, including intravenous, intramuscular, subcutaneous, and peri-incisional [41–44]. In general, patients without contraindications will receive 30 mg of IV ketorolac during the procedure to help with postoperative pain.

Oral metronidazole was previously discussed, and no clear benefit is known to routine postoperative administration.

Table 5.4 Elements of multi-modal postoperative analgesia

Intraoperative:
Local injection of short or long-acting (liposomal) bupivacaine
Intravenous Ketorolac
Postoperative:
Sitz baths
Oral narcotics in combination with acetaminophen
Ibuprofen or other NSAIDs
Topical agents (Metronidazole, Sucralfate)
Bowel regimen to avoid constipation

Topical Analgesia

Many topical agents have been employed as adjuncts for postoperative pain control; this discussion focuses on the most commonly used medications.

Two small randomized controlled trials evaluated topical metronidazole cream (10%) for pain relief after hemorrhoidectomy, both of which concluded that there was a significant reduction in pain, but no change in narcotic consumption [45, 46].

Topical sucralfate has been well studied for alleviation of radiation proctitis, and has recently earned the enthusiasm of a single group from Nagpur, India. Dr. Prasad et al. published a randomized controlled trial in 2008 using sucralfate 7% ointment after hemorrhoidectomy [47], and then a second study in 2011 focusing on fistulotomy [48]. Both studies showed sucralfate ointment to improve postoperative wound healing and decrease postoperative pain when compared to placebo.

Topical glyceryl trinitrate (GTN) and topical calcium channel blockers (CCBs) are known to reduce intra-anal pressures, and have long been used for the conservative management of anal fissures. Since much of the pain after anorectal surgery is thought to be secondary to muscle spasm, these agents have also been studied for the relief of postoperative pain. Topical GTN has shown

modest reductions in postoperative pain, but headache is a common side effect, which limits compliance [49]. Topical diltiazem has shown similar modest benefits in pain, but no reduction in narcotic consumption [50].

In summary, topical agents can be used safely, but the benefits are modest, and most agents require a visitation to a compounding pharmacy, where cost can be a limiting factor.

Outpatient Follow-Up

In the early postoperative period, inspection of the wound should typically be limited to an external exam, with digital rectal exam and anoscopy reserved for the investigation of specific concerns. Otherwise, early invasive techniques will result in a great deal of pain to the patient, and it may lead to unnecessary wound trauma and suture line disruption.

The interval between surgery and the first follow up appointment is left to the discretion of the surgeon, and is often based on individual and institutional workflows and practice patterns. Typically, patients should be seen 2–6 weeks after surgery to ensure they are recovering well and ready to resume normal activity. Some surgeons advocate for the first visit to be 4–6 weeks after surgery because at that time the pain will generally have markedly decreased and the patient is usually more satisfied with the surgical outcome than they were at 2 weeks.

Dismissal from clinic should be allowed once the wounds have healed, and the patient's underlying pathology has been adequately alleviated. Certain conditions will require more long-term follow up, including patients with complex anal fistulas, inflammatory bowel disease, anal condyloma, anorectal neoplasia, and perianal Crohn's disease.

Ambulatory Surgery Outcomes

The move toward ambulatory anorectal surgery came with many benefits to both the patient and surgeon. Surgeons often prefer the increased levels of speed and efficiency in the ambulatory setting, while patients appreciate many of the mechanical benefits that include more convenient locations, easier scheduling, closer parking, and a quicker return to a familiar home environment.

Ambulatory anorectal surgery has been shown to be safe, with low rates of complications and unplanned patient admissions. Patient outcomes have been shown to be equivalent or better than what can be achieved in the hospital setting [2, 51–55]. Ambulatory anorectal surgery has also been shown to be cost-effective, with cost savings of 30–50% when compared to inpatient surgery [56, 57]. Of equal importance is patient satisfaction, which has been very high in published surveys of ambulatory surgery [58]. A 2012 survey study looking specifically ant ambulatory anorectal surgery showed very high scores for postoperative quality of life and functional outcomes, with an overall postoperative satisfaction rate of 92.4% [55].

Complications After Anorectal Surgery

An in-depth discussion of complications after anorectal surgery likely deserves its own chapter or even its own textbook. However, this section will summarize common problems that arise after anorectal surgery. The two main categories to consider are early/acute complications and late/chronic complications.

Acute Complications

Infection

Infection after anorectal surgery can be difficult to identify, as the symptoms of swelling, pain, and foul-smelling drainage are very common and considered to be a normal part of the recovery process for many procedures. As mentioned earlier, major infection after anorectal surgery is rare [22–25]. However, since the incidence is low, and the symptoms are vague, the surgeon must maintain a high level of suspicion when evaluating postoperative patient complaints.

One caveat is that pain and urinary retention should not become progressively worse after anorectal surgery, and such occurrences should alert the treatment team to the possibility of pelvic sepsis. The triad of fever, worsening pain, and the inability to urinate should lead to a prompt examination by the surgeon, along with lab work and a CT of the pelvis if the diagnosis remains in question. If faced with pelvic sepsis, the next step would be an emergent exam under anesthesia with drainage of abscess, debridement of any devitalized tissue, and consideration for fecal diversion.

Urinary Retention

As mentioned earlier, urinary retention is very common after anorectal surgery, with rates of 15–50% for male patients [27, 29, 59, 60]. When urinary retention occurs despite the limitation of fluids and adequate pain control, the first step is the have the patient to lie waist-deep within a bathtub of very warm water, with hopes that this will reduce spasm and swelling and allow the patient to void. If still unable to void, the next step is either an indwelling urinary catheter or intermittent straight catheterization, which often has to continue for several days while the anorectal inflammation cools off. Most patients can have their urinary catheter removed in the office after 3–4 days, at which time their ability to void is improved. If problems persist after the first postoperative week, consultation with an urologist is appropriate.

Hemorrhage

Minor bleeding after anorectal surgery is nearly universal, and patients are typically poor judges of the true volume of blood experienced, especially when the toilet bowl water has been colored red. While significant postoperative hemorrhage is uncommon, it does occur in up to 6% of anorectal surgeries, with the incidence being the highest after hemorrhoidectomy [61, 62].

When bleeding occurs, the treatment of choice depends on the severity and location. Most bleeds will resolve without intervention, and patients can be placed in observation with serial exams and serial hemoglobins. For anal margin bleeding, bedside electrocautery or sutures can be used for control. Anal canal bleeding is more problematic, and 15–33% of patients who bleed after hemorrhoidectomy will require an unplanned return to the operating room for surgical control [63, 64].

Side Effects of Local Trauma

Constipation is common after surgery and has been previously discussed. In addition, patients may experience acute anal fissures and thrombosed external hemorrhoids as a result of their recent surgery and the associated constipation. These problems are typically self-limited and should be treated with supportive care including Sitz baths and topical ointments.

Chronic Complications

Fecal Incontinence

Postoperative fecal incontinence (FI) is often multi-factorial. While uncommon, it can be devastating to the patient. A preoperative discussion of risk, along with, when appropriate, a preoperative assessment of baseline fecal continence using a validated instrument [65], are of utmost importance.

Internal hemorrhoids provide 15% of the resting anal tone, and hemorrhoidectomy should be avoided if possible in patients with pre-existing fecal incontinence. Immediate and delayed reductions in fecal continence can also occur when sphincter muscle is intentionally divided. Approximately 25% of patients with complex fistulotomy and up to 8% of patients following sphincterotomy will experience some degree of FI [66–70]. In addition, unintentional sphincter injuries can occur, including thermal trauma to the sphincter. Thermal trauma can occur from any source, but the surgeon should practice with extreme caution when using energy devices for hemorrhoidectomy, including ultrasonic shears, as there is potential for lateral thermal spread. Other patients may have new or recurrent anal fistulas with symptoms that mimic incontinence.

The workup of iatrogenic fecal incontinence is similar to the approach to other causes of FI, and

includes anorectal manometry and endorectal ultrasound to better define the injury. The treatment algorithm is also similar to traditional FI, and includes an initial trial of bulking agents and low-dose anti-diarrheal agents. Biofeedback may also be effective. When conservative treatment fails, these patients are candidates for sacral neuromodulation or sphincteroplasty, but long-term outcomes in patients with non-obstetrical trauma are not well known [71–73].

Anal Stenosis

Any trauma to the anal canal can result in scarring and long-term stenosis, which can cause difficulty with evacuation, incontinence, anal fissures, and severe pain with defecation. Patients undergoing three-quadrant hemorrhoidectomy are at an increased risk due to the large volume of resected anoderm.

Once anal stenosis has been discovered, the first step is to ensure there is no underlying malignancy. If an office exam is inadequate for this, patients may require an exam under anesthesia, possibly with biopsy. Depending on the location and severity of stenosis, patients often benefit from serial office dilations. When these measures fail, the surgeon may consider anoplasty to introduce healthy tissue into the anal canal.

Chronic Pain

Chronic pain after anorectal surgery is thankfully uncommon. Causes are multiple, and include complications of surgery, such as stenosis, retained staples from a procedure for prolapsed hemorrhoids, and persistence of the presenting pathology such as residual fissures, abscesses, or fistulas. Spasm of the internal anal sphincter secondary to the trauma of surgery may also contribute.

The first step in the evaluation of chronic pain is to ensure there is no untreated anorectal sepsis. Once this step has been completed, the focus can shift to symptom control. Most chronic pain will improve with time, and a combination of Sitz baths, NSAIDs, low-dose antispasmodics, and patient reassurance will be adequate. For patients with persistent hypertonicity and anismus, botulinum toxin injection can help to alleviate symptoms [74]. For patients with retained staples after PPH, exam under anesthesia with staple removal can also be quite helpful [75]. Sacral neuromodulation for chronic pelvic pain has also been described in a small case series with promising results [76]. However, there is no USA FDA labeling for this indication.

Summary

The perioperative management of the ambulatory anorectal surgery patient has evolved over time, and is currently supported by higher level evidence than was previously available. When surgeons take leadership in the perioperative care of their patients, and invest time into the creation of standardized treatment protocols, they can ensure a successful surgery with a safe and expeditious recovery. Complications after anorectal surgery are typically minor, and can be easily managed when identified in a timely manner.

References

1. Smith LE. Ambulatory surgery for anorectal diseases: an update. South Med J. 1986;79(2):163–6.
2. Ternent CA, Fleming F, Welton ML, Buie WD, Steele S, Rafferty J. Clinical practice guidelines for ambulatory anorectal surgery. Dis Colon Rectum. 2015;58:915–22.
3. https://imis.fascrs.org/ASCRSIMIS/Members/Store/StoreLayouts/Store.aspx. Accessed 4 Feb 2016.
4. ASA physical status classification system, last approved by the ASA House of Delegates on October 15, 2014. Available at: https://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system. Accessed 21 June 2018.
5. Apfelbaum JL, Connis RT, Nickinovich DG, et al. Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. Anesthesiology. 2012;116(3):522–38.
6. Chung F, Yuan H, Yin L, Vairavanathan S, Wong DT. Elimination of preoperative testing in ambulatory surgery. Anesth Analg. 2009;108:467–75.
7. Czoski-Murray C, Lloyd Jones M, McCabe C, et al. What is the value of routinely testing full blood count, electrolytes, and urea, and pulmonary function tests before elective surgery in patients with no apparent clinical indication and in subgroups of patients with common comorbidities: a systematic review of the

clinical and cost-effective literature. Health Technol Assess. 2012;16:i–xvi,1.
8. Hyman NH, Cataldo PA, Trevisani GT, Burns BH, Shackford SR. Tracking outcomes of anorectal surgery: the need for a disease-specific quality assessment tool. Dis Colon Rectum. 2008;51:1221–4.
9. Ansell GL, Montgomery JE. Outcomes of ASA III patients undergoing day case surgery. Br J Anaesth. 2004;92(1):71–4.
10. Joshi GP, Chung F, Vann MA, et al. Society for ambulatory anesthesia consensus statement on perioperative blood glucose management in diabetic patients undergoing ambulatory surgery. Anesth Analg. 2010;111:L1378–87.
11. http://packageinserts.bms.com/pi/pi_glucophage.pdf. Accessed 4 Feb 2016.
12. Albaladejo P, Marret E, Samama CM, et al. Noncardiac surgery in patients with coronary stents: the RECO study. Heart. 2011;97:1566–72.
13. Fujikawa T, Tanaka A, Abe T, et al. Does antiplatelet therapy affect outcomes of patients receiving abdominal laparoscopic surgery? Lessons from more than 1,000 laparoscopic operations in a single tertiary referral hospital. J Am Coll Surg. 2013;217(6):1044–53.
14. Sahebally SM, Healy D, Coffey JC, Walsh SR. Should patients taking aspirin for secondary prevention continue or discontinue the medication prior to elective, abdominal surgery? Best evidence topic (BET). In J Surg. 2014;12(5):16–21.
15. Giannarini G, Mogorovich A, Valent F, et al. Continuing or discontinuing low-dose aspirin before transrectal prostate biopsy: results of a prospective randomized trial. Urology. 2007;70(3):501–5.
16. Oscarsson A, Gupta A, Fredrikson M, et al. To continue or discontinue aspirin in the perioperative period: a randomized, controlled clinical trial. Br J Anaesth. 2010;104(3):305–12.
17. Burger W, Chemnitius JM, Kneissl GD, Rücker G. Low-dose aspirin for secondary cardiovascular prevention—cardiovascular risks after its perioperative withdrawal versus bleeding risks with its continuation—review and meta-analysis. J Intern Med. 2005;257:399–414.
18. Gerstein NS, Schulman PM, Gerstein WH, Petersen TR, Tawil I. Should more patients continue aspirin therapy perioperatively? Clinical impact of aspirin withdrawal syndrome. Ann Surg. 2012;255:811–9.
19. Devereaux PJ, Mrkobrada M, Sessler DI, et al. Aspirin in patients undergoing noncardiac surgery. N Engl J Med. 2014;370(16):1494–503.
20. Bailey HR, Snyder MJ. Selection, preoperative assessment, and education of the patient for ambulatory surgery. In: Ambulatory anorectal surgery. New York: Springer; 2000. p. 37–45.
21. Beck DE, Wexner SD. Preoperative and postoperative management. In: Fundamentals of anorectal surgery. 2nd ed. New York: McGraw-Hill;1992; 50–56.
22. Bonardi RA, Rosin JD, Stonesifer GL Jr, Bauer FW. Bacteremias associated with routine hemorrhoidectomies. Dis Colon Rectum. 1976;19:233–6.
23. Adami B, Eckardt VF, Suermann RB, Karbach U, Ewe K. Bacteremia after proctoscopy and hemorrhoidal injection sclerotherapy. Dis Colon Rectum. 1981;24:373–4.
24. Nelson DW, Champagne BJ, Rivadeneira DE, et al. Prophylactic antibiotics for hemorrhoidectomy: are they really needed? Dis Colon Rectum. 2014;57:365–9.
25. Khan KI, Akmal M, Wagas A, Mahmood S. Role of prophylactic antibiotics in Milligan Morgan hemorrhoidectomy—a randomized control trial. Int J Surg. 2014;12(8):868–71.
26. Pannucci CJ, Shanks A, Moote MJ, et al. Identifying patients at high risk for venous thromboembolism requiring treatment after outpatient surgery. Ann Surg. 2012;255(6):1093–9.
27. Petros JG, Bradley TM. Factors influencing postoperative urinary retention in patients undergoing surgery for benign anorectal disease. Am J Surg. 1990;159:374–6.
28. Prasad ML, Abcarian H. Urinary retention following operations for benign anorectal diseases. Dis Colon Rectum. 1978;21:490–2.
29. Zaheer S, Reilly WT, Pemberton JH, Ilstrup D. Urinary retention after operations for benign anorectal diseases. Dis Colon Rectum. 1998;41:696–704.
30. Bailey HR, Ferguson JA. Prevention of urinary retention by fluid restriction following anorectal operations. Dis Colon Rectum. 1976;19:250–2.
31. Hoff SD, Bailey HR, Butts DR, et al. Ambulatory surgical hemorrhoidectomy—a solution to postoperative urinary retention? Dis Colon Rectum. 1994;37(12):1242–4.
32. Sozener U, Gedik E, Kessaf Aslar A, et al. Does adjuvant antibiotic treatment after drainage of anorectal abscess prevent development of anal fistulas? A randomized, placebo-controlled, double- blind, multicenter study. Dis Colon Rectum. 2011;54(8):923–9.
33. Carapeti EA, Kamm MA, McDonald PJ, Phillips RK. Double-blind randomised controlled trial of effect of metronidazole on pain after day-case haemorrhoidectomy. Lancet. 1998;351:169–72.
34. Balfour L, Stojkovic SG, Botterill ID, Burke DA, Finan PJ, Sagar PM. A randomized, double-blind trial of the effect of metronidazole on pain after closed hemorrhoidectomy. Dis Colon Rectum. 2002;45(9):1186–90.
35. Hosseini SV, Sabet B, Nouri Amirkolaee M, Bolandparvaz S. A randomized clinical trial on the effect of oral metronidazole on wound healing and pain after anal sphincterotomy and fissurectomy. Arch Iran Med. 2008;11(5):550–2.
36. http://www.cardinalhealth.com/en/consumer-products/home-healthcare-solutions/Daily-Living-Aids/Sitz-Bath.html. Accessed 3 Feb 2016.
37. http://www.cvs.com/shop/home-health-care/other-daily-living-aids/bath-body-products/cvs-sitz-bath-skuid-741742. Accessed 4 Feb 2016.

38. Gupta PJ. Effects of warm water sitz bath on symptoms in post-anal sphincterotomy in chronic anal fissure—a randomized and controlled study. World J Surg. 2007;31(7):1480–4.
39. Gupta PJ. Warm sitz bath does not reduce symptoms in posthaemorrhoidectomy period: a randomized, controlled study. ANZ J Surg. 2008;78(5):398–401.
40. Dodi G, Bogoni F, Infantino A, Pianon P, Mortellaro LM, Lise M. Hot or cold in anal pain? A study of the changes in internal anal sphincter pressure profiles. Dis Colon Rectum. 1986;29(4):248–51.
41. Richman IM. Use of Toradol in anorectal surgery. Dis Colon Rectum. 1993;36(3):295–6.
42. Place RJ, Coloma M, White PF, Huber PJ, Van Vlymen J, Simmang CL. Ketorolac improves recovery after outpatient anorectal surgery. Dis Colon Rectum. 2000;43(6):804–8.
43. O'Donovan S, Ferrara A, Larach S, Williamson P. Intraoperative use of Toradol facilitates outpatient hemorrhoidectomy. Dis Colon Rectum. 1994;37(8):793–9.
44. De Oliveira GS, Agarwal D, Benzon HT. Perioperative single dose ketorolac to prevent postoperative pain: a meta-analysis of randomized trials. Anesth Analg. 2012;114(2):424–33.
45. Nicholson TJ, Armstrong D. Topical metronidazole (10 percent) decreases posthemorrhoidectomy pain and improves healing. Dis Colon Rectum. 2004;47(5):711–6.
46. Ala S, Saeedi M, Eshghi F, Mirzabeygi P. Topical metronidazole can reduce pain after surgery and pain on defecation in postoperative hemorrhoidectomy. Dis Colon Rectum. 2008;51(2):235–8.
47. Gupta PJ, Heda PS, Kalaskar S, Tamaskar VP. Topical sucralfate decreases pain after hemorrhoidectomy and improves healing: a randomized, blinded, controlled study. Dis Colon Rectum. 2008;51(2):231–4.
48. Gupta PJ, Heda PS, Shrirao SA, Kalaskar SS. Topical sucralfate treatment of anal fistulotomy wounds: a randomized placebo-controlled trial. Dis Colon Rectum. 2011;54(6):699–704.
49. Ratnasingham K, Uzzaman M, Andreani SM, Light D, Patel B. Meta-analysis of the use of glyceryl trinitrate ointment after haemorrhoidectomy as an analgesic and in promoting wound healing. Int J Surg. 2010;8(8):606–11.
50. Silverman R, Bendick PJ, Wasvary HJ. A randomized, prospective, double-blind, placebo-controlled trial of the effect of a calcium channel blocker ointment on pain after hemorrhoidectomy. Dis Colon Rectum. 2005;48(10):1913–6.
51. Faiz OD, Brown TJ, Colucci G, Grover M, Clark SK. Trends in colorectal day case surgery in NHS Trusts between 1998 and 2005. Color Dis. 2008;10:935–42.
52. Lohsiriwat D, Lohsiriwat V. Outpatient hemorrhoidectomy under perianal anesthetics infiltration. J Med Assoc Thail. 2005;88:1821–4.
53. Hidalgo Grau LA, Heredia Budó A, Llorca Cardeñosa S, et al. Day case stapled anopexy for the treatment of haemorrhoids and rectal mucosal prolapse. Color Dis. 2012;14:765–8.
54. Chan PY, Lee MP, Cheung HY, Chung CC, Li MK. Unplanned admission after day-case haemorrhoidectomy: a retrospective study. Asian J Surg. 2010;33:203–7.
55. Grucela A, Gurland B, Kiran RP. Functional outcomes and quality of life after anorectal surgery. Am Surg. 2012;78:952–6.
56. Stephenson SV. Ambulatory surgical centers. JAMA. 1985;253(3):342–3.
57. Lacerda-Filho A, Cunha-Melo JR. Outpatient haemorrhoidectomy under local anaesthesia. Eur J Surg. 1997;163:935–40.
58. Tong D, Chung F, Wong D. Predictive factors in global and anesthesia satisfaction in ambulatory surgical patients. Anesthesiology. 1997;87:856–64.
59. Toyonaga T, Matsushima M, Sogawa N, et al. Postoperative urinary retention after surgery for benign anorectal disease: potential risk factors and strategy for prevention. Int J Color Dis. 2006;21(7):676–82.
60. Baldini G, Bagry H, Aprikian A, Carli F. Postoperative urinary retention: anesthetic and perioperative considerations. Anesthesiology. 2009;110(5):1139–57.
61. MacRae HM, McLeod RS. Comparison of hemorrhoidal treatment modalities. A meta-analysis. Dis Colon Rectum. 1995;38(7):687–94.
62. Rosen L, Sipe P, Stasik JJ, Riether RD, Trimpi HD. Outcome of delayed hemorrhage following surgical hemorrhoidectomy. Dis Colon Rectum. 1993;36(8):743–6.
63. Nisar PJ, Acheson AG, Neal KR, Scholefield JH. Stapled hemorrhoidopexy compared with conventional hemorrhoidectomy: systematic review of randomized, controlled trials. Dis Colon Rectum. 2004;47(11):1837–45.
64. Chen HH, Wang JY, Changchien CR, Yeh CY, Tsai WS, Tang R. Effective management of posthemorrhoidectomy secondary hemorrhage using rectal irrigation. Dis Colon Rectum. 2002;45(2):234–8.
65. Jorge JM, Wexner SD. Etiology and management of fecal incontinence. Dis Colon Rectum. 1993;36(1):77–97.
66. Roig JV, Jordán J, García-Armengol J, Esclapez P, Solana A. Changes in anorectal morphologic and functional parameters after fistula-in-ano surgery. Dis Colon Rectum. 2009;52(8):1462–9.
67. Visscher AP, Schuur D, Roos R, Van der Mijnsbrugge GJ, Meijerink WJ, Felt-Bersma RJ. Long-term follow-up after surgery for simple and complex cryptoglandular fistulas: fecal incontinence and impact on quality of life. Dis Colon Rectum. 2015;58(5):533–9.
68. Jordán J, Roig JV, García-Armengol J, García-Granero E, Solana A, Lledó S. Risk factors for recurrence and incontinence after anal fistula surgery. Color Dis. 2010;12(3):254–60.

69. Oh C, Divino CM, Steinhagen RM. Anal fissure. 20-year experience. Dis Colon Rectum. 1995;38(4):378–82.
70. García-Aguilar J, Belmonte Montes C, Perez JJ, Jensen L, Madoff RD, Wong WD. Incontinence after lateral internal sphincterotomy: anatomic and functional evaluation. Dis Colon Rectum. 1998;41(4):423–7.
71. Altomare DF, Ratto C, Ganio E, Lolli P, Masin A, Villani RD. Long-term outcome of sacral nerve stimulation for fecal incontinence. Dis Colon Rectum. 2009;52(1):11–7.
72. Wexner SD, Coller JA, Devroede G, et al. Sacral nerve stimulation for fecal incontinence: results of a 120-patient prospective multicenter study. Ann Surg. 2010;251(3):441–9.
73. Glasgow SC, Lowry AC. Long-term outcomes of anal sphincter repair for fecal incontinence: a systematic review. Dis Colon Rectum. 2012;55(4):482–90.
74. Ron Y, Avni Y, Lukovetski A, et al. Botulinum toxin type-A in therapy of patients with anismus. Dis Colon Rectum. 2001;44(12):1821–6.
75. Mari FS, Nigri G, Di Cesare T, et al. Does the removal of retained staples really improve postoperative chronic sequelae after transanal stapled operations? Dis Colon Rectum. 2014;57(5):658–62.
76. Martellucci J, Naldini G, Del Popolo G, Carriero A. Sacral nerve modulation in the treatment of chronic pain after pelvic surgery. Color Dis. 2012;14(4):502–7.

6 Operative and Anesthetic Techniques

Amy J. Thorsen and Jasneet Singh Bhullar

Introduction

The medical and surgical management of anorectal disease represents a substantial portion of a typical colorectal surgery practice. A variety of diseases are encountered, ranging from the benign processes of hemorrhoidal and cryptoglandular fistula disease to a range of premalignant and neoplastic lesions of the anorectum. For many of these conditions, there is no consensus on optimal surgical approach or technique. An individual patient may also present some challenges. Adequate operative and airway exposures can be difficult to optimize in the obese; a simple sphincterotomy under local and sedation may not be appropriate for an opioid tolerant patient. Although anorectal procedures may seem to be routine, a patient specific operative plan will guide the surgeon, operative team, and patient through a successful procedure.

In this chapter, we will review patient positioning, anesthetic techniques, and instrumentation that are employed in modern anorectal surgical procedures.

A. J. Thorsen (✉)
Colon and Rectal Surgery Associates,
Minneapolis, MN, USA

University of Minnesota,
Minneapolis, MN, USA
e-mail: athorsen@crsal.org

J. S. Bhullar
Department of Surgery,
UPMC Susquehanna Health, Williamsport, PA, USA

Positioning

Optimal patient positioning for anorectal surgery involves selecting a posture that optimizes exposure to the operative site while maintaining adequate ventilation and perfusion during anesthesia administration. Patient related factors, such as BMI and cardiopulmonary disease, as well as anesthetic technique contribute to determining the best position. Although a surgeon may have a preferred position for most anorectal procedures, consensus among operative team members may be the safest approach.

Many surgeons consider the prone-jackknife position to be the gold standard for anorectal procedures (Fig. 6.1). If the patient is to receive only mild sedation and local anesthesia, self-positioning of the patient on the provided cushions may best avoid injury. The patient is placed on the operative bed face down. The head is placed in a cradle with an occasional mild tilt to the side. Care should be taken to keep the eyelids closed to avoid corneal abrasions if the patient is positioned anesthetized. Adequate cushioning is provided from the clavicle to the iliac crests, usually with two chests roles or occasionally pillows, to allow adequate expansion of the lungs and diaphragm and minimal pressure on the abdomen. The arms can be placed alongside the torso with hands facing up, or flexed above the head on arm boards with a mild bend in the elbow and hands facing down. A hip roll is used to prop the operative

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_6

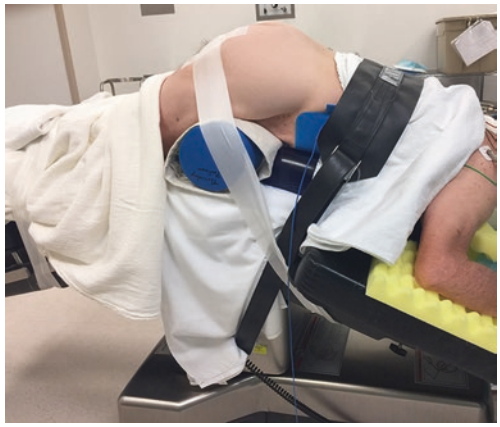


Fig. 6.1 Prone jackknife position

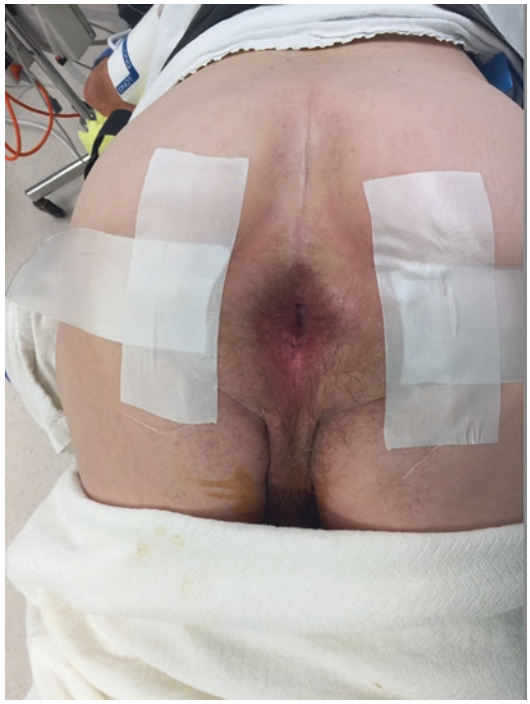


Fig. 6.2 Taping of gluteal cheeks

field up, and mild tilt of the head of the table downward will help accentuate this. The buttocks are taped apart with lateral traction (Fig. 6.2). To prevent plantar flexion of the feet and toes, a pillow is placed under the ankles. The female breasts should be adequately positioned on the chest rolls, and the male genitalia should be checked to avoid compression on the hip roll [1].

The advantages to the prone-jackknife position include better visualization, illumination, and retraction of the operative field. An assistant standing opposite the surgeon can easily access the field to retract and aid as needed. These advantages may lead to less blood loss in procedures such as the perineal portion of a proctectomy. The prone position limits the anesthesia provider's access to the patients airway, can limit ventilation compared to other operative positions, and can limit venous return in patients who are pregnant or have significant cardiac disease. Hence, patients with these conditions or who need significant sedation without the desire for endotracheal intubation may be best suited for other operative approaches.

Lithotomy position is often preferred by anesthesia providers, given it allows optimal airway access for any choice of anesthetic technique. The patient is first placed in the supine position, usually with the arms secured bilaterally on arm boards. The legs are then placed in stirrups, with the thighs flexed nearly ninety degrees (Fig. 6.3). The sacrum, knees, and feet are padded to prevent pressure ulceration and neurologic damage.

Lithotomy position can be advantageous to the colorectal surgeon in procedures where the dissection occurs posterior to the operative incision, such as transvaginal or transperineal approaches to rectocele repair, or in mobilizing a posterior endorectal advancement flap for cryptoglandular fistula disease. Lithotomy also allows better exposure to the groin and legs for harvesting Martius or gracilus flaps to repair rectovaginal fistulas. Although the operative workspace between the legs limits accessibility for a surgical assistant, use of an operative table or tray between the surgeon and patient allows the surgeon to have the necessary operative instruments near the field to allow the technician to focus on retraction and exposure (Fig. 6.4).

The left lateral or Sims' position can be useful in selected patients (Fig. 6.5). In the authors'

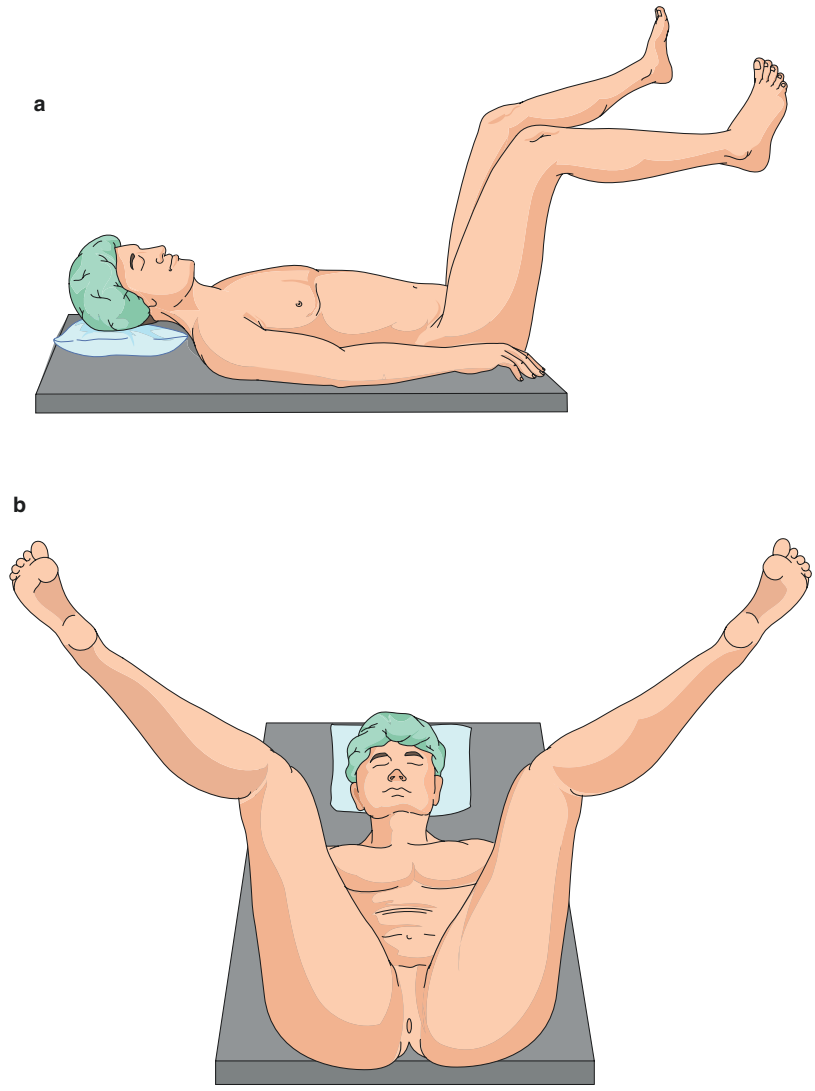


Fig. 6.3 Modified lithotomy position

practice, this position is most commonly used in patients requiring emergency anorectal procedures in the third trimester of pregnancy, or in patients having very minor procedures such as botulinum toxin injections or sphincterotomy in addition to lower endoscopy. Left lateral positioning may also be a good compromise in a patient that cannot tolerate prone positioning and anatomic exposure is limited in lithotomy. The patient is placed on the left side, braced with either a bean bag, brace, or sand bags for support of the torso. The patient's head is positioned at the upper away corner of the bed and the torso is angled to position the patient's buttocks at the edge or slightly over the edge of the bed. The left arm is flexed with the hand toward the head, and the right arm allowed to lay in front of the chest after support with an axillary roll. The knees are bent, and a pillow is placed between the knees and lower legs for adequate support and cushioning. With the hips at the most right lateral aspect of the bed, and with tape retraction of the buttocks, the surgeon and assistant can usually both access the operative field.

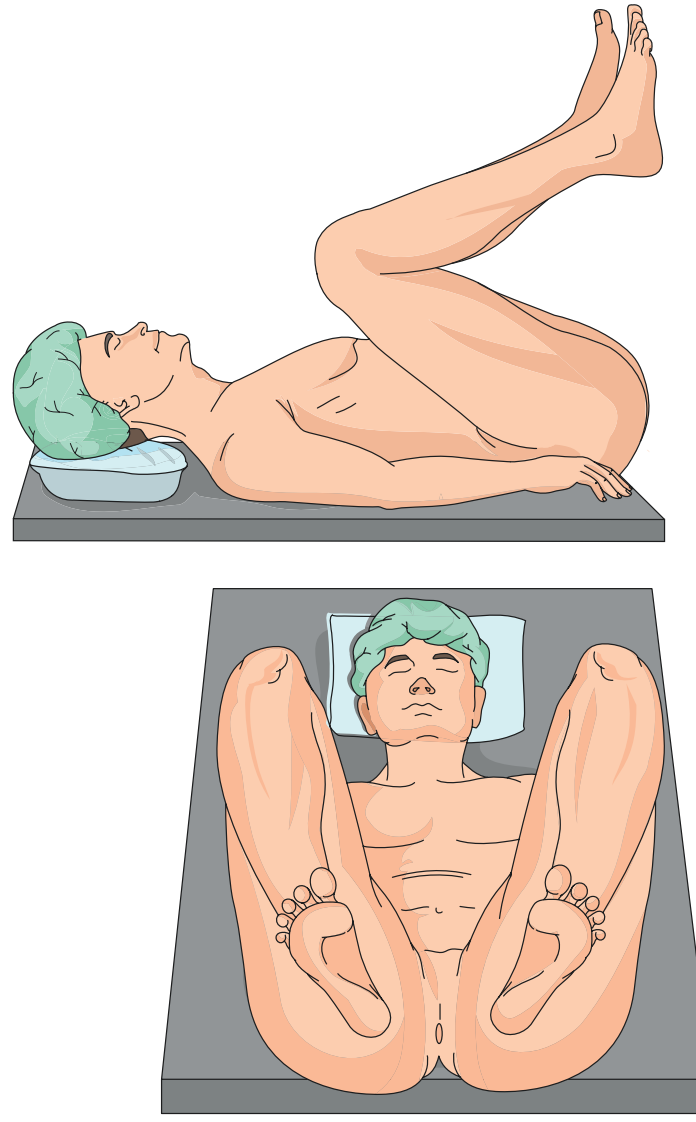


Fig. 6.4 Lithotomy position with buttocks extended over the edge of the table

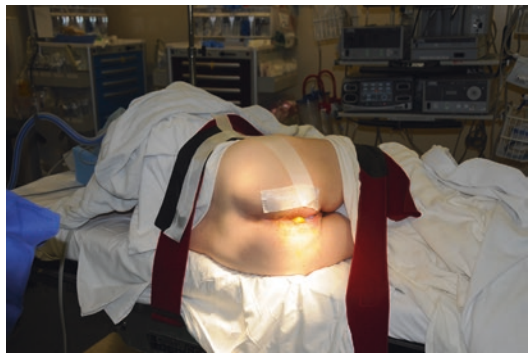


Fig. 6.5 Simm's position

Anesthetic Techniques

The role of anesthesia is to provide the appropriate amount of relaxation, sedation, and pain relief while maintaining vital life functions under the stresses of the surgical procedure. When performing anorectal surgery, these goals may be best achieved by joint efforts of the anesthesia provider and surgeon. Hence, a preoperative discussion between providers and patient should lead to the most successful outcome. The amount of sedation required may vary vastly depending on the

patient's size, airway, and opioid tolerance as well as the specific procedure being performed [2–8].

General Anesthesia

General anesthesia is the condition in which medications are used to provide sedation, amnesia, analgesia and paralysis to the operative patient. In addition to the patient not being able to respond or recall painful stimuli, muscle paralysis prevents airway protection and spontaneous ventilation; hence endotracheal intubation or a laryngeal mask airway must be employed. Patients may request general anesthesia due to modesty or fear.

Anesthesiologists may prefer to administer general anesthesia for patients with difficult airways, poor ventilation due to obesity, or high narcotic tolerance. This bias is especially true when these patients must be placed in the prone position. The surgeon can take advantage of general anesthesia in several situations. General anesthesia provides complete relaxation of the pelvic floor, which is helpful in procedures such as transanal excision, perineal rectosigmoidectomy, sphincter or rectocele repair, and procedures to correct high transphincteric fistulas. General anesthesia cannot be routinely used in the placement of sacral neuromodulation leads, given the surgeon needs to assess the patient's motor and occasional sensory response to lead stimulation.

Disadvantages to general anesthesia include increased anesthetic risks to patients with significant cardiac and pulmonary disease, postoperative nausea and vomiting, sore throat, headache, or shivering, and the increased costs and complexity of care in maintaining the patient compared to lower levels of anesthesia. The use of anticholinergics, beta blockers, or sympathomimetics interfere with normal bladder function and can contribute to higher rates or postoperative urinary retention.

Regional Anesthesia

Given the visceral and somatic reflexogenic innervation of the anorectum, regional spinal anesthesia is a popular anesthetic method for anorectal procedures. The typical spinal saddle block involves injection of a local anesthetic into the subarachnoid space. For procedures performed in the prone jack knife position, two different techniques are employed. A hypobaric block is administered by injecting an anesthetic solution of a lower density than cerebral spinal fluid in the subarachnoid space between L3–4. The patient is then quickly placed in the prone jack knife position or the block can be performed in this position. A hyperbaric block uses low doses of heavy local anesthesia allowing a quick onset of the sensory block as well as a longer lasting postoperative analgesia. The density of the anesthetic is increased by adding glucose to the solution. Cephalad spread of the block can be prevented by keeping the patient seated for 5–10 min prior to prone-jack knife positioning. With either technique, the duration of the block will depend on the local anesthetic that is utilized.

Spinal anesthesia is contraindicated in patients who are anticoagulated or who suffer from disorders that affect normal coagulation. It is also contraindicated in patients who have increased intracranial pressure or active infections near the site where the block is administered. Caution should be used in patients with underlying neurologic or significant cardiac disease. The sympathetic blockade from a spinal can cause hypotension; the fluids used to treat this as well as the concomitant parasympathetic block on bladder function can contribute to postoperative urinary retention. Spinal headaches can occur in 0.1–36% of patients who undergo intentional dural puncture. This occurs when the leak of cerebrospinal fluid from the puncture site exceeds the rate of its production. The headache is described as severe, worse in the upright position, and improved with the supine position. It may occur up to 5 days after the puncture. Symptoms are initially treated with hydration, bed rest, and analgesics. If symptoms persist, the anesthesiologist can administer a blood patch by injecting a small amount of the patient's blood in the epidural space to clot and seal the leak. The incidence of spinal headaches decreases with the use of smaller needles in administering the block.

Although spinal anesthesia usually provides enough analgesia and relaxation for most anorectal

procedures, it is not uncommon for patients to request additional sedation during the procedure due to embarrassment, fear, positional discomfort, or for the desire to be unaware of operative proceedings. Despite high satisfaction in patients who choose this mode of anesthesia, many patients fear the use of needles near the spinal cord and decline this method for their procedure.

Monitored Anesthetic Care (MAC)

The use of sedation with local anesthesia may allow the anesthetist and surgeon the greatest amount of flexibility in tailoring the degree of anesthesia to the needs of the patient. A variety of intravenous medications are utilized; the patient may or may not experience awareness or memory of intraoperative events. The incidence of postoperative nausea and emesis is decreased compared to general anesthesia, which facilitates quicker home discharge for day surgery patients.

The risks of MAC sedation, however, are similar to those of general anesthesia; cardiovascular complications are comparable in both groups. Respiratory depression is the most common cause of mortality and neurologic morbidity. Hence, MAC is contraindicated in patients who may have difficulty maintaining their airway or respiratory function due to underlying body habitus, disease, cognitive dysfunction, or operative positioning.

Local Anesthesia

Local anesthesia is the use of injectable medications in the operative field to inhibit excitation of nerve endings or conduction of sensation by peripheral nerves. Depolarization of nerve cell membranes and subsequent propagation of impulses requires sodium influx into the cell. Local anesthetics create temporary sensory loss by reversibly binding and inactivating sodium channels. Potency of the anesthetic is related to the agent's lipid solubility; the speed of onset of action depends on its diffusion properties through non-neurologic tissue; and the duration of action is dependent on drug binding properties to sodium channel proteins. Local anesthetics exist in both ionized and non-ionized forms based on the pH of the environment. Given the non-ionized drug is the component that can diffuse the cell membrane, inflammatory tissues with acidic properties may delay the onset of the block and contribute to it being less effective. Adding low doses of an alkalinizing agent such as sodium bicarbonate can enhance the onset of action. Almost all local anesthetics are vasodilators, which contributes to faster absorption and a shorter duration of action. Hence it is common to counteract this effect with the use of epinephrine in the anesthetic solution.

The most common local anesthetics used in anorectal surgery are lidocaine and bupivacaine. Their properties are shown in Table 6.1. Liposomal bupivacaine (Exparel®, Pacira Pharmaceutocals, Parsippany, NJ) has recently become available at some centers as an additional local anesthetic agent. By encapsulating the drug in a multivesicular phospholipid bilayer, a predictable time release of the anesthetic can be achieved leading to increased stability and duration of action. The use of liposomal bupivacaine in patients undergoing hemorrhoidectomy has been shown to delay the first use of opioid analgesics, decrease the overall use of opiates, and improve pain scores at 72 h postoperatively compared to 0.25% bupivacaine with epinephrine [8].

Table 6.1 Local anesthetic drugs

Agent	Onset	Duration	Maximum dose	Maximum dose with epinephrine
Tetracaine	1 min	2–3 h	20 mg	
Lidocaine	2–5 min	30–45 min	5 mg/kg	7 mg/kg
Mepivacaine	2 min	1.5–3 h	3 mg/lb (400 mg)	
Prilocaine	2 min	2 h	8 mg/kg	
Bupivacaine	30 min	2 h	2 mg/kg	4 mg/kg
Procaine	5–10 min	15–30 min	10 mg/kg	
Liposomal Bupivacaine	30 min	48–72 h	266 mg (with 133 mg bupivacaine)	266 mg

A perianal block can be administered with several different techniques. One method involves puncture of the sphincter complex in the anterior and posterior midline positions, and distributing the anesthesthetic in a fan shaped pattern from these sites. The perianal skin is also circumferentially anesthetized. Diaz-Palacios and Eslava-Schmalbach [5] describe a second two-puncture technique: In the left lateral and right lateral positions, the needle is advanced through the skin, subcutaneous tissue, and submucosal space. Anesthetic is deposited as the needle is withdrawn. A subcutaneous block is then performed at both puncture sites, directing the needle posteriorly and anteriorly; firm pressure to the anus is then applied for 3 min to improve the spread of medication through the tissues. Brunat et al. [7] describe a posterior perineal block performed by puncturing the skin 2 cm posterior to the posterior midline to a depth of 5 cm, accessing the presacral compartment and blocking the anococcygeal nerves. The needle is then redirected laterally at a 45-degree angle into each ischiorectal fossa to a depth of 5 cm to block the inferior hemorrhoidal and posterior pudendal branches (Fig. 6.6). The block is completed by left lateral and right lateral superficial skin punctures to administer a subcutaneous block in a fan-like distribution on each side. Bilateral pudendal nerve block with the use of a nerve stimulator is described by several authors but is not widely utilized in the United States. A blinded block can be performed by palpating each ischial tuberosity intrarectally with the nondominant index finger. Using a 22 gauge spinal needle, 5–10 cc of solution is injected around the nerve medial to this landmark.

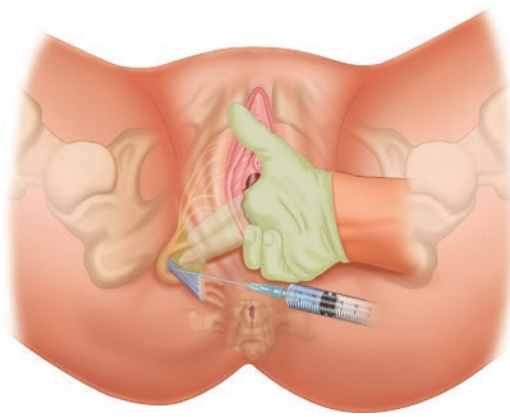


Fig. 6.6 Transanal placement of pudendal nerve block

Complications from local anesthetics are rare but should be recognized. Peripheral vasodilation and myocardial decompression should be treated with intravenous fluids and vasopressors. Cardiac conduction abnormalities should be noted and addressed. Neurologic toxicity manifested with restlessness, vertigo, tinnitus, and slurred speech can progress to CNS depression and seizures. In this situation, the airway should be secured, ventilation should be optimized, and seizure activity addressed with repeated dosing diazepam.

Lighting

Proper lighting has always remained a critical help in anorectal surgery. Weak or improper lighting could result in dissection in the wrong planes and troublesome bleeding which leads to intraoperative and postoperative complications. In many anorectal procedures, the rectum can appear to be a deep, dark tunnel that is not easily illuminated to satisfactory levels. Standard overhead lighting found in most operating rooms does not suffice for anorectal surgery; even with proper positioning, it is frequently eclipsed by the head or hands of the operating surgeon and/or the assistant preventing adequate visualization of the anal canal. To overcome this problem, it is recommended that the surgeon should use either a good headlight (Fig. 6.7), lighted retractors, or both as they are effective in maintaining adequate illumination for anorectal procedures.

There are many commercially available fiberoptic headlights—some examples are Luxtec® (Luxtec Corporation, Technology Park, Sturbridge, Massachusetts) and Cogent Light® (Santa Clarita, California). Some cordless headlights are also available, but most have a restricted battery life and the illumination is usually not at par with the fiberoptic lights. A variety of fiberoptic illuminated retractors are also available (Pilling Company, Fort Washington, PA).

Fig. 6.7 Welch Allyn headlight

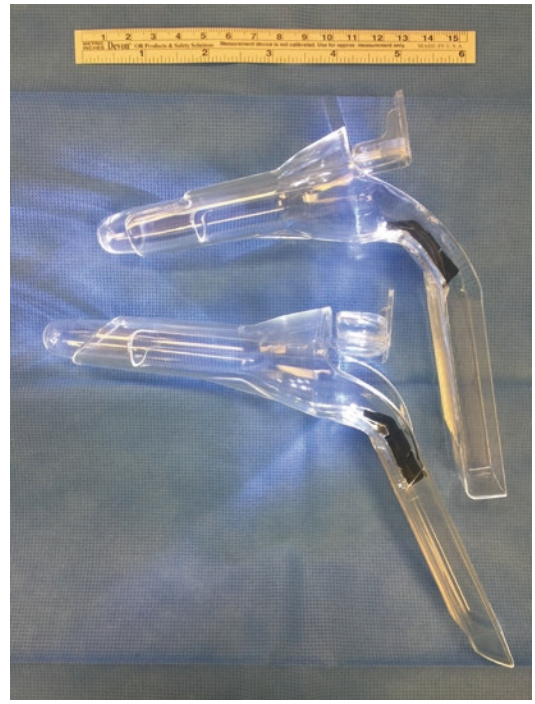


Fig. 6.8 Lighted anoscopes

It is recommended that at the start of the case the surgeon should focus the headlight. Ideally a properly adjusted headlight should focus the light along the surgeon's line of sight thus illuminating the operative field and preventing the surgeon's hand maneuvers from hindering adequate visualization. Additionally, as the beam of light descends through the surgeon's line of sight, the shadow created by the surgeon's head frequently positioned between the standard overhead light and the operative field is eliminated thus allowing better illumination of the operative area.

For a colorectal office practice, using a headlight is also recommended while examining patients. The typical office examining room has less adequate lighting than most operating rooms. The use of a headlight in the examining room is a good and easy solution of this problem. While a variety of cordless headlights are commercially available, the authors have found the rechargeable Welch Allyn (Welch Allyn, Inc., Skaneateles Falls, NY) physician headlight to be an excellent and inexpensive light source for anorectal examination in the office setting (Fig. 6.7). This bulb-type (non-fiberoptic) light allows focusing directly into the anal canal. Good lighting is essential to provide adequate illumination examining the patient, as it may lead to incomplete or even inaccurate diagnosis that may alter overall management.

An alternative to using a headlight in the office the lighter anoscope. The authors use the single use, disposable, lighted anoscopes (Fig. 6.8) which are commercially available in different sizes—slotted and beveled versions (ANOSPEC-OBP Medical Lawrence, MA). The light is good for 30–45 min and can be used for the office-based procedures like diagnostic anoscopy (Fig. 6.9) and hemorrhoidal banding (Fig. 6.10), without the need for a headlight. The authors find the slotted type of this anoscope to be very helpful as it is open on one side, allowing easy identification of the hemorrhoid as it falls into the lumen. These instruments also alleviate the logistic problems of having the instruments sterilized for

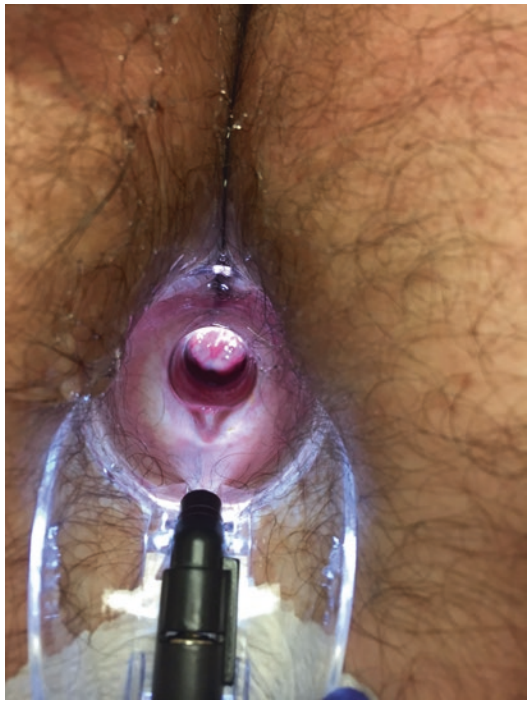


Fig. 6.9 Office anoscopy

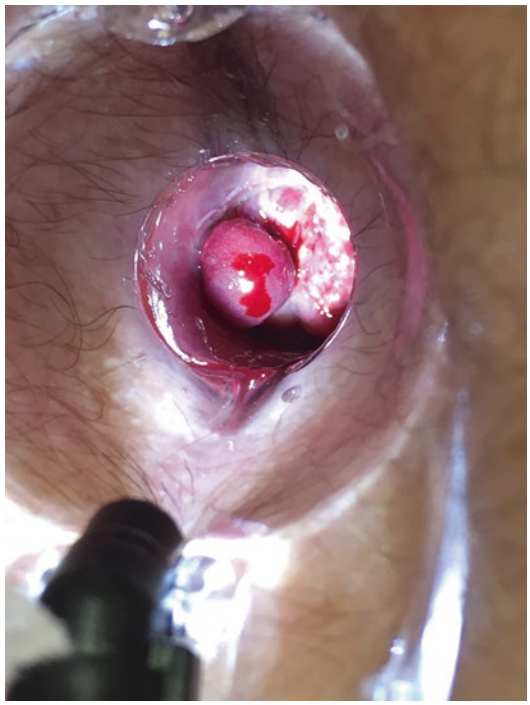


Fig. 6.10 Hemorrhoidal banding

the patients. Single-use lighted anoscopes are also found to be extremely helpful in evaluating the hospitalized patient at the bedside.

Instrumentation

Instrumentation designed specifically for anorectal surgery can make a big difference between a smooth and efficient surgery and its nemesis; the awkward, frustrating, and frequently dangerous procedure. The instrument selection is very important and is based on the setting (office vs. operating room), the pathologic condition being treated, and the surgeon's preference. The basic instruments needed for the anorectal surgery consist of anoscopes, speculums, retractors, and supporting surgical instruments, which include the needle holders, sutures, forceps, suction and electrocautery.

Anoscopes

There is a big distinction between the instruments that are used in the office and those used in the operating room. The instruments used in the office are generally smaller in caliber compared to operative instruments to ensure patient comfort. They are adequate for diagnostic work but do not offer enough exposure for most operative maneuvers. Many practicing colorectal surgeons use the Vernon-David anoscope (Becton, Dickinson and Company, Franklin Lakes, NJ) modified with the handle of the Hirschman anoscope as their office anoscope (Figs. 6.11 and 6.12). The conventional Hirschman anoscopes are preferred by some surgeons.

The Hinkel-James anoscope (Sklar Medical and Surgical Instruments, Issaquah, WA) is used by many for rubber-band ligation of the hemorrhoids (Fig. 6.13). It is longer and provides a larger diameter orifice through which to manipulate the ligating instrument. Despite its length, it is tapered to allow for excellent tolerance by the patient.

There are different types of hemorrhoidal banding instruments. The authors prefer a suction type hemorrhoidal gun, which allows the surgeon to hold the anoscope and hemorrhoid gun simultaneously (Fig. 6.14). Many surgeons prefer directly

Fig. 6.11 Vernon-David anoscope

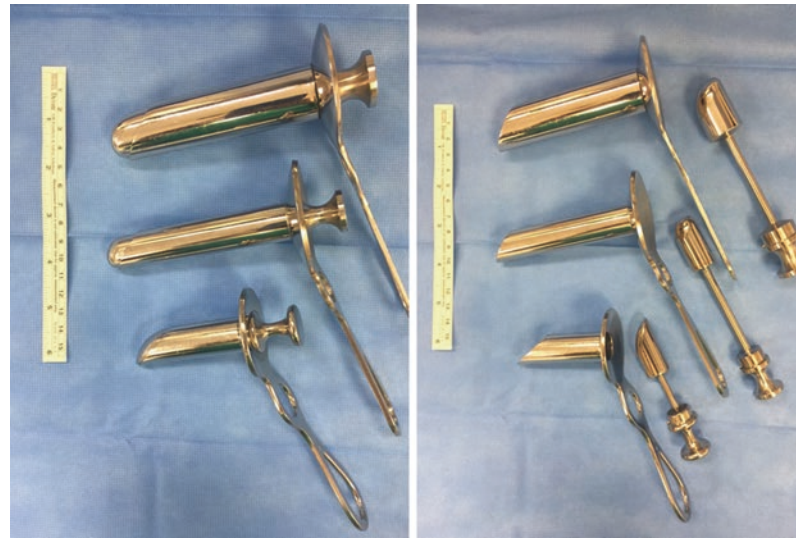


Fig. 6.12 Hirschman anoscope

Fig. 6.13 Hinkel-James anoscope

Fig. 6.14 Suction hemorrhoidal banding gun

grasping the mucosa to be banded; in this case, a McGivney hemorrhoid bander (Medline Industries) with grasping forceps is used. An assistant must provide exposure by holding the anoscope while the surgeon controls the forceps and bander.

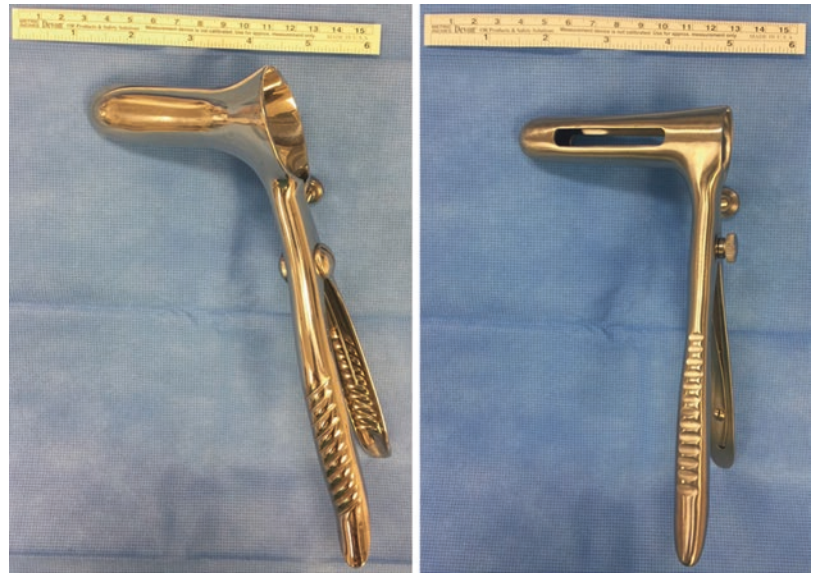


Fig. 6.15 Pratt (left) and Fenestrated (right) speculum

Speculums

Speculums are usually used only in the operating room for anesthetized patients (Fig. 6.15). Different types of speculums—including bi- or tri-valved are available. Speculums can pinch mucosa and thus are poorly tolerated in an unanesthetized patient. This limitation is particularly true of fenestrated speculums. The authors recommend the nonfenestrated bi-valve type instrument, such as the Pratt, as it is very useful in evaluating the anesthetized anal canal. With gentle dilation, it can be slowly opened to allow a wide operative field. Opening it to a mild degree of tension allows the accurate and rapid identification of the caudal edge of the internal sphincter, which can be palpated as a firm cord. This technique is very useful when performing internal sphincterotomies and during rectal mucosectomies. Nasal speculums can be useful in instances of severe stenosis where a speculum the size of a Pratt instrument (Sklar Surgical Instruments, West Chester, PA) cannot be placed in the anal canal.

The Fansler operative anoscope is preferred by some colorectal surgeons for operative hemorrhoidectomy (Fig. 6.16). It provides an ample operating field to one side of the anal canal while all other quadrants are tucked neatly behind the lumen of the remainder of the instrument. However, this instrument is too large to be used in the unanesthetized canal. A lighted version of this instrument is also available. The authors have a preference of using the Pratt for the hemorrhoidectomy as the amount of opening of the anal canal can be controlled, unlike the Fansler, which is helpful while suturing in the anal canal.

Retractors

Many types of anal retractors, which are available. The Sawyer (Medline Industries), Hill-Ferguson (Sklar Surgical Instruments) (Fig. 6.17), Ferguson-Moon (V. Mueller), and other similar retractors are alike in providing an anal "spoon" or "cup" which exposes about 40–50% of the circumference of the anal canal. The small size of these retractors leads to minimal dilation and distortion of the hemorrhoidal cushions but they may limit working room for maneuvering instruments. Some colorectal surgeons prefer a Hill-Ferguson retractor for operative hemorrhoidectomies.

Using the Fansler anoscope (Novo Surgical, Oak Brook, IL) (Fig. 6.17) can lead to bleeding vessels hidden by the tamponade of the instru-

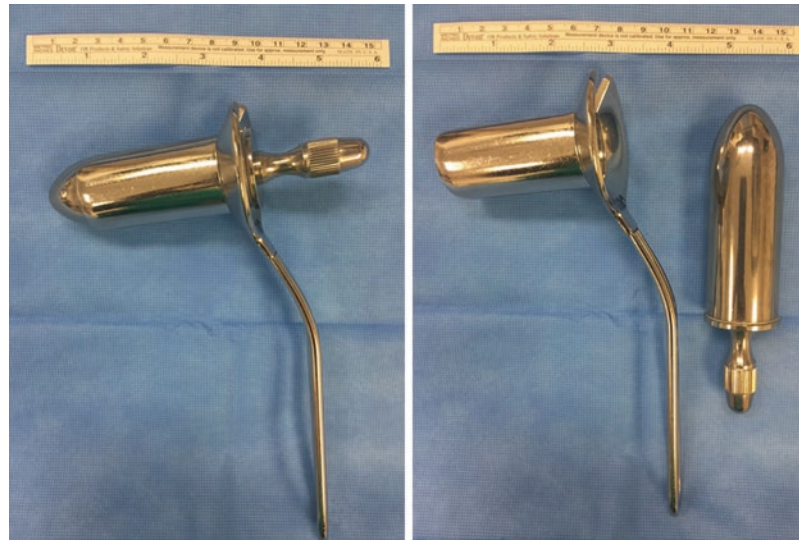


Fig. 6.16 Fansler anoscope

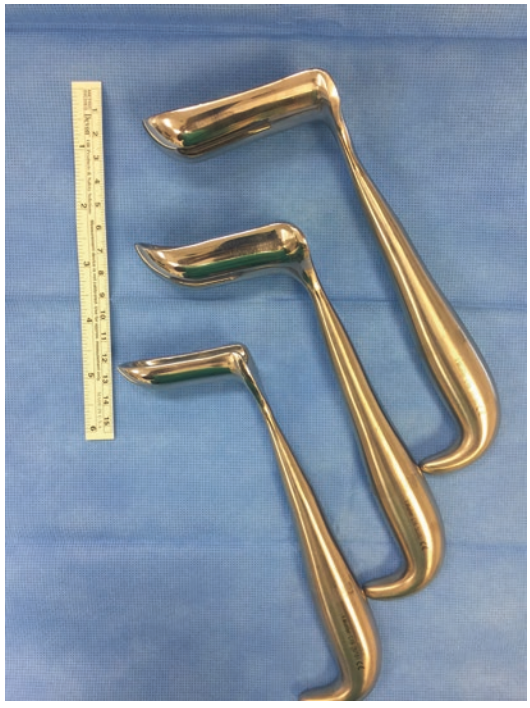


Fig. 6.17 Hill Ferguson retractor

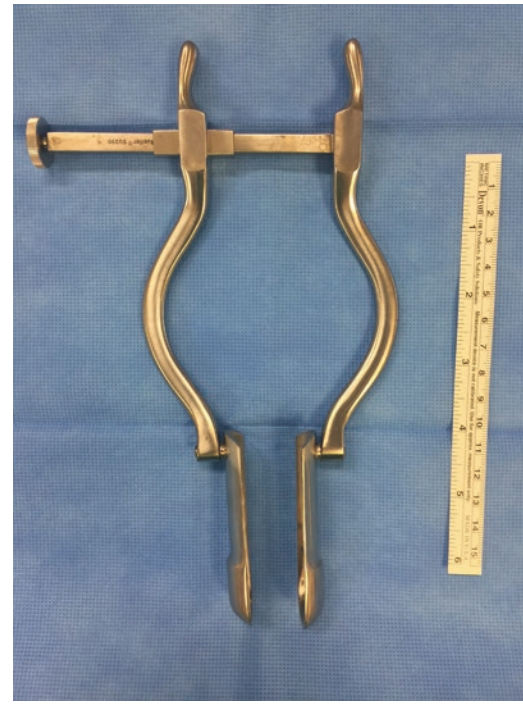


Fig. 6.18 Buie-Smith retractor

ment. In such a situation, the judicious use of a Ferguson-Moon or Pratt bivalve type retractor often allows the identification and control of the bleeding vessel as the anal canal is not subjected to the same stretch and compression as with the Fansler instrument.

Several self-retaining anal retractors, such as the Buie-Smith (Medline Industries) (Fig. 6.18) and Parks' (Fig. 6.19) are occasionally used in transanal excisions and mucosectomies. It is generally thought that the frames of such retractors can interfere with the instrumentation necessary

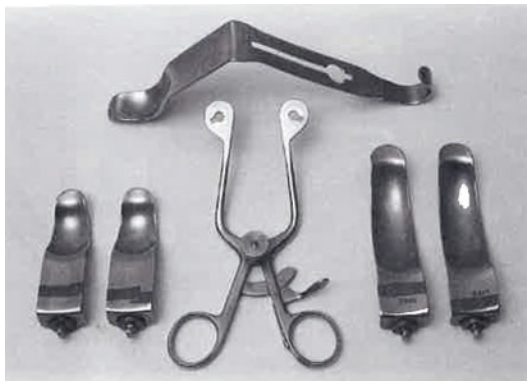


Fig. 6.19 Parks' retractor

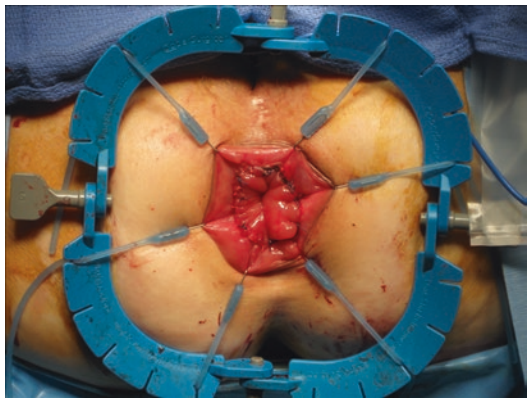


Fig. 6.20 Lone Star Retractor (Cooper Surgical, Trumbull, CT)

to accomplish the desired task; anal eversion can be preferable in these situations (especially with mucosectomies). Eversion can be accomplished by using four to six heavy silk sutures placed at intervals from either the dentate line or anal verge to well out on the buttocks.

The Lone Star Retractor (Fig. 6.20) has become popular as it can perform the same function and has conveniently packaged several types of elastic retractor hooks. The Lone Star Retractor is disposable, self-retaining and adjustable, providing exposure in the perineum for vaginal and colorectal procedures. The authors find this a critical tool in performing more advanced anorectal surgeries, such as an overlapping sphincteroplasty or perineal rectosigmoidectomy.

Supporting Material

Other considerations include selection of proper needle holders, suture material, needles, forceps, clamps, and cautery equipment.

The needle holder must be personally selected to the preference of the surgeon. In general, however, it must have adequate length to reach beyond the depth of the retractor being used while allowing the operator's hand to remain completely external to the anal canal. Thus, a nine-inch instrument of medium weight is usually preferred.

Depending upon surgeon preference and type of surgery being performed, absorbable suture material of chromic catgut, vicryl or polydioxane suture (PDS) is preferred. Suture removal is not required and absorption is at a rate that will allow wounds to open in case of infection rather than serving as a site for abscess formation. The authors prefer 3–0 suture for most hemorrhoidal and anal canal work. Slower absorbing polyglycolic suture material is more frequently used for low rectal work including transanal excisions and anal anastomoses.

When suturing is confined to the perianal skin, a cutting needle is preferred; when suturing the rectal mucosa, a taper needle is preferred. For hemorrhoidal surgery, when the incision to be closed extends across both columnar and squamous epithelium, a taper-cut needle is preferred. It is less likely to tear the rectal mucosa than is a cutting needle and will still allow penetration of the perianal skin.

Many surgeons use Debakey forceps (Sklar Surgical Instruments) for tissue handling. Some type of toothed forceps (e.g. Cushing) should be readily available in instances of complicated and edematous hemorrhoids and when operating for fistulae. An Allis or Babcock clamp is indispensable when operating in a scarred field or in the presence of fibrotic tissue. They are particularly useful when elevating tissue, whether a hemorrhoidal cushion or a mucosal advancement flap.

To complete the basic anorectal surgery tray, an assortment of probes for use in identification and treatment of fistulas is necessary (Fig. 6.21). It is helpful to have a malleable probe available

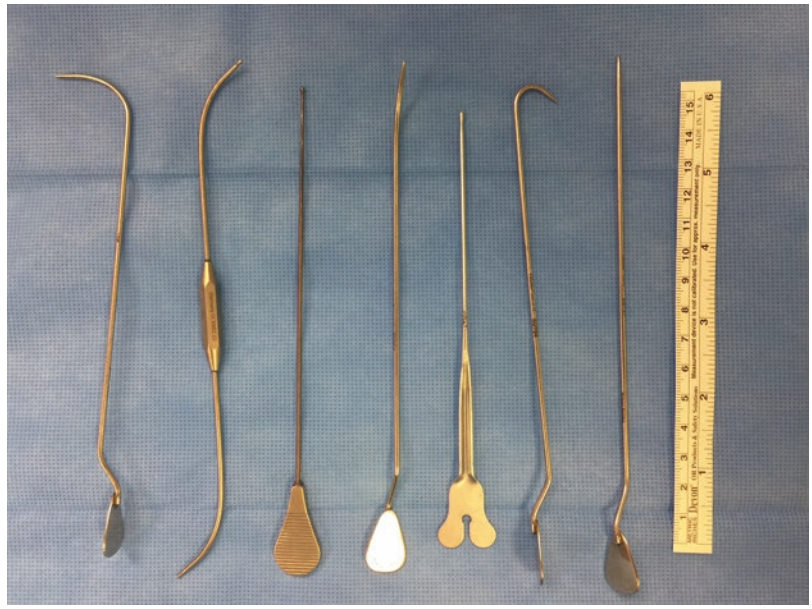


Fig. 6.21 Fistula probes

in the operating room for investigating and documenting the pathway of a fistula. A fine malleable probe with an eye at one end is helpful when placing a seton. Lockhart-Mummery grooved retractors (Sklar Surgical) are ideal for laying open a fistula once its course has been confirmed.

Special instruments and armamentarium are needed when operating for fistula in ano [9]. For the initial identification of the fistulous tract, a 22-sized Angiocath (Medline Industries) is used to inject the external fistulous opening. The injecting liquid can be diluted hydrogen peroxide, milk or diluted methylene blue. All these three have their advantages and disadvantages. While the hydrogen peroxide can be easily identified in the anal canal and can also open small fistulous openings, excessive bubbling can obscure the operative field. Some colorectal surgeons use milk as it does not cause bubbling and the white color can help with an easy identification of the internal fistulous opening. Methylene blue stains the fistulous tract in addition to helping identify the internal opening but can cause extensive staining of the anal canal and operative field.

Seton techniques occupy an important position in the treatment of anal fistulas. A seton can be any type of foreign material inserted through a fistulous track. Prolene suture, a Penrose drain, silk suture, and rubber bands have been described in the literature from all over the world. Previously used cutting setons like silk have fallen out of favor in view of sphincter damage resulting from their use and most surgeons prefer a non-cutting seton in their practice. Colored vessel loops are presently the most common seton used in our practices. These are made of soft rubber, which is well tolerated by patients. This seton helps with maturation of the fistulous tract while also helping with adequate drainage. Vessel loops are easily available in most operating rooms and can be made into a loose loop with silk suture.

The appropriate application of electrosurgery to operations on the anal canal provides rapid, effective hemostasis. The monopolar hand-activated bayonet-type cautery unit is particularly helpful when performing hemorrhoidectomy. Its use is ideal in allowing the simultaneous control and cauterization of bleeding vessels. A blade-type unit is much more effective when cautery is used for tissue cutting such as when elevating flaps or unroofing chronically inflamed fistula tracks. A needle tip cautery is helpful when coring out fistula tracks as described by Parks. However, this tip does increase the risk of "needle stick" injury. This is best avoided in

high-risk patients and when practicing universal precautions. Newer means of achieving hemostasis during hemorrhoid surgery include reusable bipolar scissors and the disposable Harmonic Scalpel® (Ethicon, Cincinnati, OH) and LigasureTM vessel sealing device (Medtronic, Minneapolis, MN). Advantages of the bipolar scissors include precise application of electrical current between the scissor blades, assisting in the maintenance of a hemostatic hemorrhoidectomy. Ultrasonic and advanced bipolar energy devices achieve hemostasis without thermal injury to the tissue. While both instruments allow a relatively "bloodless" field, even during hemorrhoidectomy, they do increase the cost of the operation. Their cost may be better justified when performing a perineal rectosigmoidectomy, given they save operative time by avoiding repetitive clamping and tying of suture.

Gauze sponges are essential for keeping a clear operative field. Although suction is very helpful at the operating table, surgeons make liberal use of sponges in association with the cautery to control hemostasis. The size of the sponge is critical to effective use in the anal canal: unopened "4 X 4" or laparotomy sponges are too large to pass through the operative scopes, while "2 X 2" sponges cannot absorb enough blood to be helpful and are easily lost in the rectum. The 3 in X 3 in sponge is helpful when operating in the anal canal and should always be available in sufficient quantity.

References

1. Goldberg SM, Gordon PH, Nivatvongs S. Essentials of anorectal surgery. Philadelphia: JB Lippincott; 1980. p. 80.
2. Summeral WD, Beck DE. Anesthesia and intraoperative positioning. In: Kann BR, Whitlow CB, Margolin DA, Vargas HD, Beck DE, editors. Improving outcomes in colorectal surgery. 2nd ed. Boca Raton: Tayler and Freancis; 2018. p. 23–34.
3. Thorson AG, Blatchford GJ. Operative and anesthetic techniques. In: Fundamentals of anorectal surgery. 2nd ed. Philadelphia: WB Saunders; 1998.
4. Dripps RD, Eckenhoff JE, Vandam LD, editors. Introduction to anesthesia: the principles of safe practice. 7th ed. Philadelphia: WB Saunders; 1988. p. 221.
5. Diaz-Palacios GA, Eslava-Schmalbach JH. Perirectal block for out-patient anorectal surgery: a new technique. Biomedica. 2011;311:196–9.
6. Reshma PJ, Begani MM. Proctologic surgery as day care: 8 year experience of a successful day care centre. Bombay Hosp J. 2008;50:179–83.
7. Brunat G, et al. Posterior perineal block with ropivacaine 0.75% for pain control during and after hemorrhoidectomy. Reg Anesth Pain Med. 2003;28:228–32.
8. Haas E, et al. A double-blind, randomized, active-controlled study for post-hemorrhoidectomy pain management with liposome bupivacaine, a novel local analgesic formulation. Am Surg. 2012;78:574–81.
9. Subhas G, Singh Bhullar J, Al-Omari A, Unawane A, Mittal VK, Pearlman R. Setons in the treatment of anal fistula: review of variations in materials and techniques. Dig Surg. 2012;29(4):292–300.

Functional Anorectal Disorders

7

Brian L. Bello, D. Owen Young, and Anjali S. Kumar

Introduction

Functional anorectal disorders generally arise from or result in abnormal defecatory habits. Many anorectal manifestations, such as a non-relaxing puborectalis muscle or *anismus*, rectal prolapse or intussusception, rectocele, perineal descent syndrome, solitary rectal ulcer syndrome, hemorrhoids and even fecal incontinence, commonly present as constipation, though specific treatment is dictated by the specific condition. This chapter discusses the syndromes of anismus, perineal descent syndrome, solitary rectal ulcer and sigmoidocele as well as treatment options (Table 7.1).

Table 7.1 Treatment options for functional anorectal disorders

	Medical	Nonsurgical interventions	Surgical
Anismus	Fiber and bulking agents Biofeedback	Botulinum toxin Anal dilation	Puborectalis division/resection Ostomy
Perineal descent	Fiber and bulking agents Biofeedback	Perineal devices	Posterior perineorrhaphy Transperineal approach Retroanal levator plate myorrhaphy Ostomy
SRUS	Fiber and bulking agents PEG Biofeedback		Ventral rectopexy
Sigmoidocele	Biofeedback		Sigmoidectomy

B. L. Bello
Colorectal Surgery Program, MedStar Washington Hospital Center, Washington, DC, USA

D. Owen Young
Pacific Medical Centers, Seattle, WA, USA

A. S. Kumar (✉)
Washington State University, Elson S. Floyd College of Medicine, Everett, Spokane, Tri-Cities, Vancouver, WA, USA

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_7

Anismus

Anismus—also called 'puborectalis syndrome,' 'spastic pelvic floor syndrome,' 'non-relaxing puborectalis syndrome,' and 'dyssynergic defecation'—describes ineffective defecation in patients in whom the puborectalis muscle does not relax. Patients present with chronic constipation with the feeling of incomplete evacuation, and often times using digital maneuvers to facilitate defecation. On physical exam, the resting and squeeze tone can be assessed. The patient should then be asked to push to mimic defecation—the examiner should feel the relaxation of the external sphincter and puborectalis muscle. If this is absent, anismus is suspected. The pathophysiology and diagnostic evaluation for anismus is discussed in detail in other sections of this textbook. Paradoxical contraction of the puborectalis muscle is a key finding in anismus, although a subset of these patients develop puborectalis hypertrophy, adding an organic element to this functional disorder.

The initial treatment for anismus is dietary fiber and bulking agents, such as psyllium, methylcellulose, calcium polycarbophil or wheat dextrin. Laxatives and enemas may also be used. Although simple and inexpensive, the efficacy of these agents is unclear, as studies are confounded by inclusion of all patients with chronic constipation or obstructive defecation without subset analysis of anismus patients [1, 2].

Low-cost and low-risk, biofeedback therapy is another cornerstone of anismus treatment. Published results of successful outcomes with biofeedback therapy range widely between 8–93% [3–8]. The variability is likely because many different selection criteria, treatment protocols, outcome measurements, and lengths of follow-up are used in these studies. Moreover, not all patients are able to finish the entire biofeedback treatment course [9]. Nevertheless, recent prospective trials demonstrate an advantage to biofeedback when compared to placebo, diazepam, diet, exercise and laxatives for anismus [10–13].

Botulinum toxin A (BTX-A) injection, available since the 1980s, is another option for treating anismus [14]. As with biofeedback, there is marked variation in the literature in patient selection, technique, outcome measurement, and follow-up for botulinum treatment of anismus. The original method describes placing the toxin into both sides of the puborectalis and the external anal sphincter, but subsequent modifications include the use of ultrasound or electromyography to help target injection sites. Wide ranges in dosing are reported (6–100 units per injection) [14, 15]. There is likely a role for repeat injections due to the temporary nature of BTX-A [15–17]. Overall, treatment efficacy has been 25–95% with both subjective and objective outcomes [16–19].

A prospective randomized trial has examined BTX-A versus biofeedback in anismus. BTX-A was initially more successful (70% clinical improvement versus 50% for biofeedback), but at 1 year the efficacy of both treatments was less than 33% and there was no longer any significant difference [19], highlighting the potential for repeat BTX-A injections.

For those patients who do not respond well to biofeedback or BTX-A, puborectalis hypertrophy may need to be addressed as a component of their therapy. Anal dilation may be a useful adjunct in these patients. In one case series, 13 patients serially dilated themselves using dilators of 20, 23, and 27 mm for 10 min each, every day over 3 months. This approach led to an improved number of weekly bowel movements and decrease in laxative use and enema use. Pressure during straining was also decreased in follow-up manometry. Zero of 13 patients had incontinence at 6 months [20]. However, there are no further dedicated studies in the literature for anismus, limiting the widespread use of this technique.

Surgical intervention for anismus is controversial and carries the potential for incontinence, but may be useful in those patients with hypertrophic fibers of the puborectalis. The original surgical approach, reported along with one of the initial descriptions of anismus in 1964, involves posterior division of the puborectalis muscle [21]. This approach, as well as a modification with only lateral puborectalis division, has been overall disappointing in terms of high rates of incontinence and minimal symptom improvement [22, 23].

Partial resection of the puborectalis muscle has also been described. In one series of 149 patients, 90% were successfully treated [24]. In this procedure, the puborectalis is approached

through an incision from the posterior anal verge to the tip of the coccyx. Approximately 1.5 cm of the puborectalis in the posterior midline is excised and the remaining muscle ends are ligated with suture [25]. It is important to note that these studies were conducted over 10 years ago and provided limited data on this approach.

Alternatively, bilateral partial division of the puborectalis has been described more recently. A prospective study randomizing 60 patients with anismus to biofeedback, BTX-A, or surgery offers favorable surgical results. To address concerns about incontinence, the authors divided only the inner half of the puborectalis on each side. Clinical improvement was defined by no straining, digitations, hard stool or sense of anorectal obstruction in addition to >3 BM a week. At both 1 month and 1-year follow-up, surgery showed more clinical improvement compared to biofeedback and BTX-A (95% versus 50% and 75%, at 1 month; 70% versus 30% and 35%, at 1 year, respectively). In contrast to earlier studies, fecal incontinence was noted in only 10% of patients [26]. More studies need to be done to verify the clinical improvement and low incontinence rate in this study.

Finally, a diverting ostomy remains a consideration for severe anismus refractory to the other treatments. Figure 7.1 proposes a simple treatment algorithm for anismus with primary focus on nonsurgical management.

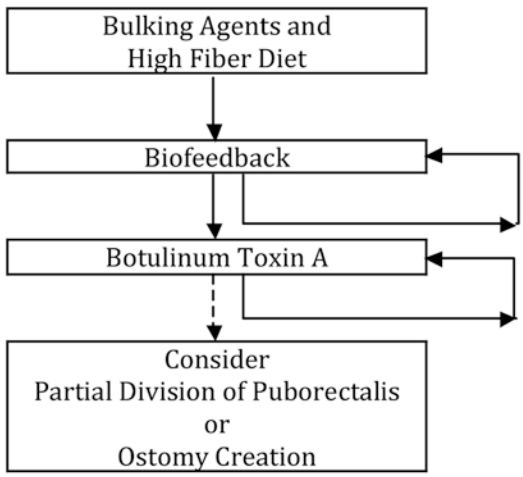


Fig. 7.1 Treatment algorithm for anismus

Perineal Descent Syndrome

Perineal descent syndrome (PDS) is marked by bulging or 'ballooning' of the perineum during straining (though rarely it can present at rest as well). Perineal descent is the caudal movement of the pelvic floor in reference to the pubococcygeal line (the imaginary line between the tip of the coccyx and the pubic symphysis). Generally, the diagnosis of PDS is established in patients with trouble defecating and perineal descent of more than 3–5 cm (Fig. 7.2) [27, 28].

These patients have chronic constipation with excessive straining; most patients are women and up to 75% have undergone hysterectomy [29, 30]. They frequently describe a feeling of partial rectal emptying that leads to continued, albeit ineffective, efforts to evacuate; these efforts may include digital self-disimpaction. Anterior rectal wall prolapse may create discharge and perineal irritation. The continued descent of the perineum may cause stretch injury of the pudendal nerve and neuropathy [31–34]. The chronic sequelae of these repetitive behaviors cause a further weakening of the pelvic floor, exacerbating the underlying problem and leading to a 'vicious cycle' that in many instances culminates in fecal incontinence.

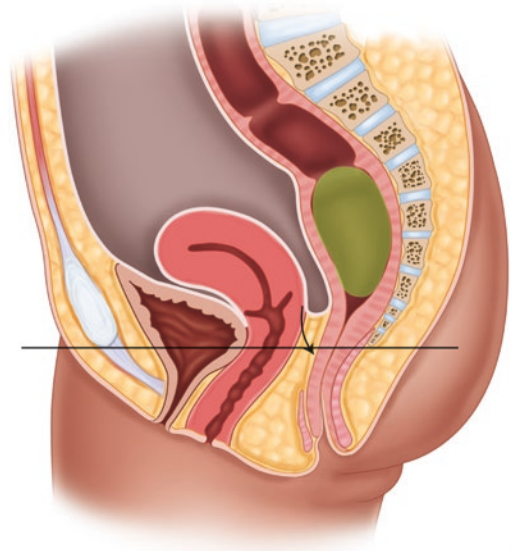


Fig. 7.2 Perineal descent syndrome. The pelvic floor is bulging well below the pubococcygeal line (*solid line*) and curved arrow is direction of descent

Though a perineometer was historically used to estimate perineal descent [35], defecography has become the standard diagnostic tool. The choice between conventional fluoroscopic defecography and MR defecography has been studied. Both are accurate in PDS diagnosis, though conventional defecography utilizes a physiologic, upright position during straining (versus supine in traditional MRI). This has to be balanced against the advantages of MRI: multi-planar, multi-compartmental images, direct depiction of surrounding musculature, and absence of non-ionizing radiation [36–39]. Recently, open MRI, which allows MR defecography in the upright position, has become more available. Several studies have shown accurate assessment of PDS using the open configuration [40, 41].

PDS is difficult to treat and can be frustrating for both patient and clinician. Non-operative treatments are preferred, and these focus on elimination of straining with dietary modification and bulking agents, enemas, and biofeedback therapy [42]. Perineal devices, such as the 'Defecom' and 'Colorec'—modified commodes that have perineal support—may also be employed [43, 44], though they are not widely available and have little supporting data (Fig. 7.3).

Success rates with biofeedback have ranged from 29 to 80% [42, 44, 45]. Some literature suggests that biofeedback is more helpful in patients with less severe perineal descent [44]. One study found that the responders to biofeedback had a mean descent of 3.3 cm compared to the non-responders, whose mean descent was 4.9 cm [42]. In fact, for patients with more severe descent *and* fecal incontinence—which is usually a late finding in patients with PDS—the initial benefits of biofeedback seem to deteriorate between 6 and 30 months after treatment. These patients may benefit from additional biofeedback [45].

Surgery has no role to cure PDS. The multiplicity of surgical approaches underscores the lack of an optimal operation; each has limited efficacy and significant morbidity. Multidisciplinary collaboration is advisable. One of the largest series in the literature has 19 patients diagnosed with vaginal vault prolapse and varying degrees of perineal descent who

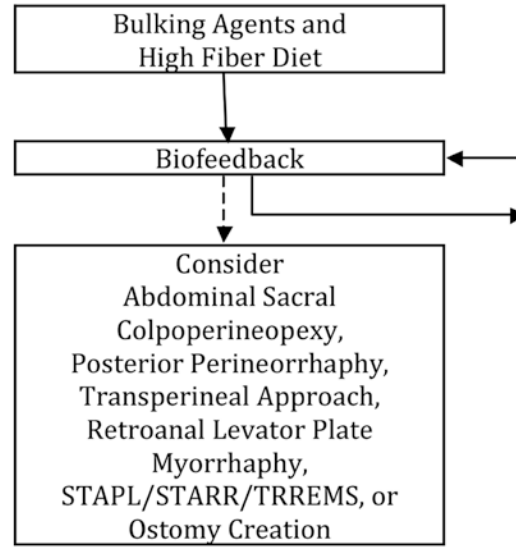


Fig. 7.3 Treatment algorithm for perineal descent syndrome. *STAPL* Stapled trans-anal prolapsectomy associated with perineal levatorplasty; *STARR* Stapled transanal rectal resection; *TRREMS* Transanal repair of rectocele and rectal mucosectomy with a single circular stapler

underwent abdominal sacral colpoperineopexy. In this procedure, the lax perineal body is digitally elevated by the surgeon's finger in the vagina. Mesh is sutured to the posterior vaginal wall far enough down to securely engage fascia and then secured to the sacral promontory, thus acting as a suspensory mesh (Fig. 7.4a). This is similar to a sacrocolpopexy. A culdoplasty (closing the space between the rectum and vagina) is also performed. In short-term follow-up, symptoms improved in most patients [46]. A laparoscopic version of this technique was later performed successfully in a patient with both PDS and vaginal vault prolapsed (Fig. 7.4b) [47].

Other perineal operations include posterior perineorrhaphy (apposing the levator muscles, puborectalis, and sphincter muscle behind the anal canal) [48], a transperineal approach (plication of the posterior rectum with fixation to the presacral fascia and reapproximation of the levators in the posterior midline) (Fig. 7.4c) [49], and retroanal levator plate myorrhaphy (suturing together of the levator plates bilaterally between the coccyx and the anorectal junction to restore the anorectal angle) (Fig. 7.4d) [50].

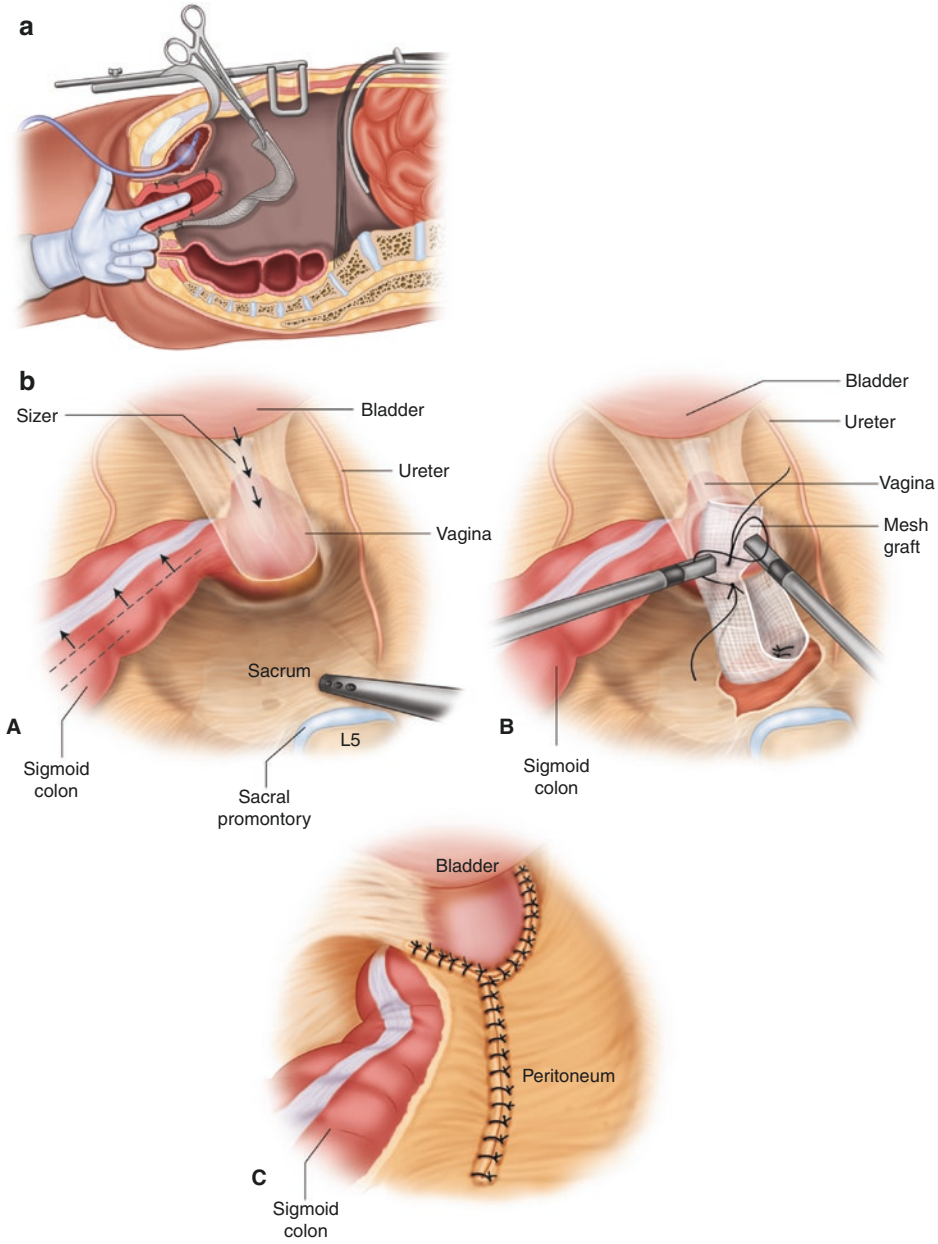


Fig. 7.4 Different surgical approaches for perineal descent syndrome. (**a**) Abdominal sacral colpoperineopexy—sagittal section illustrating dissection of rectovaginal space and attachment of mesh to perineal body, which is elevated by surgeon's hand. (**b**) Laparoscopic sacral colpoperineopexy—A. Initial laparoscopic view with sizer in vagina showing position of vaginal apex and sacral promontory. B. Suturing graft material to anterior aspect of vaginal cuff. C. Laparoscopic view after completion of culdoplasty showing complete excision of graft material from peritoneal cavity. (**c**) Retrorectal levatoroplasty—A. A series of placation of stitches have been placed 1 cm apart in the posterior wall of the rectum and tied as shown in A. These are then sewn individually to the anterior periosteum of the sacrum as shown in B. The levator plate is restored and lengthened by bringing the pubococcygei of each side together in the midline between the coccyx and the rectum as shown in C. The bellies of the pubococcygei may be shortened with a Z stitch placed as shown in C. (**d**) Retro-anal levator plate myorrhaphy: surgical steps—A. Skin incision. B. Scissors introduced between levator plate and ano-coccygeal ligament (also called intermediate loop of the external anal sphincter). C. The ano-coccygeal ligament ready to be cut (two extremities marked with a thread). D. Levator plate myorrhaphy between coccyx and ano-rectal junction until suppression of the sagging (checked by rectal examination). E. Ano-coccygeal ligament repaired. F. Skin closure with a Y-shaped multi-tubular drain at the posterior edge of the incision

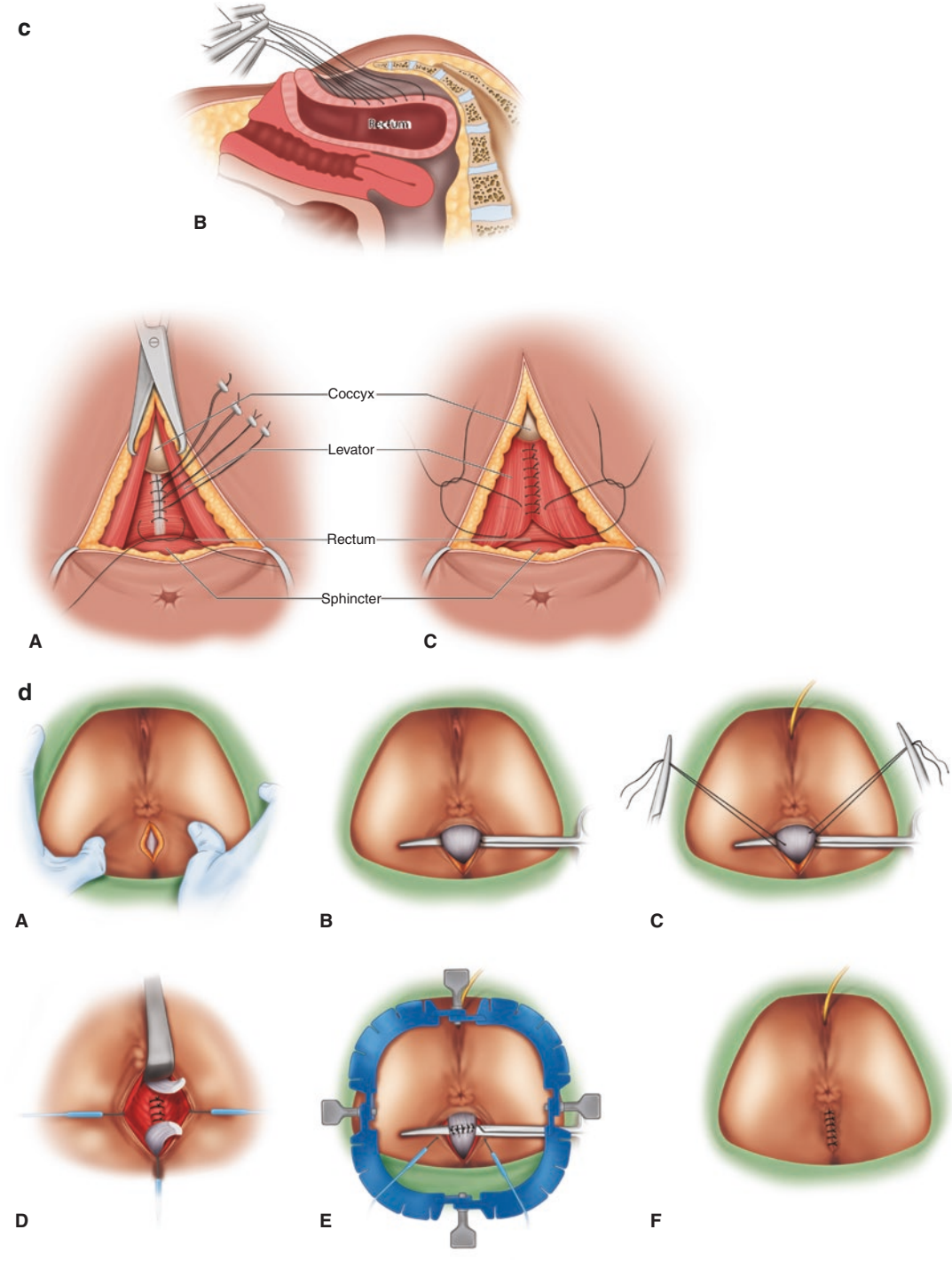


Fig. 7.4 (continued)

To avoid the morbidity of a perineal incision, operations utilizing staplers have been developed. One randomized trial examined the use of the hemorrhoidal stapler by comparing single Stapled Trans-Anal Prolapsectomy associated with Perineal Levatorplasty (STAPL) with double Stapled Transanal Rectal Resection (STARR) in patients with outlet obstruction, including patients with perineal descent. Constipation symptoms improved with both operations, but the STARR procedure was associated with less pain and dyspareunia [51].

Transanal repair of rectocele and rectal mucosectomy with a single circular stapler (TRREMS) is another stapler technique in patients with obstructed defecation syndrome caused by rectocele and rectal mucosal prolapse. In this procedure, the rectocele and associated mucosa are resected transanally and the defect is then closed with the aid of a single circular stapler [52]. The TRREMS procedure has been shown to be safe and effective in appropriately selected patients with improvement in measures of constipation [53, 54].

As in the case of anismus, a final surgical option may be the creation of a diverting stoma. We propose a treatment algorithm with core focus on nonsurgical therapy (Fig. 7.1). If unsuccessful, surgery is considered, but should be limited to those with substantial experience. A multidisciplinary evaluation may be useful and may involve colorectal surgery, urogynecology and gynecology.

Solitary Rectal Ulcer Syndrome

Solitary rectal ulcer syndrome (SRUS) is a term introduced by M. R. Madigan in 1964 [55]. Both 'solitary' and 'ulcer' are misnomers, as the condition may not be solitary in nature and does not always produce an ulcer. Moreover the ulcers are rarely typical. Because it is an uncommon entity, diagnosis is often delayed and a high clinical suspicion is necessary for timely diagnosis. A related entity, colitis cystic profunda (CCP) is marked by inflamed areas filled with mucin resulting in a cystic-appearing neoplasm. CCP and SRUS are related diagnoses that some clinicians consider interchangeable. Both SRUS and CCP are seen more commonly in women and usually affect those between the third and seventh decade, though patients as young as 3 years with SRUS have been reported [56–58].

Local chronic ischemia is thought to be the underlying etiology of SRUS, with causes ranging from internal rectal intussusception, trauma from digitation or instrumentation of the rectum, or even the use of strong vasoconstricting agents such as ergotamine suppositories. The classic etiologic sequence begins with straining that induces rectal intussusception or prolapse. Direct pressure at the point of prolapse leads to local tissue congestion and ischemia, ultimately causing ulcer formation.

The symptoms of SRUS are nonspecific, but usually include some combination of bloody or mucous rectal secretions, chronic constipation with a feeling of outlet obstruction, tenesmus, and pelvic or abdominal pain. These patients usually have a history of significant straining to defecate. During digital examination in a patient with SRUS, there may be a palpable area of induration. Endoscopic assessment typically demonstrates a solitary ulcer on the anterior rectal wall, though lesions may be multiple and variably located. An ulcer is not mandatory for diagnosis: manifestations range from shallow 'punched-out' gray-white lesions with a hyperemic base to rectal erythema to rectal pseudopolyps.

Imaging studies may aid in the diagnosis of SRUS. Defecography is especially useful but is often only available at specialized centers. The dynamic images of defecography are more specific than the static views of a barium enema [59]. Characteristic features of SRUS include intussusception, nonrelaxing puborectalis muscle, or incomplete or delayed rectal emptying. Though magnetic resonance (MR) defecography is a now available in some centers, it has not shown any advantage over conventional defecography and may overdetect incomplete evacuation in 30% of patients [36, 60]. Endoscopic anorectal ultrasound is another adjunct in SRUS diagnosis that typically demonstrates a hyperechoic layer between the circular and longitudinal muscle

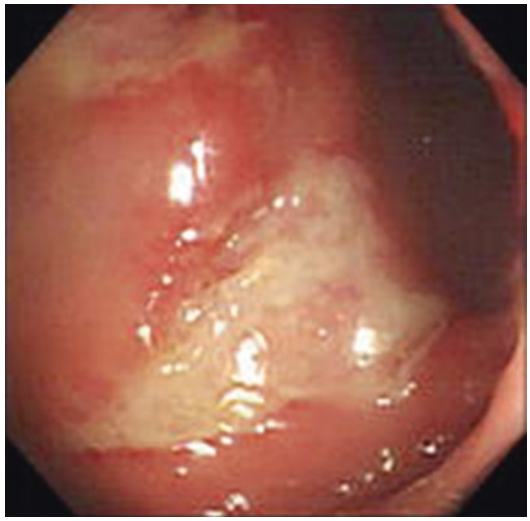


Fig. 7.5 Solitary rectal ulcer syndrome. Endoscopy findings—anterior ulcer with white sloughy base. With permission from [57] © 2006 Springer

layer of muscularis propria and may aid in differentiating SRUS from rectal cancer (Fig. 7.5).

Biopsy and histopathologic examination is key to both the diagnosis of SRUS and to excluding other pathologies, such as inflammatory bowel disease or cancer. Microscopically, SRUS appears as so-called 'fibromuscular obliteration', which is characterized by an obliterated, fibrotic lamina propria that contains excess collagen and disorganized hypertrophy of the smooth muscle fibers from the muscularis mucosae towards the lumen. The presence of collagen infiltration of the lamina propria distinguishes SRUS from other inflammatory, infectious and ischemic colitides [57]. In contrast, mucus-filled cystic spaces are seen in CCP with thickened, fibrotic submucosa with mixed inflammatory infiltration.

The initial treatment for SRUS is non-operative. Interventions that decrease straining, such as patient education, bulk laxatives, and stool softeners, can be effective in about 20% of patients. Topical enemas and agents containing steroids, 5-ASA, sucralfate, or sulfasalazine may not heal the lesions because they are not true ulcers. Biofeedback may alleviate associated pelvic floor dysfunction. In a series of 11 patients, biofeedback decreased straining effort and stool frequency and improved quality-of-life measures; 6 patients had at least 50% healing of their ulcers [61]. Although these non-operative therapies may be effective initially, they do not often produce good long term results. In one series of 23 patients, 16 failed nonsurgical measures [56].

If the outlet obstruction and ulceration of SRUS is caused by prolapse, this may need definitive treatment. Abdominal rectopexy has a reported 55–60% long-term improvement in symptoms [62]. Traditionally, this involved a low short midline incision and suture proctopexy to the sacrum at the distal third of the rectum. This can also be done laparoscopically, though some early efforts were not entirely successful. However, a recent series of 39 patients reported 70% success rate after laparoscopic rectopexy [63]. There may also be a large role for robotic-assisted laparoscopic ventral rectopexy as experience with this technology increases worldwide.

Sigmoidocele

Sigmoidocele, a type of enterocele in which a loop of sigmoid colon herniates through the pelvic floor, is another cause of outlet obstruction. Hysterectomy predisposes patients to develop enterocele generally, including sigmoidocele. Among patients undergoing defacography, the incidence of sigmoidocele is about 5% with an overwhelming predominance in women [64].

The suggested mechanism of outlet obstruction in sigmoidocele is complex and not all patients with sigmoidocele have symptoms. In symptomatic patients, several factors, including collapse of the rectal wall due to extrinsic compression of the hernia contents and stasis of the sigmoid loop, as well as rectoanal intussusception, rectocele and paradoxical contraction of puborectalis, frequently contribute to the symptomatology.

Sigmoidocele is best diagnosed with conventional defecography, as physical examination is not reliable [65]. Jorge and colleagues proposed a sigmoidocele classification system based on extent of sigmoid herniation in relation to anatomic landmarks. In first-degree sigmoidocele, the intrapelvic sigmoid loop remains above the pubococcegeal line, in second-degree

between the pubococcygeal and ischiococcygeal lines, and in third-degree the loop is below the ischioccygeal line. The cinedefecographic degree of sigmoidocele correlates well with symptoms (Fig. 7.6a–c) [66].

Biofeedback therapy is the mainstay of treatment in symptomatic patients with first- and second-degree sigmoidocele, with approximately a 50% success rate. Surgical repair is rarely indicated. Third-degree sigmoidoceles may also benefit from biofeedback therapy, but sigmoid resection is often indicated. The surgical results are excellent, resolving symptoms in nearly all patients in the experience of one editor (SDW) [66]. Laparoscopic sigmoidectomy can be performed for these patients, with shorter hospitalization and less disability when compared to laparotomy. Coexisting intussusception can be

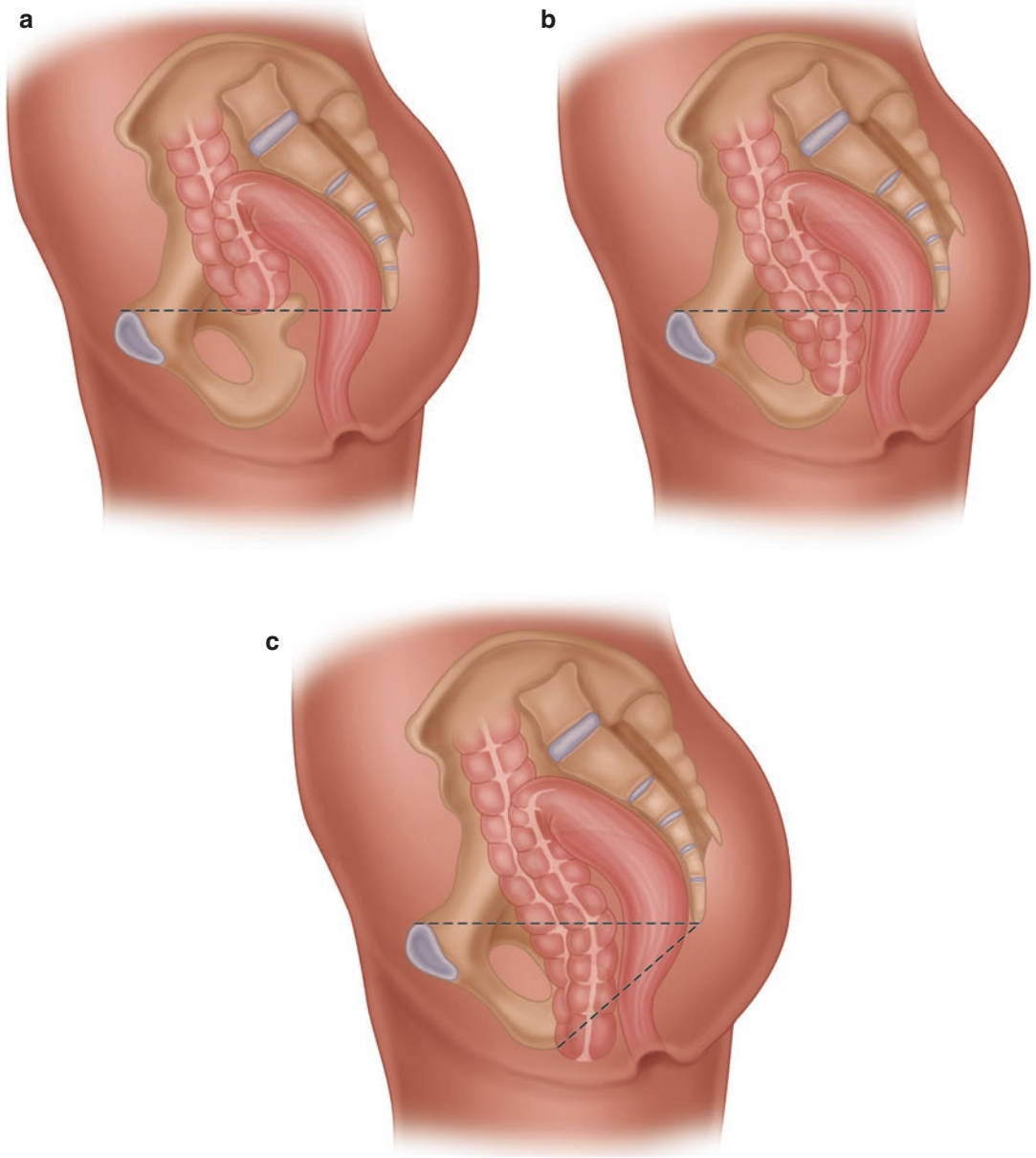


Fig. 7.6 Sigmoidocele. (**a**) First degree, (**b**) Second degree, (**c**) Third degree

treated with rectopexy at the time of sigmoidectomy [67]. Rectocele coexisting with third-degree sigmoidocele is usually a small outpouching with minimal clinical significance and likely can be observed.

Conclusion

Functional anorectal disorders can produce significant symptoms. Improvements in our knowledge of these disorders and experience with physiologic testing has allowed more accurate diagnosis and in many cases successful therapy.

References

1. Ramkumar D, Rao S. Efficacy and safety of traditional medical therapies for chronic constipation: systematic review. Am J Gastroenterol. 2005;100(4):936–71.
2. Bove A. Consensus statement AIGO/SICCR diagnosis and treatment of chronic constipation and obstructed defecation (Part II: Treatment). World J Gastroenterol. 2012;18(36):4994.
3. Loening-Baucke V. Persistence of chronic constipation in children after biofeedback treatment. Dig Dis Sci. 1991;36(2):153–60.
4. Dahl J, Lindquist B, Tysk C, Leissner P, Philipson L, Järnerot G. Behavioral medicine treatment in chronic constipation with paradoxical anal sphincter contraction. Dis Colon Rectum. 1991;34(9):769–76.
5. Turnbull G, Ritvo P. Anal sphincter biofeedback relaxation treatment for women with intractable constipation symptoms. Dis Colon Rectum. 1992;35(6):530–6.
6. Papachrysostomou M, Smith A. Effects of biofeedback on obstructive defecation—reconditioning of the defecation reflex? Gut. 1994;35(2):252–6.
7. Keck J, Staniunas R, Coller J, Barrett R, Oster M, Schoetz D, et al. Biofeedback training is useful in fecal incontinence but disappointing in constipation. Dis Colon Rectum. 1994;37(12):1271–6.
8. Glia A, Gylin M, Gullberg K, Lindberg G. Biofeedback retraining in patients with functional constipation and paradoxical puborectalis contraction. Dis Colon Rectum. 1997;40(8):889–95.
9. Gilliland R, Heymen S, Altomare D, Park U, Vickers D, Wexner S. Outcome and predictors of success of biofeedback for constipation. Br J Surg. 1997;84(8):1123–6.
10. Heymen S, Scarlett Y, Jones K, Ringel Y, Drossman D, Whitehead W. Randomized, controlled trial shows biofeedback to be superior to alternative treatments for patients with pelvic floor dyssynergia-type constipation. Dis Colon Rectum. 2007;50(4):428–41.
11. Chiarioni G, Salandini L, Whitehead W. Biofeedback benefits only patients with outlet dysfunction, not patients with isolated slow transit constipation. Gastroenterology. 2005;129(1):86–97.
12. Rao S, Valestin J, Brown C, Zimmerman B, Schulze K. Long-term efficacy of biofeedback therapy for dyssynergic defecation: randomized controlled trial. Am J Gastroenterol. 2010;105(4):890–6.
13. Hart S, Lee J, Berian J, Patterson T, del Rosario A, Varma M. A randomized controlled trial of anorectal biofeedback for constipation. Int J Color Dis. 2011;27(4):459–66.
14. Hallan R, Melling J, Womack N, Williams N, Waldron D, Morrison J. Treatment of anismus in intractable constipation with botulinum a toxin. Lancet. 1988;332(8613):714–7.
15. Maria G, Brisinda G, Bentivoglio A, Cassetta E, Albanese A. Botulinum toxin in the treatment of outlet obstruction constipation caused by puborectalis syndrome. Dis Colon Rectum. 2000;43(3):376–80.
16. Joo J, Agachan F, Wolff B, Nogueras J, Wexner S. Initial North American experience with botulinum toxin type A for treatment of anismus. Dis Colon Rectum. 1996;39(10):1107–11.
17. Ron Y, Avni Y, Lukovetski A, Wardi J, Geva D, Birkenfeld S, et al. Botulinum toxin type-A in therapy of patients with anismus. Dis Colon Rectum. 2001;44(12):1821–6.
18. Hompes R, Harmston C, Wijffels N, Jones O, Cunningham C, Lindsey I. Excellent response rate of anismus to botulinum toxin if rectal prolapse misdiagnosed as anismus ('pseudoanismus') is excluded. Color Dis. 2012;14(2):224–30.
19. Farid M, El Monem H, Omar W, El Nakeeb A, Fikry A, Youssef T, et al. Comparative study between biofeedback retraining and botulinum neurotoxin in the treatment of anismus patients. Int J Color Dis. 2008;24(1):115–20.
20. Maria G, Anastasio G, Brisinda G, Civello I. Treatment of puborectalis syndrome with progressive anal dilation. Dis Colon Rectum. 1997;40(1):89–92.
21. Wasserman I. Puborectalis syndrome (rectal stenosis due to anorectal spasm). Dis Colon Rectum. 1964;7(2):87–98.
22. Barnes P, Hawley P, Preston D, Lennard-Jones J. Experience of posterior division of the puborectalis muscle in the management of chronic constipation. Br J Surg. 1985;72(6):475–7.
23. Kamm M, Hawley P, Lennard-Jones J. Lateral division of the puborectalis muscle in the management of severe constipation. Br J Surg. 1988;75(7):661–3.
24. Liu Y, Zang J, Li Y. Treatment of musculi puborectalis syndrome with partial resection of musculi puborectalis: analysis in 149 cases. J LuoYang Med Coll. 2001;19:17–8.
25. Yu D, Jin H. Surgical treatment for puborectalis hypertrophy. In: Wexner S, Duthie G, editors. Constipation: etiology, evaluation and management. 2nd ed. London: Springer; 2006. p. 247–56.

26. Faried M, El Nakeeb A, Youssef M, Omar W, El Monem H. Comparative study between surgical and non-surgical treatment of anismus in patients with symptoms of obstructed defecation: a prospective randomized study. J Gastrointest Surg. 2010;14(8):1235–43.
27. Parks A, Porter N, Hardcastle J. The syndrome of the descending perineum. Proc R Soc Med. 1966;59(8):477–82.
28. Thapar R, Patankar R, Kamat R, Thapar R, Chemburkar V. MR defecography for obstructed defecation syndrome. Indian J Radiol Imaging. 2015;25(1):25.
29. Alves-Ferreira P, Gurland B, Zutshi M, Hull T. Perineal descent does not imply a more severe clinical disorder. Color Dis. 2012;14(11):1372–9.
30. Pucciani F, Boni D, Perna F, Bassotti G, Bellini M. Descending perineum syndrome: are abdominal hysterectomy and bowel habits linked? Dis Colon Rectum. 2005;48(11):2094–9.
31. Ho Y, Goh H. The neurophysiological significance of perineal descent. Int J Colorectal Dis. 1995;10(2):107–11.
32. Kiff E, Barnes P, Swash M. Evidence of pudendal neuropathy in patients with perineal descent and chronic straining at stool. Gut. 1984;25(11):1279–82.
33. Jorge M, Wexner S, Ehrenpreis E, Nogueras J, Jagelman D. Does perineal descent correlate with pudendal neuropathy? Dis Colon Rectum. 1993;36(5):475–83.
34. Vaccaro C, Wexner S, Teoh T, Kyung Choi S, Cheong D, Salanga V. Pudendal neuropathy is not related to physiologic pelvic outlet obstruction. Dis Colon Rectum. 1995;38(6):630–4.
35. Ambrose S, Keighley M. Outpatient measurement of perineal descent. Ann R Coll Surg Engl. 1985;67(5):306–8.
36. Foti P, Farina R, Riva G, Coronella M, Fisichella E, Palmucci S, et al. Pelvic floor imaging: comparison between magnetic resonance imaging and conventional defecography in studying outlet obstruction syndrome. Radiol Med. 2013;118(1):23–39.
37. Vanbeckevoort D, Hoe L, Oyen R, Ponette E, De Ridder D, Deprest J. Pelvic floor descent in females: comparative study of colpocystodefecography and dynamic fast MR imaging. J Magn Reson Imaging. 1999;9(3):373–7.
38. Kelvin F, Maglinte D, Hale D, Benson J. Female pelvic organ prolapse. Am J Roentgenol. 2000;174(1):81–8.
39. Healy J, Halligan S, Reznek R, Watson S, Bartram C, Phillips R, et al. Dynamic MR imaging compared with evacuation proctography when evaluating anorectal configuration and pelvic floor movement. Am J Roentgenol. 1997;169(3):775–9.
40. Roos J, Weishaupt D, Wildermuth S, Willmann J, Marincek B, Hilfiker P. Experience of 4 years with open MR defecography: pictorial review of anorectal anatomy and disease. Radiographics. 2002;22(4):817–32.
41. Fiaschetti V, Squillaci E, Pastorelli D, Rascioni M, Funel V, Salimbeni C, et al. Dynamic MR defecography with an open-configuration, low-field, tilting MR system in patients with pelvic floor disorders. Radiol Med. 2011;116(4):620–33.
42. Harewood G, Coulie B, Camilleri M, Rath-Harvey D, Pemberton J. Descending perineum syndrome: audit of clinical and laboratory features and outcome of pelvic floor retraining. Am J Gastroenterol. 1999;94(1):126–30.
43. Lesaffer L, Milo R. Descending perineum syndrome: control defecogram with a "perineum device", perspective in prevention and conservative therapy. J Belg Radiol. 2007;71(6):709–12.
44. Schey R, Cromwell J, Rao S. Medical and surgical management of pelvic floor disorders affecting defecation. Am J Gastroenterol. 2012;107(11):1624–33.
45. Guillemot F, Bouche B, Gower-Rousseau C, Chattier M, Wolschies E, Lamblin M, et al. Biofeedback for the treatment of fecal incontinence. Dis Colon Rectum. 1995;38(4):393–7.
46. Cundiff G, Harris R, Coates K, Low V, Bump R, Addison W. Abdominal sacral colpoperineopexy: a new approach for correction of posterior compartment defects and perineal descent associated with vaginal vault prolapse. Am J Obstet Gynecol. 1997;177(6):1345–55.
47. Link R, Su L, Bhayani S, Wright E. Laparoscopic sacral colpoperineopexy for treatment of perineal body descent and vaginal vault prolapse. Urology. 2004;64(1):145–7.
48. Parks A. Post-anal perineorrhaphy for rectal prolapse. Proc R Soc Med. 1967;60(9):920–1.
49. Nichols D. Retrorectal levatorplasty with colporrhaphy. Clin Obstet Gynecol. 1982;25(4):939–47.
50. Beco J. Interest of retro-anal levator plate myorrhaphy in selected cases of descending perineum syndrome with positive anti-sagging test. BMC Surg. 2008;8(1):13.
51. Boccasanta P, Venturi M, Salamina G, Cesana B, Bernasconi F, Roviaro G. New trends in the surgical treatment of outlet obstruction: clinical and functional results of two novel transanal stapled techniques from a randomised controlled trial. Int J Color Dis. 2004;19(4):359–69.
52. Regadas F, Regadas S, Rodrigues L, Misici R, Silva F, Regadas Filho F. Transanal repair of rectocele and full rectal mucosectomy with one circular stapler: a novel surgical technique. Tech Coloproctol. 2005;9(1):63–6.
53. Cruz J, Regadas F, Murad-Regadas S, Rodrigues L, Benicio F, Leal R, et al. TRREMS procedure (transanal repair of rectocele and rectal mucosectomy with one circular stapler): a prospective multicenter trial. Arq Gastroenterol. 2011;48(1):3–7.
54. Leal V, Regadas F, Regadas S, Veras L. Clinical and functional evaluation of patients with rectocele and mucosal prolapse treated with transanal repair of rectocele and rectal mucosectomy with a single

circular stapler (TRREMS). Tech Coloproctol. 2010;14(4):329–35.
55. Madigan Morson B. Solitary ulcer of the rectum. Gut. 1969;10(11):871–81.
56. Torres C, Khaikin M, Bracho J, Luo C, Weiss E, Sands D, et al. Solitary rectal ulcer syndrome: clinical findings, surgical treatment, and outcomes. Int J Color Dis. 2007;22(11):1389–93.
57. Chiang J, Changchien C, Chen J. Solitary rectal ulcer syndrome: an endoscopic and histological presentation and literature review. Int J Color Dis. 2006;21(4):348–56.
58. Perito E, Mileti E, Dalal D, Cho S, Ferrell L, McCracken M, et al. Solitary rectal ulcer syndrome in children and adolescents. J Pediatr Gastroenterol Nutr. 2012;54(2):266–70.
59. Halligan S, Nicholls R, Bartram C. Evacuation proctography in patients with solitary rectal ulcer syndrome: anatomic abnormalities and frequency of impaired emptying and prolapse. Am J Roentgenol. 1995;164(1):91–5.
60. Otto S, Oesterheld A, Ritz J, Gröne J, Wolf K, Buhr H, et al. Rectal anatomy after rectopexy: cinedefecography versus MR-defecography. J Surg Res. 2011;165(1):52–8.
61. Rao S, Ozturk R, De Ocampo S, Stessman M. Pathophysiology and role of biofeedback therapy in solitary rectal ulcer syndrome. Am J Gastroenterol. 2006;101(3):613–8.
62. Sitzler K, Nicholls M. Long-term clinical outcome of surgery for solitary rectal ulcer syndrome. Br J Surg. 1998;85(9):1246–50.
63. Kargar S, Salmanroughani H, Binesh F, Taghipoor S, Kargar S. Laparoscopic rectopexy in solitary rectal ulcer. Acta Med Iran. 2011;49(12):810–3.
64. Kelvin F, Maglinte D, Hornback J, Benson J. Pelvic prolapse: assessment with evacuation proctography (defecography). Radiology. 1992;184(2):547–51.
65. Fenner D. Diagnosis and assessment of sigmoidoceles. Am J Obstet Gynecol. 1996;175(6):1438–42.
66. Jorge J, Yang Y, Wexner S. Incidence and clinical significance of sigmoidoceles as determined by a new classification system. Int J Color Dis. 1994;37(11):1112–7.
67. Laubert T, Kleemann M, Roblick U, Bürk C, Hildebrand P, Lewejohann J, et al. Obstructive defecation syndrome: 19 years of experience with laparoscopic resection rectopexy. Tech Coloproctol. 2013;17(3):307–14.

8 Rectal Prolapse and Intussusception

Jonathan R. Snyder and Ian M. Paquette

Introduction

Rectal prolapse is the full thickness, circumferential protrusion of the rectum through the anus. This relatively uncommon disorder is estimated to occur in 0.5% of the population [1]. The true incidence of this condition may be under-reported because patients are often too embarrassed to seek medical attention. Full thickness rectal prolapse is one of the many pelvic floor disorders, which mostly affects women and the elderly. Though prolapse can occur in multiple clinical settings, some of the risks factors that have been described include chronic constipation, obstetric related pelvic floor dysfunction, and chronic straining with defecation [1–7]. Rectal prolapse obviously has a great impact on quality of life [3], and as such, many attempts have been made to develop a surgical solution that can alleviate the symptoms, including incontinence to stool or mucus, constipation, sensation of incomplete evacuation, rectal bleeding, pain, or urgency [1, 2, 4].

J. R. Snyder
Department of Surgery, Division of Colon and Rectal Surgery, University of Cincinnati Medical Center, Cincinnati, OH, USA

I. M. Paquette (✉)
Division of Colon and Rectal Surgery, University of Cincinnati College of Medicine, Christ Hospital Center for Pelvic Floor Disorders, Cincinnati, OH, USA
e-mail: ian.paquette@uc.edu

Before discussing the surgical treatment of rectal prolapse, one must be able to differentiate a full thickness rectal prolapse from rectal intussusception, or partial thickness mucosal prolapse. The main feature differentiating full thickness prolapse from mucosal prolapse is the presence of concentric mucosal rings with Rectal prolapse:full thickness prolapse (Fig. 8.1). Internal rectal intussusception is known as the intussusception of the middle or upper portion of the rectum, which does not prolapse through the anal canal. This finding is most often diagnosed in the setting evaluating constipation with defecography (Fig. 8.2). Mucosal prolapse is simply prolapse of the distal rectal mucosa, which is noted by radial folds in the tissue when a patient is examined on the commode (Fig. 8.3). Differentiating among these disorders is critical, as the treatment of these conditions varies.

Over 100 procedures have been described to treat rectal prolapse [5], suggesting there is no universally accepted panacea [1, 2, 4–6]. Most often, the debate lies in whether to use an abdominal or a perineal surgical approach. These decisions are often made based on the overall health of the patient and on whether there are any other associated bowel abnormalities present, as well as a review of any prior surgical procedures [2, 4, 6, 7, 9]. In general, abdominal procedures have lower recurrence rates but may have a higher incidence of

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_8

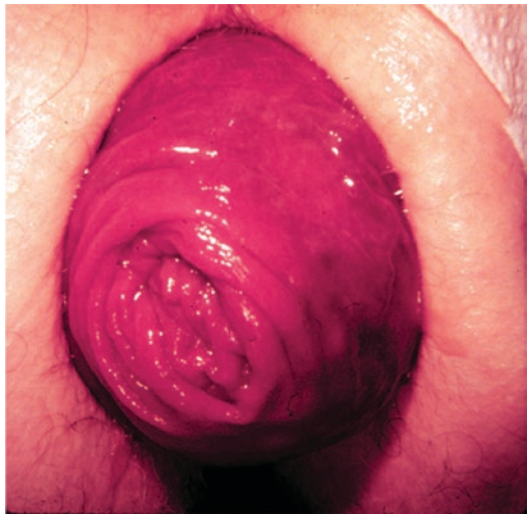


Fig. 8.1 Full thickness rectal prolapse characterized by circumferential mucosal folds

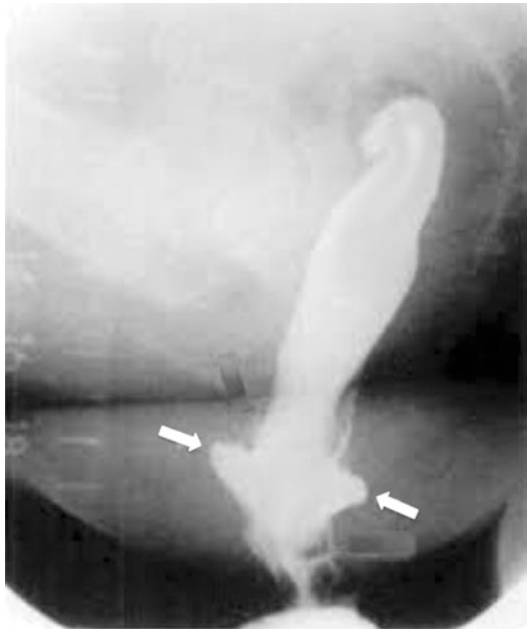


Fig. 8.2 Defecography demonstrating internal intussusception of the rectum as demonstrated by the *white arrows*

postoperative complications compared to perineal surgery [10]. Russell et al. used the NSQIP database to examine 1485 patients who underwent surgery for rectal prolapse. A total of 706 patients underwent an abdominal approach

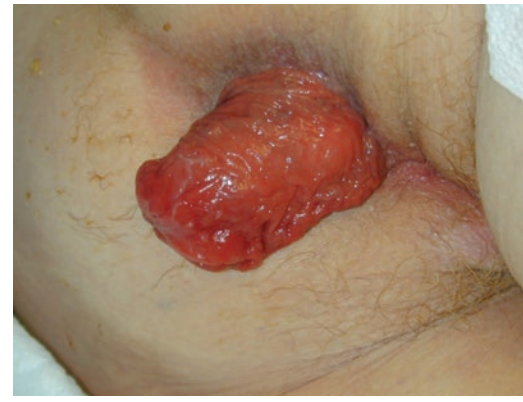


Fig. 8.3 Mucosal prolapse is characterized by radial folds of tissue protruding from the anus. With permission [8] © Springer 2014

versus 779 with a perineal approach. Complications (12.9% vs. 7.6%) and infection rates (9.8% vs. 3.7%) were higher following the abdominal approach [10]. Since this study focused only on 30-day postoperative outcomes, there was no long-term recurrence data available. Another recent trial, the PROSPER trial randomized patients to different treatment methods. Patients were first randomized to abdominal vs. perineal surgery. Abdominal surgery patients were randomized to suture vs. resection rectopexy, and perineal surgery patients were randomized to Altemeier vs. Delorme procedure. There were no differences in recurrence rates between abdominal and perineal approaches, though it was difficult to recruit patients to this study and it was likely underpowered to detect clinically meaningful differences in outcomes [11].

Based upon available evidence, perineal approaches may be best suited for patients who are not ideal candidates for abdominal surgery, as they may be potentially safely performed without the need for general anesthesia [12–16]. There is mounting evidence that these decisions are best made by taking the patient's overall condition and perceived physiologic reserve into account rather than simply using chronologic age, as excellent outcomes have been shown with abdominal approaches even in octogenarians [17–20].

Abdominal Approaches

Overview of Abdominal Approaches

Once the decision has been made to perform an abdominal operation for correction of rectal prolapse, there are several additional questions to be answered: open vs. laparoscopic; suture rectopexy vs. mesh rectopexy (vs. dissection alone) and resection vs. non-resection. There are many factors at play when making these decisions: surgeon experience and comfort with various techniques; patient body habitus and general health status; a history of prior abdominopelvic surgery or previous pelvic sepsis; a history of severe constipation and/or slow colonic transit; and the coexistence of other elements of pelvic floor dysfunction.

When mobilizing the rectum for a prolapse repair, division of the lateral ligaments has been the subject of much debate and scrutiny. While individual studies have demonstrated evidence either for or against division of the lateral ligaments [21], a review of the available literature in 2005 demonstrated a trend towards reduction of constipation with preservation of the lateral ligaments [22]. A Cochrane review reported similar findings but also decreased recurrence with division of the lateral ligaments [23]. A more recent review retrospectively evaluated 532 patients who had undergone abdominal repair of rectal prolapse and studied factors related to recurrence, specifically looking at the extent of mobilization, the type of rectal fixation and surgical access (i.e., open vs. laparoscopic). On multivariate analysis, the only factor independently associated with recurrence was the degree of mobilization, in that circumferential mobilization led to less recurrence ($p = 0.026$) [24]. Nonetheless, given the potential for lessening constipation with sparing of the lateral ligaments, in patients with pre-existing constipation and/or those undergoing initial repair of their rectal prolapse, the decision of whether to divide the lateral ligaments needs to be individualized.

Open Rectopexy

The abdominal rectopexy procedure begins with an abdominal exploration and exposure to the pelvis. Once the small bowel has been packed out of the pelvis, the sigmoid colon is grasped and elevated while the peritoneal attachments on the left and right side of the sigmoid mesentery are incised down beyond the level of the sacral promontory. Care is taken to identify and preserve the retroperitoneal structures, including the left ureter, gonadal vessels and hypogastric nerve plexus. Dissection is carried down into the pelvis as the rectum is reflected anteriorly to expose the avascular plane between the mesorectal fascia and presacral fascia. This plane is dissected sharply with electrocautery down to the level of the levator ani muscles. The extent of anterior dissection is up for debate but, generally speaking, halting this dissection at the level of the seminal vesicles in men or the upper/mid-vagina in women will minimize the risk of parasympathetic nerve injury. The peritoneum over the lateral ligaments is incised but the bulk of the neurovascular tissue along the lateral rectum is left in place. The rectum is then evaluated for adequate mobility and for its ability to be fixed to the sacral promontory without tension and with appropriate alignment. The peritoneum and mesentery of the lateral rectum are then secured to the periosteum of the sacral promontory using permanent suture. In the absence of mesh placement, the peritoneum is typically left open and drains are not mandated.

While various approaches to non-resection abdominal repair for prolapse had been reported for decades prior, Loygue first described the conventional technique of fixation of the rectum to the sacral promontory in 1965 [25]. This technique has been further refined and reproduced many times since, with excellent results in terms of recurrence rates as low as 0–5% (Table 8.1) [26–31]. It should be noted, however, that constipation is made worse in as many as 50% of patients with pre-existing constipation, and de-novo constipation arises in 15% without this dysfunction pre-operatively [32].

Table 8.1 Results of open rectopexy procedure

Author	# Patients	Recurrence (%)	Morbidity (%)	Mortality (%)
Loygue [25]	140	4	–	1
Carter [26]	32	3	–	–
Blatchford et al. [27]	42	2	20	0
Novell et al. [28]	32	3	9	0
Khanna et al. [29]	65	5[a]	–	–
Briel et al. [30]	24	0	–	0

[a]Defined as recurrence of mucosal prolapse only

Table 8.2 Results of laparoscopic rectopexy

Author	# Patients	Recurrence (%)	Morbidity (%)	Mortality (%)
Foppa et al. [35]	179	20	4	0
Kariv et al. [36]	111	9	–	–
Wilson et al. [37]	72	9	5.6	–
Sahoo et al. [38]	32	0	0	0
Kessler et al. [39]	32	6.3	9.4	0
Heah et al. [40]	25	0	20	0

Laparoscopic Rectopexy

For laparoscopic rectopexy, the initial preparation and positioning (i.e., low lithotomy) are the same as for an open approach. A camera port is placed at the umbilicus and two working trocars are placed in the right mid-abdomen and right lower quadrant. Either one or two additional trocars can be placed on the left, depending on surgeon preference and the number of assistants available. While elevating the rectosigmoid anteriorly, the dissection commences with either an energy device or a scissors. A medial-to-lateral dissection behind the distal sigmoid mesentery is then performed, as the sigmoid mesentery is elevated and the left ureter, nerves and gonadal vessels are identified. The degree of dissection and mobilization should recreate what would typically be done in an open procedure. The mobilized rectum is then evaluated for adequate dissection and for ability to be appropriately fixed to the sacral promontory. Similar to the open technique, fixation is performed using permanent suture between the periosteum of the sacral promontory and peritoneum and lateral mesentery of the rectum. When introduced through a lower port and as perpendicular to the sacral promontory as possible, a laparoscopic tacking device can also be used for fixation and has been shown to have good results [33]. Based on surgeon comfort and experience, a hand-assisted approach may be beneficial in cases of difficult anatomy, recurrent prolapse or previous pelvic sepsis. This method typically involves placing a hand port at the level of the umbilicus versus the lower abdomen via a Pfannenstiel incision.

First described as a sutureless mesh rectopexy in 1992 [34], the laparoscopic technique has been widely adopted and has demonstrated durable results with morbidity and recurrence rates comparable with those of an open approach (Table 8.2) [35–40]. The decision whether to perform a laparoscopic or open repair depends on many factors: surgeon experience, patient body habitus, previous abdominopelvic surgery, and patient ability to tolerated prolonged general anesthesia and steep Trendelenburg positioning. For patients able to tolerate a laparoscopic repair, there are decades of evidence supporting its safety and outcomes.

In a retrospective review of 21 patients randomly assigned to either open or laparoscopic rectopexy with preservation of the lateral ligaments, Boccasanta et al. found, with a roughly 2 year mean follow-up, that recurrence rates and functional outcomes were similar between the two groups, while patients who underwent laparoscopic repair experienced shorter hospital stays

and significantly reduced cost [41]. A randomized trial of laparoscopic versus open approach subsequently assessed at short-term measures of success, including patient pain scores, use of narcotics and length of stay, and favored the laparoscopic approach in every category except for operative time, which favored the open approach by a mean of 49 min [42].

When compared to the open approach, the laparoscopic approach has been shown to reduce length of stay by over 2 days ($p < 0.001$). In this same study, post-operative constipation was more likely to be improved in the laparoscopic group, while the remaining post-operative outcomes of improvement in continence and satisfaction scores were similar between the two groups [36]. A Cochrane review of 12 randomized control trials concluded that a laparoscopic approach was associated with fewer immediate complications and shorter length of stay [43].

Even when followed for 10 years after surgery, laparoscopic repair has stood up well to open repair in terms of recurrence rates and long-term functional results [44, 45]. As such, when possible and safe to perform, a laparoscopic repair should be considered primarily in the management of patients with rectal prolapse, particularly in those with no history of prior repair.

Mesh Techniques

Mesh is frequently used to bolster fixation to the sacral promontory. Many different types of mesh have been used for this purpose over the years, including PTFE and polypropylene, as well as, in more recent years, biologic mesh products. Reports of mesh erosion, infection, chronic pain and constriction, as well as the increasingly litigious environment of medicine have led many surgeons away from synthetic mesh and towards biologic material.

Mesh can be anteriorly or posteriorly secured and in a variety of configurations including partial wrap or complete wrap. Whether working laparoscopically or in an open fashion, the set up and dissection should be identical as for a suture rectopexy. Once the initial dissection of the rectum is complete, the mesh is then secured.

When utilized as an anterior-based wrap, this is most accurately described as a Ripstein procedure. As originally described, this method involves mobilization of the rectum down to the tip of the coccyx. The rectangular mesh is perpendicularly oriented to the axis of the rectum. It is then placed around the anterior rectum at the level of the peritoneal reflection and secured with interrupted sutures (permanent or absorbable depending on the type of mesh) on the anterolateral rectum bilaterally prior to wrapping the mesh around the rectum/mesorectum. It is then posteriorly fixed to the presacral fascia with interrupted sutures. This sling creates a change in the angulation of the rectum. In 1972, Ripstein reported on a series of 289 patients with one death and no recurrences [46]. Subsequent studies reported on complications involving fecal impaction potentially due to a severe angulation of the rectum or the sling being too tight and constricting the rectum [47].

A posterior-based wrap is identical in initial setup and dissection. The rectangular mesh is similarly oriented, perpendicular to the rectum. The difference lies in initial fixation, which occurs to the presacral fascia with interrupted suture (Fig. 8.4). The mesh is then anteriorly wrapped around the rectum and either overlapped prior to fixation to the anterolateral rectum or trimmed short to avoid a complete 360-degree wrap and, thus, potentially minimize the risk of rectal constriction.

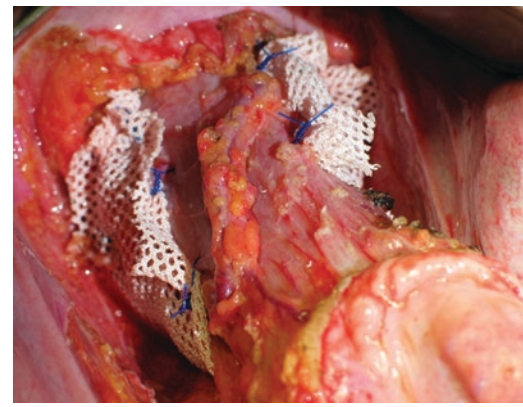


Fig. 8.4 Posterior mesh rectopexy

When the mesh is used as a posterior vertical strip, it is longitudinally oriented and secured to the distal mesorectum. The mesh is then pulled in a cephalad direction to establish appropriate tension on the repair. The tension should be such that it prevents descent of the rectum while avoiding undue tension that would lead to pulling through the tissue at the point of fixation.

An anteriorly placed vertical strip may also be posteriorly secured to the sacral promontory. This approach has its own title, known as a ventral mesh rectopexy. This differs substantially from the above-described procedures, in that the posterior dissection is typically limited to exposure of the promontory. With this approach, the right aspect of the distal sigmoid mesentery and upper rectum are mobilized by incising the right side of the peritoneal reflection at the level of the sacral promontory and then sweeping the mesentery off of the retroperitoneum in order to expose a site of fixation of the mesh to the sacral promontory. The left side of the peritoneum is left intact, while the right peritoneum is incised in a curvilinear fashion, over the lateral ligaments and into the anterior peritoneal reflection. The anterior dissection is undertaken to the level of the mid-vagina or seminal vesicles. The mesh is fashioned to the appropriate width and length and is then secured to the anterior rectum with interrupted suture. The mesh then courses along the right anterior rectum and is ultimately fixed to the sacral promontory in a similar fashion as previously described. Drains are not routinely placed.

With the ventral mesh rectopexy as well as all other mesh procedures in rectal prolapse surgery, the mesh is extraperitonealized, typically by closing the peritoneum with a running, absorbable suture. This step is performed in order to theoretically minimize the potential for small bowel obstruction secondary to adhesions to the mesh as well as to minimize the potential for mesh erosion and fistula formation.

Laparoscopic Mesh Rectopexy

The principles, anatomy and landmarks for laparoscopic mesh rectopexy are identical to those for open mesh rectopexy, as detailed above. One impact the use of mesh will have on a laparoscopic case may be port selection, as a 12 mm port is typically required for introduction of the mesh. While most synthetic mesh products can be laparoscopically handled with similar ease as in open procedures, many biologic grafts are thick and the handling and suturing of such materials laparoscopically can pose a challenge. For that reason, when selecting a biologic mesh for laparoscopic rectopexy, a thinner and partially transparent mesh may reduce some of the difficulty and clumsiness when handling and securing the mesh.

The use of robotic assisted surgery in rectal prolapse repair is not discussed separately in this chapter, as the dissection and points of fixation remain the same as for laparoscopic repair. However, it should be noted that some surgeons prefer the robotic approach for ease of deep pelvic dissection and knot tying.

Results of Mesh Rectopexy

In its various iterations, mesh rectopexy has performed well in terms of low recurrence rates, but occasionally high morbidity rates have led to evolution of the procedure over time (Table 8.3) [38, 46–50]. With the original Ripstein repair,

Table 8.3 Results of mesh rectopexy

Author	# Patients	Recurrence (%)	Morbidity (%)	Mortality (%)
Gordon and Hoxter [47][a]	1111	2	17	–
Ripstein [46][a]	289	0	0	0.3
Dyrberg et al. [48][b]	81	11.1	14.8	1.2
Tjandra et al. [49][a]	134	8	21	0.6
Dulucq et al. [50][b]	77	1	4	0
Sahoo et al. [38][b]	38	0	2.6	0

[a]Denotes Ripstein procedure
[b]Denotes laparoscopic posterior mesh rectopexy

recurrence rates ranged from 4 to 10%, but the morbidity was high, with complications including mesh erosion, large bowel obstruction, fecal impaction and rectovaginal fistula in up to 50% of patients [47, 51, 52]. Secondary to this relatively high complication rate, Ripstein modified the procedure to involve posterior fixation of the mesh with anterolateral fixation to the rectum/mesorectum with improved results [53].

The technique of posterior fixation of the rectum to the sacrum with insertion of an Ivalon sponge was first described by Wells with excellent results and a low complication rate [54]. The use of an Ivalon sponge was later abandoned following a randomized control trial demonstrating significant complication rates, including increased constipation and pelvic abscess formation [28]. The principles of this technique have persisted, however, with use of various synthetic and absorbable mesh products, used in both open and laparoscopic approaches [50, 55–57]. Due to increased rates of complications, we believe that mesh should likely only be utilized in a laparoscopic ventral rectopexy procedure, or in a repair of a recurrent prolapse.

Ventral Mesh Rectopexy

In 2004, D'Hoore et al. described their initial results with laparoscopic ventral rectopexy in the management of rectal prolapse [58]. The operative details are provided above. In brief, this technique involves fixation of the rectum to the sacral promontory by anchoring mesh to the anterior rectum. The rationale is, in part, that an anterior dissection alone may minimize the post-operative morbidity of constipation, or sexual and bladder dysfunction, more often seen with posterolateral dissection of the mesorectum and exposure of the autonomic nerves. In addition, the placement of mesh anteriorly, rather than circumferentially around the rectum, as in a Ripstein procedure, should minimize the possibility of rectal constriction and decreased rectal filling capacity. Every patient with rectal prolapse has, by definition, an element of pelvic floor dysfunction. The various components of pelvic floor dysfunction (rectocele, enterocele, cystocele, uterine or vaginal prolapse, for example) often co-exist. Another advantage of a ventral rectopexy is that, if the dissection is carried low enough, it can concomitantly address a symptomatic rectocele as well with low recurrence rates [59, 60]. Ventral mesh rectopexy has demonstrated excellent results in terms of low rates of major morbidity and mortality with recurrence rates of 0–6% and no higher than 8.2% in long-term follow-up (Table 8.4) [58, 61–63, 65–68].

The recurrence rate of the original 109 patients was 3.7% and the rate of minor morbidity 7%, with no peri-operative mortality [64]. Nearly a decade later, as this cohort grew in number to 919 consecutive patients between two institutions, the results were once again examined, demonstrating a long-term (10-year) recurrence rate of 8.2% [62]. Mesh-related complications, including mesh erosion into the vagina, occurred in 4.6% of patients studied. Rates of obstructed defecation and fecal incontinence decreased significantly ($P < 0.00001$).

Laparoscopic ventral rectopexy has repeatedly been demonstrated to have a positive impact on patients with existing constipation. In 2010, Boons et al. published a series of 65 consecutive patients who underwent laparoscopic ventral rec-

Table 8.4 Results of ventral mesh rectopexy

Author	# Patients	Recurrence (%)	Morbidity (%)	Mortality (%)
Evans et al. [61]	2203	–	13	0.1
Consten et al. [62]	919	8.2	4.6	–
Randall et al. [63]	190	3	–	1
D'Hoore et al. [64]	109	3.7	7	0
Boons et al. [65]	65	2	17	0
Sileri et al. [66]	34	5.9	23.5	–
Bloemendaal et al. [67]	28	7	14	–
Owais et al. [68]	18	0	20	0

topexy for external rectal prolapse [65]. They report only one (2%) recurrence and found that constipation was improved in 72% at 3 months and mildly induced in 2% ($P < 0.00001$). Continence scores also improved in 83% and worsened in 5% ($P < 0.00001$). A review of 12 non-randomized case series with 574 patients who underwent laparoscopic ventral rectopexy demonstrated improvement in constipation ranging from 3–72% and worsening constipation in 0–20%. Incontinence improved in 31–84% of patients with varying degrees of preoperative fecal incontinence [69].

When a cohort of patients undergoing laparoscopic ventral rectopexy was compared to a similar cohort undergoing laparoscopic resection rectopexy, significant improvements in both constipation and incontinence were found in both groups [70]. While there was a trend towards greater improvements in continence in the laparoscopic resection rectopexy group ($P = 0.09$), the resection group also experienced a significantly higher rate of complications than the laparoscopic ventral rectopexy group ($P < 0.05$).

The use of biologic mesh in the exercise of laparoscopic ventral rectopexy has been evaluated in multiple studies and reviewed in conjunction with nearly a dozen studies using synthetic mesh [71]. The authors found that, at least in short term follow-up of 12 months, there was no difference in recurrence between the use of synthetic (3.7%) and biologic mesh components (4.0%, $P = 0.78$). The incidence of mesh complications (0.7% synthetic and 0% biologic) were no different between the two approaches. Similar results have been found in other retrospective analyses over the short term [72, 73].

More recently, a multi-institutional review of 2203 patients undergoing laparoscopic ventral rectopexy with either synthetic mesh (80.1%) or biologic grafts (19.9%) examined the incidence of mesh-related complications in either group [61]. The authors report erosion of mesh in 2.4% of cases using synthetic mesh and 0.7% of those using biologic mesh. The median time to mesh erosion was 23 months. Recurrences of rectal prolapse were not included in the outcomes and were not reported in either group.

Resection Rectopexy

The decision to combine a segmental resection with a rectopexy should be made pre-operatively, not only for the sake of clarity in the surgeon's planning, but largely for the sake of the patient, as the risk of anastomotic leak and subsequent need for diversion and/or removal of infected mesh need to be carefully disclosed to the patient ahead of time. In cases of severe colonic inertia, as demonstrated by pre-operative colonic transit studies, a total abdominal colectomy with ileorectal anastomosis may need to be performed at the time of prolapse repair. Regardless of the surgical technique being used, careful attention should be paid to the patient's co-existing functional and anatomic disorders, in the event that these elements of dysfunction need to be addressed prior to surgery or in the operative theater. In cases of complex pelvic floor dysfunction, consideration should be given to a multi-disciplinary approach, employing the expertise of a gynecologist, urologist or urogynecologist in addition to that of the colorectal surgeon.

The idea of sigmoid resection combined with rectopexy was first described by Frykman in 1955 [74] and further developed and popularized by Goldberg; it ultimately became known as the Frykman-Goldberg procedure [75].

Indications to consider resection at the time of rectopexy include the following: constipation not managed on an easily sustainable bowel regimen; the presence of severe diverticular disease or other pathology independently warranting resection; and the presence of significant redundancy of the sigmoid colon that would otherwise predispose the patient to future sigmoid volvulus. The last of these features is difficult to objectively define and is not routinely a singular indication for resection. While patients with severe constipation should be considered for resection, those with chronic diarrhea, incontinence or otherwise normal function should be considered for a rectopexy alone [76].

Table 8.5 Results of resection rectopexy

Author	# Patients	Recurrence (%)	Morbidity (%)	Mortality (%)
Laubert et al. [78][a]	152	11.1	19.2	0.7
Ashari et al. [79][a]	117	2.5	9	0.8
Watts and Thompson [80]	102	2	4	0
Husa et al. [81]	48	9	0	2
Huber et al. [82]	39	0	7	0
Luukonen et al. [83]	15	0	20	7
Sayfan et al. [84]	13	0	23	0

[a]Denotes laparoscopic resection rectopexy

Although not necessarily an indicator for clinically significant differences in outcomes, it has been demonstrated that mesh rectopexy without resection produces radiographic evidence of slower colonic transit. In a prospective study of 30 patients undergoing a Ripstein procedure for rectal prolapse, post-operative transit studies demonstrated retention of significantly more markers when compared with pre-operative results. Additionally, retention of markers pre-operatively was predictive of post-operative constipation following the non-resection approach [77].

The overall results of resection rectopexy are quite good in terms of recurrence rates in the low single-digit range, (Table 8.5) [78–84] with one study reporting 11.1% recurrence [78]. The morbidity of this operation, however, ranges from 0–23% again drawing attention to the fact that resection should not be routinely offered outside of specific indications, namely severe constipation [76].

Perineal Approaches

Perineal approaches most commonly include the full-thickness perineal rectosigmoidectomy (i.e., Altemeier) procedure or the partial-thickness (i.e., Delorme) resection. Randomized comparisons of outcomes of these two techniques are lacking. The one available study, the PROSPER study did randomize patients to either a Delorme or Altemeier procedure. Recurrence rates were 24% for the Altemeier procedure vs. 31% for the Delorme procedure (p = 0.4). There were no major differences noted in functional outcomes between the two procedures [11]. A retrospective series from the Cleveland Clinic compared outcomes of 22 Altemeier and 53 Delorme procedures performed from 2005–2013. The recurrence rate was 9% in the Altemeier group vs. 16% in the Delorme group (p = NS). Quality of life was no different in the two treatment groups [85]. However, an earlier study from Cleveland Clinic Florida found the Altemeier to offer a lower recurrence rate, a longer recurrence-free interval, and better function than did the Delorme [85].

Perineal Rectosigmoidectomy

The perineal rectosigmoidectomy involves a full thickness perineal resection of the rectum with coloanal anastomosis and sometimes includes an anterior levatoroplasty [86–99]. It is thought to be the better option for a patient with a longer segment full thickness prolapse [7]. This procedure has a low complication rate; in general, <20% of cases. Most of the complications described are mild, however, severe complications such as anastomotic leak have been described [7]. The procedure begins with exteriorization of the prolapse. A full-thickness circumferential incision is then made through all layers of the outer wall about 1 cm from the dentate line. The anteriorly based hernia sac at the peritoneal reflection needs to be opened. The redundant bowel is then delivered from the perineum, as the mesentery is ligated sequentially until there is no further redundancy noted. Following this maneuver, a levatoroplasty may eliminate the defect in the pelvic floor [100–102]. The bowel is then sequentially transected while a hand-sewn anastomosis

is performed (Fig. 8.5). However, a modified anastomotic technique using a circular stapler has been described [96]. There is some evidence that the addition of a levatoroplasty may reduce the recurrence rate to as low as 7% in patients who have a levator diastasis [100, 101]. In addition, a transperineal colonic J pouch with either hand sewn or stapled coloanal anastomosis may be performed [103, 104].

The Altemeier operation is generally performed with low morbidity, but a high rate of recurrent prolapse (Table 8.6). Recurrence rates have been shown to be as high as 39% in some series [11, 98]. However, two large series by Altemeier and Cirrocco provide some of the best available data regarding this procedure, and suggest that with meticulous attention to detail, this procedure may be performed with low rates of recurrent prolapse [87, 95, 105]. Dr. Altemeier's series published in 1971 described 106 patients treated with perineal rectosigmoidectomy. The recurrence rate was 2.8% in this series. Major surgical complications consisted of four anastomotic leaks, which were all treated with local drainage and antibiotics. The late complications described included three pelvic abscesses.

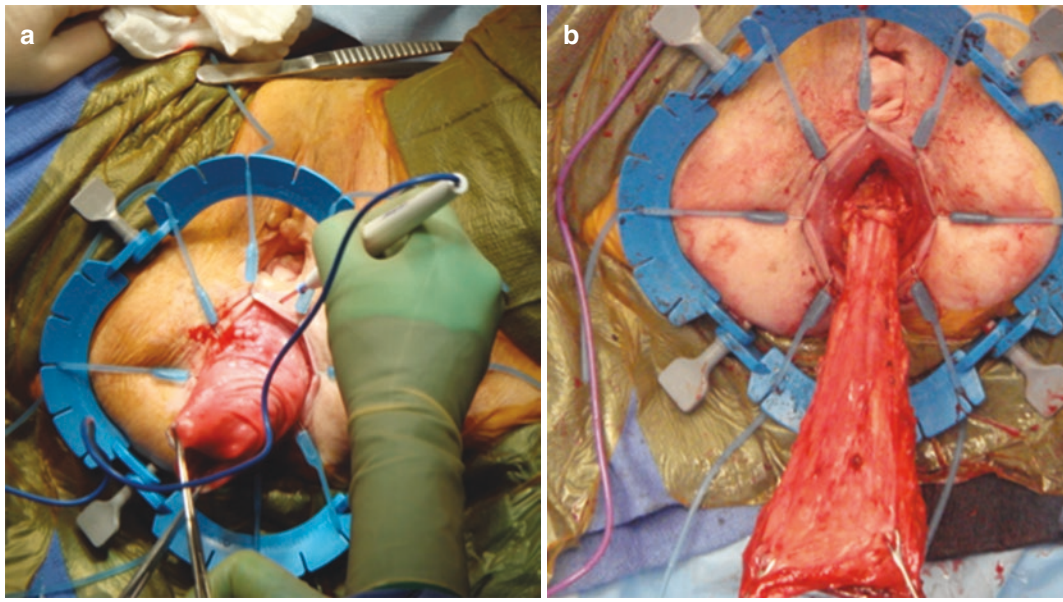


Fig. 8.5 Perineal rectosigmoidectomy: (**a**) Full thickness division of the rectum. (**b**) Final result of rectal mobilization

Table 8.6 Results of Altemeier procedure

	# Patients	Recurrence (%)	Morbidity (%)	Mortality (%)
Williams et al. [16]	114	10	12	0
Ding et al. [98]	113	18	16.8	0
Altemeier et al. [87]	106	3	24	0
Cirocco [95]	103	0	14	0
Kimmins et al. [91]	63	6.4	10	0
Cardiello et al. [97]	41	2	2.4	0
Steele et al. [99][a]	51	37	10	0
Senapati et al. [11]	28	26.9	–	0
Elagili et al. [86]	23	9	22	0

[a]Procedures performed for recurrent prolapse

Though these procedures are typically performed in older and more frail individuals, there was no mortality noted in this series [87].

Cirrocco reported on a series 103 patients with a median follow up of 43 months with no recurrences [95]. The incidence of complications was 14%, and these included primarily medical problems, such as pneumonia, *C. difficile* colitis, myocardial infarction, pleural effusion, pulmonary edema, and atrial fibrillation. The two specific surgical complications reported were two rectovaginal fistulas and two anastomotic strictures [95].

Delorme

Another commonly performed perineal approach for rectal prolapse is the Delorme procedure, first described in 1900. The Delorme procedure is often used in patients with a mucosal prolapse, or with a short segment, full thickness prolapse, as the recurrence rate is thought to be higher than that of an Altemeier procedure in the setting of a longer segment full thickness prolapse [7]. This distinction is important because the majority of clinical series describing this procedure have included mostly patients with short segment prolapse. This feature introduces potential selection bias when trying to compare case series of Altemeier vs. Delorme procedures.

The procedure begins with eversion of the prolapsed segment. A circumferential mucosal incision in then made 1 cm above the dentate line and the mucosa and submucosa are dissected free from the muscularis propria (Fig. 8.6). A mucosal sleeve resection is then performed and the muscular layer is then plicated circumferentially. The mucosal ends are then sutured together [106]. Recurrence rates as high as 27% have been described and morbidity has been reported in 9.6–45% of patients (Table 8.7) [80, 86, 106–112, 114–118].

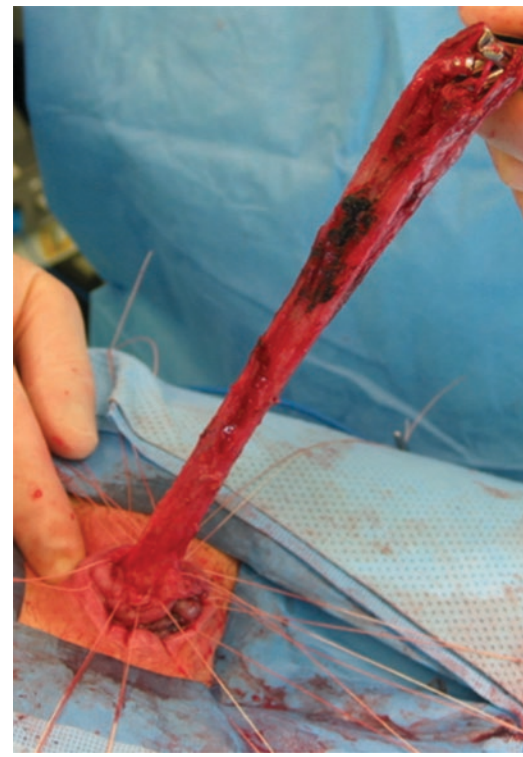


Fig. 8.6 Partial thickness dissection of a Delorme procedure

Table 8.7 Results of Delorme procedure

	# Patients	Recurrence (%)	Morbidity (%)	Mortality (%)
Watts and Thompson [80]	101	27	–	4
Senapati et al. [11]	99	31	–	2
Lechaux and Johann [107]	85	14	14	1.2
Lieberth et al. [108]	76	8	15	0
Marchal et al. [109]	60	23	15	7
Elagili et al. [86]	53	16	7	0
Watkins et al. [110]	52	10	4	0
Fazeli et al. [106]	52	9.8	9.6	0
Tobin and Scott [111]	43	26	–	0
Pescatori et al. [112]	33	18	45	0
Chen et al. [113]	25	4	32	0

Series with at least 25 patients treated with Delorme's procedure

Complications are typically minor, though serious complications such as ischemic proctitis have been described [119].

Anal Encirclement

Anal encirclement was a historically used approach to treat rectal prolapse in patients who were not fit for surgery [120]. The procedure involves bilateral radial incisions in the perianal skin, lateral to the external sphincter muscle. A tunnel is created outside of the external sphincter muscle and the encircling material is delivered through this tunnel. The repair is performed with either the surgeon's finger, or a Hegar dilator in the anal canal to attempt to prevent excessive tightening [120–123]. Multiple materials have been utilized including nylon, PDS, silastic rods, Marlex mesh, magnets, fascia, tendon, and Dacron [122, 124–134].

Though this procedure has been shown to have some benefit in improving prolapse symptoms, the notable outcomes include an infection rate as high as 44%, and morbidity in up to 59% of cases [122, 127, 131, 135–138]. This procedure has been largely abandoned [139].

Recurrent Rectal Prolapse

Since all methods of rectal prolapse repair have at least some chance of recurrence, the surgeon needs to have an organized approach to determine why the recurrence occurred and determine what the best strategy is to treat the recurrence. The most important factor to consider is the initial type of repair. The most common reason for recurrence seems to be related to technical factors [99, 140]. Blood supply to the rectum is also a critical element in choosing an option for recurrent rectal prolapse. If blood supply has been divided during an abdominal procedure such as resection rectopexpy, then an Altemeier procedure would not be available for subsequent repair due to the risk of leaving an ischemic segment of rectum or vice versa.

Literature regarding the best method of repair for recurrent prolapse is difficult to interpret due to the large number of procedures used in both the primary and the recurrent setting. A recent systematic review of all patients undergoing repair for recurrent rectal prolapse from 1950–2014 was unable to provide a rational algorithm for treatment of recurrent prolapse because the literature consisted of small case series and a heterogeneous array of approaches [141].

A study by Ding et al. examined 23 patients having an Altemeier procedure for recurrent rectal prolapse compared to patients having the same operation for primary prolapse. When comparing the two groups, there was no difference in overall complication rates, but the recurrence rate was significantly higher for patients in the recurrent prolapse group (39% vs. 18%). Some of the factors associated with recurrence were an inadequate length of resection, inexperienced surgeon, a long length of follow up, and not performing a levatoroplasty [98].

Steele et al. examined 78 patients who underwent surgery for recurrent rectal prolapse. The rate of second time recurrence with a perineal approach was 37.3% vs. 14.8% with an abdominal approach ($p = 0.03$) [99]. These data suggest that an abdominal approach should be undertaken for recurrent rectal prolapse if the patient's risk profile is acceptable for abdominal surgery. However, management of recurrent prolapse is an area where well-designed comparative studies are clearly needed.

Rectal Intussusception

Rectal intussusception refers to prolapse of the rectal wall, which does not protrude through the anus. It is also known as occult prolapse, internal rectal procidentia, rectal invagination, or occult/hidden intussusception. The diagnosis truly has only developed with the advent of radiographic studies capable of detecting this anomaly, specifically defecography, either via fluoroscopy or functional magnetic resonance imaging (fMRI). The clinical elements which would lead one to

further investigate this possible diagnosis include obstructed defecation, fecal incontinence, tenesmus, pelvic pain, or the endoscopic/histologic finding of a solitary rectal ulcer (SRUS).

The radiographic finding of rectal intussusception does not itself mandate treatment, as this can be a finding in otherwise asymptomatic patients. Patients with rectorectal (low-grade) intussusception are less likely to experience significant symptoms than those with rectoanal (high-grade) intussusception. In either case, initial management in symptomatic patients should begin with medical management including fiber supplementation, bowel modification and/or biofeedback, or pelvic floor physical therapy.

In patients with refractory symptoms and in whom appropriate clinical, radiographic and physiologic testing has been done to isolate rectal intussusception as the pathologic source of their symptoms, surgical therapy should be considered. Various surgical procedures, including mucosal proctectomy (Delorme), stapled transanal rectal resection (STARR) and rectopexy have been performed with varied success.

The most commonly employed current techniques in the surgical management of rectal intussusception are the STARR procedure and laparoscopic ventral rectopexy, and, as noted by Festen et al. [142], comparative studies between the two techniques do not exist. Moreover, they highlight the theory that laparoscopic ventral rectopexy corrects the leading cause of the symptoms (i.e., intussusception), while STARR merely addresses its consequences.

When observing the healing rate of a solitary rectal ulcer (SRUS) as the endoscopic manifestation of rectal prolapse, both internal and external, it has been demonstrated that 70% of patients will demonstrate healing of the SRUS following ventral rectopexy, while the remaining patients will often require posterior STARR for complete healing and resolution of persistent obstructed defecation [143]. Due to it's high rate of complications, the STARR procedure has been mostly abandoned.

As a stand-alone procedure, laparoscopic ventral rectopexy has shown good efficacy, with results that rival its use for external rectal prolapse [144]. In a cohort of 100 consecutive female patients with internal prolapse and rectocele, laparoscopic ventral rectopexy yielded a cure in terms of constipation, incontinence and prolapse symptoms in 79% of patients. Improvements in constipation (92%) and incontinence (86%) alone were more profound [145].

Conclusions

In summary, rectal prolapse is a pelvic floor disorder, which causes severe compromise in quality of life. Although many variations have been described in surgical management, the most common approach is an abdominal rectopexy for most patients and a perineal approach in patients who are too frail to permit an abdominal approach. The abdominal operations are generally preferred with some minimally invasive method. Rectal intussusception is a rare condition, often diagnosed during defecography, which is generally medically managed.

References

1. Bordeianou L, Hicks CW, Kaiser AM, Alavi K, Sudan R, Wise PE. Rectal prolapse: an overview of clinical features, diagnosis, and patient-specific management strategies. J Gastrointest Surg. 2014;18:1059–69.
2. Michalopoulos A, Papadopoulos VN, Panidis S, et al. Surgical management of rectal prolapse. Tech Coloproctol. 2011;15(Suppl 1):S25–8.
3. Glasgow SC, Birnbaum EH, Kodner IJ, Fleshman JW Jr, Dietz DW. Recurrence and quality of life following perineal proctectomy for rectal prolapse. J Gastrointest Surg. 2008;12:1446–51.
4. Steele SR, Varma MG, Prichard D, et al. The evolution of evaluation and management of urinary or fecal incontinence and pelvic organ prolapse. Curr Probl Surg. 2015;52:17–75. 92–136.
5. Madoff RD, Mellgren A. One hundred years of rectal prolapse surgery. Dis Colon Rectum. 1999;42:441–50.
6. Brown AJ, Anderson JH, McKee RF, Finlay IG. Strategy for selection of type of operation for rectal prolapse based on clinical criteria. Dis Colon Rectum. 2004;47:103–7.
7. Varma M, Rafferty J, Buie WD, Standards Practice Task Force of American Society of C, Rectal

S. Practice parameters for the management of rectal prolapse. Dis Colon Rectum. 2011;54:1339–46.
8. Hayden DM, Wexner SD. Rectal prolapse: current evaluation, management and treatment of a historically recurring disorder. In: Steele S, Maykel J, Champagne B, Orangio G, editors. Complexities in colorectal surgery: decision-making and management. New York: Springer; 2014. p. 173–83.
9. Raftopoulos Y, Senagore AJ, Di Giuro G, Bergamaschi R, Rectal Prolapse Recurrence Study G. Recurrence rates after abdominal surgery for complete rectal prolapse: a multicenter pooled analysis of 643 individual patient data. Dis Colon Rectum. 2005;48:1200–6.
10. Russell MM, Read TE, Roberts PL, et al. Complications after rectal prolapse surgery: does approach matter? Dis Colon Rectum. 2012;55:450–8.
11. Senapati A, Gray RG, Middleton LJ, et al. PROSPER: a randomised comparison of surgical treatments for rectal prolapse. Color Dis. 2013;15:858–68.
12. Barak M, Peted E. Anesthesia and peri-operative care of the elderly patient. Harefuah. 2011;150:153–7. 204.
13. Steinmetz J, Rasmussen LS. The elderly and general anesthesia. Minerva Anestesiol. 2010;76:745–52.
14. Halaszynski TM. Pain management in the elderly and cognitively impaired patient: the role of regional anesthesia and analgesia. Curr Opin Anaesthesiol. 2009;22:594–9.
15. Liu LL, Wiener-Kronish JP. Perioperative anesthesia issues in the elderly. Crit Care Clin. 2003;19:641–56.
16. Williams JG, Rothenberger DA, Madoff RD, Goldberg SM. Treatment of rectal prolapse in the elderly by perineal rectosigmoidectomy. Dis Colon Rectum. 1992;35:830–4.
17. Bibi S, Zutshi M, Gurland B, Hull T. Rectal prolapse in octogenarians: does surgery impact daily activity? Am Surg. 2015;81:371–2.
18. Germain A, Perrenot C, Scherrer ML, et al. Long-term outcome of robotic-assisted laparoscopic rectopexy for full-thickness rectal prolapse in elderly patients. Color Dis. 2014;16:198–202.
19. Laubert T, Bader FG, Kleemann M, et al. Outcome analysis of elderly patients undergoing laparoscopic resection rectopexy for rectal prolapse. Int J Color Dis. 2012;27:789–95.
20. Lee SH, Lakhtaria P, Canedo J, Lee YS, Wexner SD. Outcome of laparoscopic rectopexy versus perineal rectosigmoidectomy for full-thickness rectal prolapse in elderly patients. Surg Endosc. 2011;25:2699–702.
21. Speakman CT, Madden MV, Nicholls RJ, Kamm MA. Lateral ligament division during rectopexy causes constipation but prevents recurrence: results of a prospective randomized study. Br J Surg. 1991;78:1431–3.
22. Madiba TE, Baig MK, Wexner SD. Surgical management of rectal prolapse. Arch Surg. 2005;140:63–73.
23. Bachoo P, Brazzelli M, Grant A. Surgery for complete rectal prolapse in adults. Cochrane Database Syst Rev. 2000;2:CD001758.
24. Bishawi M, Foppa C, Tou S, Bergamaschi R, Rectal Prolapse Recurrence Study G. Recurrence of rectal prolapse following rectopexy: a pooled analysis of 532 patients. Color Dis. 2016;18:779–84.
25. Loygue J. Surgical treatment of complete prolapse of the rectum by promontory rectopexy. Scalpel (Brux). 1965;118:1081–7.
26. Carter AE. Rectosacral suture fixation for complete rectal prolapse in the elderly, the frail and the demented. Br J Surg. 1983;70:522–3.
27. Blatchford GJ, Perry RE, Thorson AG, Christensen MA. Rectopexy without resection for rectal prolapse. Am J Surg. 1989;158:574–6.
28. Novell JR, Osborne MJ, Winslet MC, Lewis AA. Prospective randomized trial of Ivalon sponge versus sutured rectopexy for full-thickness rectal prolapse. Br J Surg. 1994;81:904–6.
29. Khanna AK, Misra MK, Kumar K. Simplified sutured sacral rectopexy for complete rectal prolapse in adults. Eur J Surg. 1996;162:143–6.
30. Briel JW, Schouten WR, Boerma MO. Long-term results of suture rectopexy in patients with fecal incontinence associated with incomplete rectal prolapse. Dis Colon Rectum. 1997;40:1228–32.
31. Loygue J, Huguier M, Malafosse M, Biotois H. Complete prolapse of the rectum. A report on 140 cases treated by rectopexy. Br J Surg. 1971;58:847–8.
32. Aitola PT, Hiltunen KM, Matikainen MJ. Functional results of operative treatment of rectal prolapse over an 11-year period: emphasis on transabdominal approach. Dis Colon Rectum. 1999;42:655–60.
33. Nunoo-Mensah JW, Efron JE, Young-Fadok TM. Laparoscopic rectopexy. Surg Endosc. 2007;21:325–6.
34. Berman IR. Sutureless laparoscopic rectopexy for procidentia. Technique and implications. Dis Colon Rectum. 1992;35:689–93.
35. Foppa C, Martinek L, Arnaud JP, Bergamaschi R. Ten-year follow up after laparoscopic suture rectopexy for full-thickness rectal prolapse. Color Dis. 2014;16:809–14.
36. Kariv Y, Delaney CP, Casillas S, et al. Long-term outcome after laparoscopic and open surgery for rectal prolapse: a case-control study. Surg Endosc. 2006;20:35–42.
37. Wilson J, Engledow A, Crosbie J, Arulampalam T, Motson R. Laparoscopic nonresectional suture rectopexy in the management of full-thickness rectal prolapse: substantive retrospective series. Surg Endosc. 2011;25:1062–4.
38. Sahoo MR, Thimmegowda AK, Gowda MS. A single centre comparative study of laparoscopic mesh rectopexy versus suture rectopexy. J Minim Access Surg. 2014;10:18–22.
39. Kessler H, Jerby BL, Milsom JW. Successful treatment of rectal prolapse by laparoscopic suture rectopexy. Surg Endosc. 1999;13:858–61.
40. Heah SM, Hartley JE, Hurley J, Duthie GS, Monson JR. Laparoscopic suture rectopexy without resection is effective treatment for full-thickness rectal prolapse. Dis Colon Rectum. 2000;43:638–43.

41. Boccasanta P, Rosati R, Venturi M, et al. Comparison of laparoscopic rectopexy with open technique in the treatment of complete rectal prolapse: clinical and functional results. Surg Laparosc Endosc. 1998;8:460–5.
42. Solomon MJ, Young CJ, Eyers AA, Roberts RA. Randomized clinical trial of laparoscopic versus open abdominal rectopexy for rectal prolapse. Br J Surg. 2002;89:35–9.
43. Tou S, Brown SR, Nelson RL. Surgery for complete (full-thickness) rectal prolapse in adults. Cochrane Database Syst Rev. 2015;11:CD001758.
44. Byrne CM, Smith SR, Solomon MJ, Young JM, Eyers AA, Young CJ. Long-term functional outcomes after laparoscopic and open rectopexy for the treatment of rectal prolapse. Dis Colon Rectum. 2008;51:1597–604.
45. Purkayastha S, Tekkis P, Athanasiou T, et al. A comparison of open vs. laparoscopic abdominal rectopexy for full-thickness rectal prolapse: a meta-analysis. Dis Colon Rectum. 2005;48:1930–40.
46. Ripstein CB. Procidentia: definitive corrective surgery. Dis Colon Rectum. 1972;15:334–6.
47. Gordon PH, Hoexter B. Complications of the Ripstein procedure. Dis Colon Rectum. 1978;21:277–80.
48. Dyrberg DL, Nordentoft T, Rosenstock S. Laparoscopic posterior mesh rectopexy for rectal prolapse is a safe procedure in older patients: a prospective follow-up study. Scand J Surg. 2015;104:227–32.
49. Tjandra JJ, Fazio VW, Church JM, Milsom JW, Oakley JR, Lavery IC. Ripstein procedure is an effective treatment for rectal prolapse without constipation. Dis Colon Rectum. 1993;36:501–7.
50. Dulucq JL, Wintringer P, Mahajna A. Clinical and functional outcome of laparoscopic posterior rectopexy (Wells) for full-thickness rectal prolapse. A prospective study. Surg Endosc. 2007;21:2226–30.
51. Kupfer CA, Goligher JC. One hundred consecutive cases of complete prolapse of the rectum treated by operation. Br J Surg. 1970;57:482–7.
52. Roberts PL, Schoetz DJ Jr, Coller JA, Veidenheimer MC. Ripstein procedure. Lahey Clinic experience: 1963-1985. Arch Surg. 1988;123:554–7.
53. McMahan JD, Ripstein CB. Rectal prolapse. An update on the rectal sling procedure. Am Surg. 1987;53:37–40.
54. Wells C. New operation for rectal prolapse. Proc R Soc Med. 1959;52:602–3.
55. Madbouly KM, Senagore AJ, Delaney CP, Duepree HJ, Brady KM, Fazio VW. Clinically based management of rectal prolapse. Surg Endosc. 2003;17:99–103.
56. Winde G, Reers B, Nottberg H, Berns T, Meyer J, Bunte H. Clinical and functional results of abdominal rectopexy with absorbable mesh-graft for treatment of complete rectal prolapse. Eur J Surg. 1993;159:301–5.
57. Galili Y, Rabau M. Comparison of polyglycolic acid and polypropylene mesh for rectopexy in the treatment of rectal prolapse. Eur J Surg. 1997;163:445–8.
58. D'Hoore A, Cadoni R, Penninckx F. Long-term outcome of laparoscopic ventral rectopexy for total rectal prolapse. Br J Surg. 2004;91:1500–5.
59. Wong M, Meurette G, Abet E, Podevin J, Lehur PA. Safety and efficacy of laparoscopic ventral mesh rectopexy for complex rectocele. Color Dis. 2011;13:1019–23.
60. Maggiori L, Bretagnol F, Ferron M, Panis Y. Laparoscopic ventral rectopexy: a prospective long-term evaluation of functional results and quality of life. Tech Coloproctol. 2013;17:431–6.
61. Evans C, Stevenson AR, Sileri P, et al. A multicenter collaboration to assess the safety of laparoscopic ventral rectopexy. Dis Colon Rectum. 2015;58:799–807.
62. Consten EC, van Iersel JJ, Verheijen PM, Broeders IA, Wolthuis AM, D'Hoore A. Long-term outcome after laparoscopic ventral mesh rectopexy: an observational study of 919 consecutive patients. Ann Surg. 2015;262:742–8.
63. Randall J, Smyth E, McCarthy K, Dixon AR. Outcome of laparoscopic ventral mesh rectopexy for external rectal prolapse. Color Dis. 2014;16:914–9.
64. D'Hoore A, Penninckx F. Laparoscopic ventral recto(colpo)pexy for rectal prolapse: surgical technique and outcome for 109 patients. Surg Endosc. 2006;20:1919–23.
65. Boons P, Collinson R, Cunningham C, Lindsey I. Laparoscopic ventral rectopexy for external rectal prolapse improves constipation and avoids de novo constipation. Color Dis. 2010;12:526–32.
66. Sileri P, Franceschilli L, de Luca E, et al. Laparoscopic ventral rectopexy for internal rectal prolapse using biological mesh: postoperative and short-term functional results. J Gastrointest Surg. 2012;16:622–8.
67. Bloemendaal AL, Mishra A, Nicholson GA, et al. Laparoscopic rectopexy is feasible and safe in the emergency admission setting. Color Dis. 2015;17:O198–201.
68. Owais AE, Sumrien H, Mabey K, McCarthy K, Greenslade GL, Dixon AR. Laparoscopic ventral mesh rectopexy in male patients with internal or external rectal prolapse. Color Dis. 2014;16:995–1000.
69. Faucheron JL, Trilling B, Girard E, Sage PY, Barbois S, Reche F. Anterior rectopexy for full-thickness rectal prolapse: technical and functional results. World J Gastroenterol. 2015;21:5049–55.
70. Formijne Jonkers HA, Maya A, Draaisma WA, et al. Laparoscopic resection rectopexy versus laparoscopic ventral rectopexy for complete rectal prolapse. Tech Coloproctol. 2014;18:641–6.
71. Smart NJ, Pathak S, Boorman P, Daniels IR. Synthetic or biological mesh use in laparoscopic ventral mesh rectopexy—a systematic review. Color Dis. 2013;15:650–4.
72. Ogilvie JW Jr, Stevenson AR, Powar M. Case-matched series of a non-cross-linked biologic versus non-absorbable mesh in laparoscopic ventral rectopexy. Int J Color Dis. 2014;29:1477–83.

73. Wahed S, Ahmad M, Mohiuddin K, Katory M, Mercer-Jones M. Short-term results for laparoscopic ventral rectopexy using biological mesh for pelvic organ prolapse. Color Dis. 2012;14:1242–7.
74. Frykman HM. Abdominal proctopexy and primary sigmoid resection for rectal procidentia. Am J Surg. 1955;90:780–9.
75. Frykman HM, Goldberg SM. The surgical treatment of rectal procidentia. Surg Gynecol Obstet. 1969;129:1225–30.
76. Delaney CP. Laparoscopic management of rectal prolapse. J Gastrointest Surg. 2007;11:150–2.
77. Schultz I, Mellgren A, Oberg M, Dolk A, Holmstrom B. Whole gut transit is prolonged after Ripstein rectopexy. Eur J Surg. 1999;165:242–7.
78. Laubert T, Kleemann M, Schorcht A, et al. Laparoscopic resection rectopexy for rectal prolapse: a single-center study during 16 years. Surg Endosc. 2010;24:2401–6.
79. Ashari LH, Lumley JW, Stevenson AR, Stitz RW. Laparoscopically-assisted resection rectopexy for rectal prolapse: ten years' experience. Dis Colon Rectum. 2005;48:982–7.
80. Watts AM, Thompson MR. Evaluation of Delorme's procedure as a treatment for full-thickness rectal prolapse. Br J Surg. 2000;87:218–22.
81. Husa A, Sainio P, von Smitten K. Abdominal rectopexy and sigmoid resection (Frykman-Goldberg operation) for rectal prolapse. Acta Chir Scand. 1988;154:221–4.
82. Huber FT, Stein H, Siewert JR. Functional results after treatment of rectal prolapse with rectopexy and sigmoid resection. World J Surg. 1995;19:138–43. discussion 143.
83. Luukkonen P, Mikkonen U, Jarvinen H. Abdominal rectopexy with sigmoidectomy vs. rectopexy alone for rectal prolapse: a prospective, randomized study. Int J Color Dis. 1992;7:219–22.
84. Sayfan J, Pinho M, Alexander-Williams J, Keighley MR. Sutured posterior abdominal rectopexy with sigmoidectomy compared with Marlex rectopexy for rectal prolapse. Br J Surg. 1990;77:143–5.
85. Agachan F, Reissman P, Pfeifer J, Weiss EG, Nogueras JJ, Wexner SD. Comparison of three perineal procedures for the treatment of rectal prolapse. South Med J. 1997;90(9):925–32.
86. Elagili F, Gurland B, Liu X, Church J, Ozuner G. Comparing perineal repairs for rectal prolapse: Delorme versus Altemeier. Tech Coloproctol. 2015;19:521–5.
87. Altemeier WA, Culbertson WR, Schowengerdt C, Hunt J. Nineteen years' experience with the one-stage perineal repair of rectal prolapse. Ann Surg. 1971;173:993–1006.
88. Altemeier WA, Culbertson WR, Alexander JW. One-stage perineal repair of rectal prolapse. Twelve years' experience. Arch Surg. 1964;89:6–16.
89. Altemeier WA, Giuseffi J, Hoxworth P. Treatment of extensive prolapse of the rectum in aged or debilitated patients. AMA Arch Surg. 1952;65:72–80.
90. Towliat SM, Mehrvarz S, Mohebbi HA, Sate Bigdeli A. Outcomes of rectal prolapse using the Altemeier procedure. Iran Red Crescent Med J. 2013;15:620–1.
91. Kimmins MH, Evetts BK, Isler J, Billingham R. The Altemeier repair: outpatient treatment of rectal prolapse. Dis Colon Rectum. 2001;44:565–70.
92. Gravante G, Venditti D. The Altemeier procedure: new technologies for an old technique. Dis Colon Rectum. 2006;49:1801–2.
93. Gramkow CS, Lanng C, Fischer A. Altemeier repair of rectal prolapse. Ugeskr Laeger. 2005;167:286–9.
94. Gopal KA, Amshel AL, Shonberg IL, Eftaiha M. Rectal procidentia in elderly and debilitated patients. Experience with the Altemeier procedure. Dis Colon Rectum. 1984;27:376–81.
95. Cirocco WC. The Altemeier procedure for rectal prolapse: an operation for all ages. Dis Colon Rectum. 2010;53:1618–23.
96. Bennett BH, Geelhoed GW. A stapler modification of the Altemeier procedure for rectal prolapse. Experimental and clinical evaluation. Am Surg. 1985;51:116–20.
97. Carditello A, Milone A, Stilo F, Mollo F, Basile M. Surgical treatment of rectal prolapse with transanal resection according to Altemeier. Experience and results. Chir Ital. 2003;55:687–92.
98. Ding JH, Canedo J, Lee SH, Kalaskar SN, Rosen L, Wexner SD. Perineal rectosigmoidectomy for primary and recurrent rectal prolapse: are the results comparable the second time? Dis Colon Rectum. 2012;55:666–70.
99. Steele SR, Goetz LH, Minami S, Madoff RD, Mellgren AF, Parker SC. Management of recurrent rectal prolapse: surgical approach influences outcome. Dis Colon Rectum. 2006;49:440–5.
100. Chun SW, Pikarsky AJ, You SY, et al. Perineal rectosigmoidectomy for rectal prolapse: role of levatorplasty. Tech Coloproctol. 2004;8:3–8. discussion 8–9.
101. Habr-Gama A, Jacob CE, Jorge JM, et al. Rectal procidentia treatment by perineal rectosigmoidectomy combined with levator ani repair. Hepato-Gastroenterology. 2006;53:213–7.
102. Prasad ML, Pearl RK, Abcarian H, Orsay CP, Nelson RL. Perineal proctectomy, posterior rectopexy, and postanal levator repair for the treatment of rectal prolapse. Dis Colon Rectum. 1986;29:547–52.
103. Baig MK, Galliano D, Larach JA, Weiss EG, Wexner SD, Nogueras JJ. Pouch perineal rectosigmoidectomy: a case report. Surg Innov. 2005;12(4):373–5.
104. Yoshioka K1, Ogunbiyi OA, Keighley MR. Pouch perineal rectosigmoidectomy gives better functional results than conventional rectosigmoidectomy in elderly patients with rectal prolapse. Br J Surg. 1998;85(11):1525–6.
105. Cirocco WC. Explaining the undulating outcomes of perineal rectosigmoidectomy (Altemeier procedure) for rectal prolapse over the last century: technique matters! Tech Coloproctol. 2014;18:979–80.

106. Fazeli MS, Kazemeini AR, Keshvari A, Keramati MR. Delorme's procedure: an effective treatment for a full-thickness rectal prolapse in young patients. Ann Coloproctol. 2013;29:60–5.
107. Lechaux JP, Johann M. Delorme's operation in the treatment of rectal prolapse. Presse Med. 1984;13:219–20.
108. Lieberth M, Kondylis LA, Reilly JC, Kondylis PD. The Delorme repair for full-thickness rectal prolapse: a retrospective review. Am J Surg. 2009;197:418–23.
109. Marchal F, Bresler L, Ayav A, et al. Long-term results of Delorme's procedure and Orr-Loygue rectopexy to treat complete rectal prolapse. Dis Colon Rectum. 2005;48:1785–90.
110. Watkins BP, Landercasper J, Belzer GE, et al. Long-term follow-up of the modified Delorme procedure for rectal prolapse. Arch Surg. 2003;138:498–502. discussion 502–493.
111. Tobin SA, Scott IH. Delorme operation for rectal prolapse. Br J Surg. 1994;81:1681–4.
112. Pescatori M, Interisano A, Stolfi VM, Zoffoli M. Delorme's operation and sphincteroplasty for rectal prolapse and fecal incontinence. Int J Color Dis. 1998;13:223–7.
113. Chen CW, Zhang G, Yan CH, Wang CF. Delorme procedure for full-thickness rectal prolapse: a report of 25 cases. Zhonghua Wei Chang Wai Ke Za Zhi. 2012;15(3):285–7.
114. Parikh V. Re: The Delorme procedure: a useful operation for complicated rectal prolapse in the elderly. Am Surg. 1997;63:845.
115. Milito G, Cadeddu F, Selvaggio I, Grande M. The Delorme repair for full-thickness rectal prolapse: a retrospective review. Am J Surg. 2010;199:581–2.
116. Liberman H, Hughes C, Dippolito A. Evaluation and outcome of the Delorme procedure in the treatment of rectal outlet obstruction. Dis Colon Rectum. 2000;43:188–92.
117. Kling KM, Rongione AJ, Evans B, McFadden DW. The Delorme procedure: a useful operation for complicated rectal prolapse in the elderly. Am Surg. 1996;62:857–60.
118. Houry S. Delorme procedure for rectal prolapse. J Chir (Paris). 2000;137:338–41.
119. De Nardi P, Osman N, Viola M, Staudacher C. Ischemic proctitis following Delorme procedure for external rectal prolapse. Tech Coloproctol. 2006;10:253–5.
120. Turell R. The Thiersch operation for rectal prolapse and anal incontinence. N Y State J Med. 1954;54:791–5.
121. Gabriel WB. The Thiersch operation for rectal prolapse. Dis Colon Rectum. 1964;7:383–5.
122. Poole GV Jr, Pennell TC, Myers RT, Hightower F. Modified Thiersch operation for rectal prolapse. Technique and results. Am Surg. 1985;51:226–9.
123. Terrell RV. Experience with Thiersch wire in rectal prolapse. AORN J. 1968;8:72–6.
124. Abe T, Hachiro Y, Kunimoto M. Combined aluminum potassium sulfate and tannic acid sclerosing therapy and anal encirclement using an elastic artificial ligament for rectal prolapse. Dis Colon Rectum. 2014;57:653–7.
125. Burke RM, Jackman RJ. A modified Thiersch operation in treatment of complete rectal prolapse. Dis Colon Rectum. 1959;2:555–61.
126. Haskell B, Rovner H. A modified Thiersch operation for complete rectal prolapse using a Teflon prosthesis. Dis Colon Rectum. 1963;6:192–5.
127. Khanduja KS, Hardy TG Jr, Aguilar PS, et al. A new silicone-prosthesis in the modified Thiersch operation. Dis Colon Rectum. 1988;31:380–3.
128. Larach SW, Vazquez B. Modified Thiersch procedure with silastic mesh implant: a simple solution for fecal incontinence and severe prolapse. South Med J. 1986;79:307–9.
129. Sainio AP, Halme LE, Husa AI. Anal encirclement with polypropylene mesh for rectal prolapse and incontinence. Dis Colon Rectum. 1991;34:905–8.
130. Schwartz A, Marin R. Use of polyethylene in the Thiersch operation. Dis Colon Rectum. 1962;5:302–5.
131. Stimpel H, Pedersen T. A modified Thiersch surgical method with polypropylene gauze (Marlex) in rectal prolapse. Ugeskr Laeger. 1988;150:1471–3.
132. Swerdlow H. The Encircler. A new instrument for the performance of the Thiersch procedure for rectal procidentia. Dis Colon Rectum. 1986;29:145–7.
133. Thorlakson RH. A modification of the Thiersch procedure for rectal prolapse using polyester tape. Dis Colon Rectum. 1982;25:57–8.
134. Zutshi M, Hull T, Gurland B. Anal encirclement with sphincter repair (AESR procedure) using a biological graft for anal sphincter damage involving the entire circumference. Color Dis. 2012;14:592–5.
135. Earnshaw JJ, Hopkinson BR. Late results of silicone rubber perianal suture for rectal prolapse. Dis Colon Rectum. 1987;30:86–8.
136. Hunt TM, Fraser IA, Maybury NK. Treatment of rectal prolapse by sphincteric support using silastic rods. Br J Surg. 1985;72:491–2.
137. Jackaman FR, Francis JN, Hopkinson BR. Silicone rubber band treatment of rectal prolapse. Ann R Coll Surg Engl. 1980;62:386–7.
138. Vongsangnak V, Varma JS, Smith AN. Reappraisal of Thiersch's operation for complete rectal prolapse. J R Coll Surg Edinb. 1985;30:185–7.
139. Calata JF, Pai A, Marecik S, Prasad LM, Park JJ. Perineal proctectomy with bio-Thiersch procedure for complete rectal prolapse with fecal incontinence. Dis Colon Rectum. 2015;58:e45.
140. Hool GR, Hull TL, Fazio VW. Surgical treatment of recurrent complete rectal prolapse: a thirty-year experience. Dis Colon Rectum. 1997;40:270–2.
141. Hotouras A, Ribas Y, Zakeri S, et al. A systematic review of the literature on the surgical management of recurrent rectal prolapse. Color Dis. 2015;17:657–64.

142. Festen S, van Geloven AA, D'Hoore A, Lindsey I, Gerhards MF. Controversy in the treatment of symptomatic internal rectal prolapse: suspension or resection? Surg Endosc. 2011;25:2000–3.
143. Evans C, Ong E, Jones OM, Cunningham C, Lindsey I. Laparoscopic ventral rectopexy is effective for solitary rectal ulcer syndrome when associated with rectal prolapse. Color Dis. 2014;16:O112–6.
144. Gosselink MP, Joshi H, Adusumilli S, et al. Laparoscopic ventral rectopexy for faecal incontinence: equivalent benefit is seen in internal and external rectal prolapse. J Gastrointest Surg. 2015;19:558–63.
145. Franceschilli L, Varvaras D, Capuano I, et al. Laparoscopic ventral rectopexy using biologic mesh for the treatment of obstructed defaecation syndrome and/or faecal incontinence in patients with internal rectal prolapse: a critical appraisal of the first 100 cases. Tech Coloproctol. 2015;19:209–19.

Fecal Incontinence

9

Julia Saraidaridis and Liliana Bordeianou

Introduction

Fecal Incontinence (FI) is defined as the involuntary loss of feces or gas in a person who has already gained continence [1]. There is a prevalence range for FI quoted in the literature (0.4–19.6%); with the variety in estimation thought to be due to heterogeneity of study design, differing definitions of FI, and patient reluctance to report symptoms. A recent meta-analysis quoted FI to affect 5.9% of the population [2]. The largest household study in the United States reported an incidence of 18.8% [3]. Factors that increase the likelihood of reporting fecal incontinence include increasing age and institutionalized status. In fact, a US survey of patients in nursing homes estimated around 47% of residents suffered from FI. They also detailed that this was one of the main reasons for transition to such a living arrangement [4]. Overall, FI is a common disorder in the population with significant social stigma associated with it. Fortunately, in many instances, the symptoms can be improved and potentially even cured. Unfortunately, less than one third of women with FI discuss the problem with a physician. In a study by Brown et al., both the duration and severity of incontinence correlated with likelihood to seek care for the condition [5]. While there is no quick fix for fecal incontinence, patients and physicians working together can improve and potentially cure fecal incontinence and vastly improve patient quality of life.

Normal Continence

The maintenance of fecal continence requires a complex interplay of factors. Anatomically, the internal anal sphincter is a continuation of the smooth muscle layer of the rectum. This muscle thickens as it reaches the anal verge and is under continuous, tonic contraction that maintains approximately 75% of resting continence. However, during times of rectal distension, the internal anal sphincter will momentarily relax to allow for sampling of the rectal contents by the sensory nerves of the transition zone. This reflex is called the recto-anal inhibitory reflex or RAIR. The external anal sphincter and puborectalis are skeletal muscle under voluntary control and have somatic innervation via the pudendal nerve and S3–S4 sacral nerves, respectively. These muscles are also tonically contracted, but can increase their contraction force to more than double as

J. Saraidaridis
Division of Colon and Rectal Surgery, Lahey Clinic, Burlington, MA, USA

L. Bordeianou (✉)
Department of General Surgery, Pelvic Floor Disorders Center, Massachusetts General Hospital, Boston, MA, USA
e-mail: lbordeianou@partners.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_9

needed. There is a spinal reflex that prompts external anal sphincter contraction during sudden increases in intra-abdominal pressure (such as a cough). During the process of normal defecation, a patient must relax both the external anal sphincter and the puborectalis to allow straightening of the anorectal canal [6]. The maintenance of continence requires an intact mental status, normal anorectal sensation, sphincter complex function, rectal compliance, and normal stool consistency. Therefore there are a variety of ways in which continence can be disrupted [7].

Evaluation

When a patient first presents with fecal incontinence, a thorough history and physical examination are integral to understanding their condition. Efforts should be made to quantify and qualify the episodes of fecal incontinence. The severity of FI should be quantified using a validated scoring system. Although multiple graded, weighted, and unweighted scoring systems have been described in the literature [8], the most commonly employed method is the Cleveland Clinic Florida Fecal Incontinence Score (CCF-FIS) [9]. In addition, questionnaires like the Fecal Incontinence Severity Index (FISI) and Fecal Incontinence Quality of Life Scale (FIQoL) scale can be helpful to provide a standardized way of assessing a patient's FI. These questionnaires were developed in 1999 and 2000 and the FIQoL has been adopted by the American Society of Colon and Rectal Surgeons (ASCRS) as that society's tool to assess FI's effect on quality of life [10, 11]. The utility of these validated measures in assessing a patient's severity of FI and its effect on quality of life has caused them to be recommended by the ASCRS as a valuable tool in diagnosing and treating FI [12]. However, because they are more cumbersome to use than the scoring systems, they are not as widely employed clinically and are used primarily as a research tool. Moreover, they highlight the discrepancy between the views of patients and surgeons. During the clinic interview, clinicians should assess for medically or surgically treatable etiologies of fecal incontinence. The history should always include an inquiry into a previous history of sphincter trauma either through previous obstetric injury such as forceps delivery or episiotomy or through previous anorectal surgery including fistulotomy, hemorrhoidectomy, lateral internal sphincterotomy, or low anterior resection. Denervation of the pudendal nerve due to prolonged childbirth, chronic rectal prolapse, or neurologic conditions like spina bifida, myelomeningocele, or multiple sclerosis can also contribute to fecal incontinence. Additionally, any patient with reduced compliance of the rectum from ulcerative colitis or radiation proctitis will have difficulty controlling their continence. Finally, any patients with poorly controlled diarrhea due to inflammatory bowel disease, lactose intolerance, or bile salt malabsorption can appear as if they have fecal incontinence. All of these risk factors are important to assess in the initial interview as some can be treated with medical or behavioral modifications and some may benefit from surgical intervention.

Physical examination should include inspection of the perineal body to assess for thinning of the tissue or scarring from previous trauma or interventions. Fistulae, prolapse, or a patulous anus will often be obvious on inspection as well. Some patients will require a Valsalva maneuver to demonstrate rectal prolapse. A digital rectal exam, assessing for mass, resting sphincter tone, and maximum sphincter squeeze will provide good information as well. An internal exam will also rule out fecal impaction, which can cause overflow incontinence and should be treated by other treatment paradigms. Finally, if the patient has any concern for malignancy or mass, a flexible sigmoidoscopy may be required (either in the office or set up for a later date).

Following a thorough history and physical examination, the physician should have a working idea of the source of fecal incontinence. For all patients, regardless of the etiology of their FI, a trial of medical therapy inclusive of fiber supplementation and/or anti-diarrheal medications, biofeedback, and lifestyle modification is indicated. If symptoms are still severe after an adequate attempt at medical therapy, further efforts

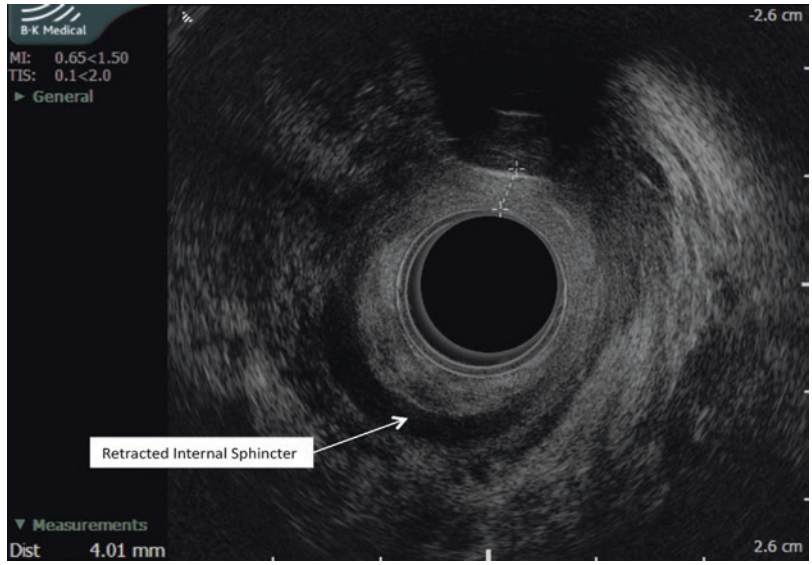


Fig. 9.1 Endoanal ultrasonography demonstrates a classic disruption in the external anal sphincter and internal anal sphincter anteriorly, with internal sphincter retraction and a thinned perineal body (4 mm)

at evaluation are merited, and the patient should undergo a pelvic floor evaluation.

The two studies that provide potentially useful diagnostic information are: anal endosonography and anal manometry. The first test to evaluate the pelvic floor is anal endosonography to assess for sphincter integrity. Anal endosonography is performed by using a two-dimensional ultrasound scanner with a rotating probe allowing for a circumferential view of the anal canal (Fig. 9.1). This probe is then inserted into the rectal cavity and slowly withdrawn allowing for cross-sectional imaging of the musculature of the pelvic floor. Anal endosonography allows the evaluation of muscular defects in the sphincter complex, which are surgically amenable to repair. There may be utility in performing anal endosonography to discover occult injuries in patients without overt injuries on physical exam. In one study examining post-partum patients without a clinically obvious tear, 28% had an anal injury that could be identified by anal endosonography. These patients were subsequently 8.8-times more likely to develop fecal incontinence in 3 months in comparison to their compatriots without an occult injury [13]. While the presence of a sphincter defect on ultrasound is not adequate information to move forward with surgical intervention, the presence of a defect is associated with symptoms of FI and decreased continence [13].

While anal endosonography aids in evaluating the anatomy of the pelvic floor, anal manometry can help elucidate the function of the pelvic floor. Anal manometry is performed by inserting a thin flexible catheter attached to a pressure transducer into the patient's rectum. Resting and squeeze pressures are obtained at different points along the rectum. Maximum resting pressure is defined as the highest measurement obtained with the patient at rest (range: 40–80 mmHg). Maximum squeeze pressure is defined as the difference between squeeze pressure and baseline pressure. Rectal compliance is assessed by filling an intra-rectal balloon with the volume that causes an intolerable sensation of distension. Actual values of maximum resting pressure <40 mmHg, a maximal squeeze pressure <60 mmHg, and a rectal capacitance <200 mL in women are thought to be seen primarily with incontinence [14, 15]. In comparison to patients who are continent, patients with fecal incontinence have significantly lower maximum resting pressure, maximal squeeze pressure, and decreased rectal capacitance. However, there is significant overlap between groups and the severity of FI is not associated with the severity of anal manometric derangement [16]. Despite these misgivings, the information from anal manometry is helpful to the clinician. While it does not provide the diagnosis of fecal incontinence or rate its severity,

anal manometry does provide useful information for potential intervention in the disorder.

Previously, pudendal nerve terminal motor latency (PNTML) was thought to be an important aspect of pelvic floor testing for fecal incontinence. The inclusion of this test in the evaluation of fecal incontinence stemmed from the belief that pudendal neuropathy due to childbirth, repeated straining, or neurologic disorders was one of the common etiologies of FI. While pudendal neuropathy is present in up to 70% of patients with FI, it's presence makes little difference to the patient or clinician. Some studies have shown that patients with prolonged PNTML do not benefit from sphincteroplasty [17], however, this claim has been contested in other studies.

Treatment

Conservative Management

As stated earlier, medical management is the first-line therapy for patients with fecal incontinence. Medical management is a multi-faceted approach that aims at ameliorating FI symptoms and controlling any underlying medical problem that results in loose, frequent stools. Conditions such as inflammatory bowel disease, hyperthyroidism, and celiac disease should be identified and treated to minimize their contribution to FI. After tight control of co-existing medical conditions, medical management should follow a multi-pronged approach including fiber supplementation, anti-diarrheals, behavior modification, and biofeedback.

The addition of fiber, anti-diarrheals, or amitriptyline to a patient's regimen can result in significant improvement in FI. Soluble (psyllium fiber) is thought to both bulk the stool and cause a gel to form within the stool improving consistency to obtain continence. A study evaluating the best type of fiber to supplement in patients with FI found that psyllium reduced the incidence of FI to 2.5 episodes per week in comparison to 4.3 with gum arabic, 6.2 with carboxymethylcellulose, and 5.5 in the placebo arm [18]. Anti-diarrheals such as loperamide and diphenoxylate-atropine are medications that can be used to improve symptoms of fecal incontinence by reducing diarrhea. Their method of action is to decrease intestinal motility and slow transit causing a more formed stool to occur. The Fecal Incontinence Prescription Management (FIRM) randomized clinical trial showed equal ability of loperamide and fiber supplementation to benefit episodes of FI in patients who had at least one episode of FI during a 1-week bowel habit diary. Those using fiber had less incidence of constipation [19]. Finally, the tri-cyclic anti-depressant, amitriptyline, has been identified as another potential beneficial medication for those with FI. In a small study in 18 individuals with FI, amitriptyline improved FI scores, decreased the number of daily BMs, and decreased the frequency and amplitude of rectal motor complexes. Overall this medication improved the symptoms of FI in 89% of the patients. The mechanism of action of amitriptyline is thought to be the decrease in amplitude and frequency of rectal motor complexes and the simultaneous increase in colonic transit time [20]. While there is much work to be done on further options for medical treatment for FI, psyllium, anti-diarrheals, and amitriptyline are good initial options.

Patients are asked to keep a food and symptom diary to aid in identifying potential triggers to incontinence episodes. In particular, patients are asked to keep careful attention to the ingestion of alcohol, fatty foods, caffeine, lactose, and artificial sweeteners as, historically, these items have been known to promote loose stools and episodes of FI [21]. Supportive measures include efforts at optimizing skin care and perineal hygiene including the use of protective ointments, gentle soaps, deodorants, and absorbent pads. Taken in concert, all of these efforts together often have significant improvement on patients' quality of life.

Another aspect of conservative management of FI is the use of biofeedback or pelvic floor rehabilitation. This is a noninvasive therapy that uses electronic or mechanical devices to improve coordination and strength of the sphincter complex. Biofeedback starts with a patient perform-

ing a modified Kegel exercise with an intra-rectal probe measuring anorectal pressure. Patients can view the pressures obtained with their squeeze so they are able to recognize when they are optimally performing. Patients also receive sensory-motor coordination training, wherein an intra-rectal balloon is inflated and patients have 1 s to produce a maximum squeeze rather than relaxation. Other therapy is guided towards improving rectal sensation for small volumes and urge resistance training (teaching patients to relax in response to overwhelming rectal distension) [22]. Overall, biofeedback is thought to be effective at re-training the pelvic floor in patients with FI. However, the studies evaluating the benefit of biofeedback on FI have been heterogeneous. One of many studies showing biofeedback's benefit demonstrated that after 3 months follow-up patients had greater reductions in incontinence scores and fewer days with FI than patients who had received verbal instructions on pelvic floor exercises alone. This benefit was durable 12 months after the study [23]. It is clear that more work is needed to evaluate the benefit of biofeedback and to whom it is of benefit, but overall, it is considered a cornerstone of the non-surgical management of FI.

Non-surgical Devices

There are a number of minimally invasive devices patients can use to help achieve continence. The most successful disposable devices have been the anal plugs. Anal plugs include the Peristeen foam anal plug, which is a disposable foam tampon that can be left in place for up to 12 h. The Procon-2 is a silicon balloon that can be inserted into the rectum and inflated with a one-way valve to allow gas to pass. Another product, the Renew plug is a disposable soft anal plug inserted into the anal canal [24]. A Cochrane review evaluated the use of anal plugs for fecal incontinence: it totaled four studies with 136 participants. They observed that episodes of FI were prevented by the anal plugs (pseudo-continence) in 38% of the participants; however, there was significant subject dropout (35%). The overall conclusion was that anal plugs are difficult to tolerate but can aid in obtaining continence if used reliably [25].

Surgical Management

If patients still have debilitating symptoms after a trial of conservative management, further evaluation for potential surgical intervention is indicated. Pelvic floor evaluation including anal endosonography, manometry, defecography, and possibly EMG/PNTML are in order. Surgical interventions focus primarily on improving the integrity of the anal sphincter, improving the overall function of the pelvic floor, or replacing the sphincter altogether.

Operations to Repair Sphincter Injury

The most likely etiology of FI in a patient with a defect on anal endosonography is an injury to the anterior sphincter complex incurred during childbirth, also known as an Obstetric Associated Sphincter Injury (OASIS). It is estimated that around 8% of primaparous women develop occult injuries to the sphincter complex at the time of their first delivery [26]. Sphincter injuries can result in immediate incontinence or can present many years later in the setting of worsening pudendal neuropathy or age-related degeneration of muscle fibers. The optimal operative repair of a discrete sphincter defect is with an overlapping sphincteroplasty. Data regarding long-term outcomes of overlapping sphincteroplasty show significant improvement in continence in around 60% of patients. However, patients who undergo this therapy must be carefully selected. For young women with an obvious sphincter defect, this operation is considered the gold standard [27]. But, for older women, overlapping sphincterotomy does not have as robust an improvement in continence as for the younger population [28]. This is thought to be due to the fact that older women have other factors that contribute to their incontinence like pudendal neuropathy and other medical conditions. Nevertheless, in older women with severe FI and an external sphincter defect of less than 120°, it is still considered appropriate to offer an overlapping sphincteroplasty.

plasty and assess improvement in continence or need for sacral neuromodulation after recovery. For elderly women, it is of particular importance to counsel patients before the operation that continence may not be achieved with surgery and that efficacy in treating incontinence decreases with increasing age [28].

An overlapping anal sphincteroplasty is performed after bowel preparation in the prone jackknife position. A curvilinear incision is made anterior to anus and the surgeon carefully dissects the injured external sphincter away from the skin, the ischiorectal fat, the anal mucosa, the internal anal sphincter complex, and the vagina. Discrete defects in the internal and external sphincter can be repaired by separating and closing each muscle. Alternatively, an en bloc resection and repair can be undertaken. A levator plication can be performed prior to sphincter imbrication and prior to isolated external sphincter repair or en-bloc internal and external sphincter overlapping repair. The sphincter muscle is overlapped anteriorly with long-term absorbable sutures. The perineal body is then closed transversely. Patients should be counselled preoperatively that these wounds are slow-healing and often complicated by wound infection or separation.

Failure to improve or relapse after improvement after sphincteroplasty may warrant an anal endosconography to assess the integrity of the repair. Repeat overlapping sphincteroplasty may be considered if a defect is still present [29]. However, for many patients, sacral neuromodulation may be a more appropriate next step.

Patients may have continued, severe FI after vaginal delivery with either no defect on anal endosonography or with limited improvement after a sphincter repair. These patients should undergo a repeat endoanal ultrasound and endovaginal ultrasound to evaluate for levator avulsion injury. This injury is responsible for FI in as many as 19% of women who have persistent symptoms of FI after a primary obstetric sphincter injury repair [30]. These patients may be candidates for a repair using a posterior anal mesh sling. A recent prospective trial showed that placement of a posterior, trans-obturator, anal sling provided a statistically significant improvement in continence in 61% of women [31]. Unfortunately, given the current climate in the United States Food and Drug Administration (FDA) towards pelvic mesh slings, this procedure has not become common practice in the United States.

Operations to Improve Pelvic Floor Function

Sacral neuromodulation (SNM) offers patients without sphincter defects and patients who have continued or recurrent incontinence despite sphincter defect repair another therapeutic maneuver to improve continence. SNM was approved by the FDA in 1997 for urinary urge incontinence and was broadened to include fecal incontinence in 2011. The therapy works by applying electrical pulses, which modulate the neural activity of the S3 nerve root through an implanted device. It is thought to work on the central nervous system, the pelvic afferent nerves, and the peripheral pelvic motor neurons. How these pathways are affected by SNM and how the device improves bowel and bladder incontinence is still unclear; however, the benefit of the therapy has been clearly demonstrated in numerous studies. The success rate of SNM is surprisingly robust. 54–63% of patients who undergo SNM demonstrate at least a 50% improvement in weekly episodes of fecal incontinence over both the short and long term [32–36]. Additionally, some patients (approximately 35–40%) will achieve full continence using this therapy. Overall, while its mechanism is poorly explained, SNM has changed the therapeutic landscape for FI significantly.

SNM is often a two-stage procedure. In the first stage, the S3 sacral nerve foramen is identified under fluoroscopy by the clinician. Once confirmed, the wire is tunneled under the skin and connected to an external stimulator for a 2-week trial period. If the trial is a success, the patient is returned to the operating room and a permanent neurostimulator is implanted into the patient's subcutaneous tissue (Fig. 9.2). The operation is well tolerated. The most common complications include infection (10%), battery loss (10%), and electrode displacement (10%) [34, 35, 37]. In a study with a median follow-up of 49 months, 41% of patients required some type of surgical revision [38]. While certainly not perfect, SNM

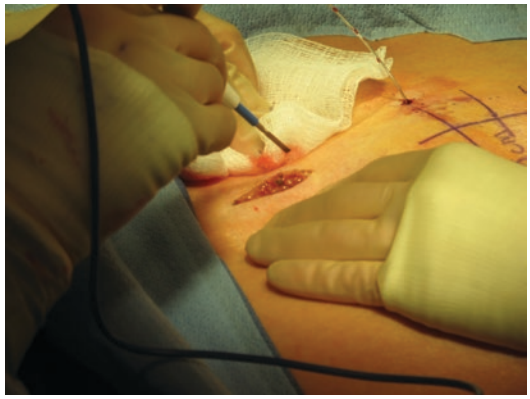


Fig. 9.2 Placement of temporary sacroneuromodulation tined lead requires tunneling of the lead away from site of insertion

has been a valuable addition to the therapeutic options for FI.

In addition to SNM, there has been mixed literature regarding the utility of posterior tibial nerve stimulation (PTNS) for the treatment of fecal incontinence. Based on the same principle of neuromodulation of the sacral nerves as SNM, PTNS is less invasive. It involves the insertion of a needle electrode into the lower leg above the medial malleolus with stimulation of the posterior tibial nerve. This stimulation is thought to travel up the tibial nerve to the sacral plexus with similar neuromodulatory effects as seen in SNM. Patients receive weekly 30-min treatments for 12 weeks [39]. A recent randomized controlled trial evaluating 227 women with FI showed no clinical benefit [40]. Further work is still merited to evaluate populations for whom this therapy could benefit.

Sphincter Augmentation

If SNM does not improve symptoms, patients can be considered for sphincter augmentation procedures. These procedures range in complexity from application of radiofrequency energy to operative placement of an artificial sphincter. Unfortunately, the current options for sphincter augmentation have equivocal utility or are associated with a significant complication profile. Therefore, sphincter augmentation procedures are usually limited to patients who fail SNM.

The application of radiofrequency energy to the anal sphincter was first performed in Mexico in 1999. The technology came to the United States in 2002, when the FDA approved the Secca® device. This platform includes a hand-held anoscopic device with a radiofrequency generator. The procedure is performed on an outpatient basis in either a surgical or endoscopy suite. The Secca® probe is placed in the anal canal and energy is applied to the anoderm to create a controlled thermal injury. As this low-level burn injury heals, collagen is deposited causing thickening and strengthening of the sphincter complex over time [41]. Secca® has had mixed results with some studies showing improvement that decrements over time [42]. Common side effects include pain, infection, and excessive scarring. For the most part, it is well tolerated although it has not shown great efficacy and has limited utility at present.

Injectables in the perianal area to cause bulking of the sphincter complex are another minimally invasive way to augment continence. A variety of substances have been trialed in this arena including detranomer in stabilized hyaluronic acid (NASHA Dx), silicone, and carbon coated beads—although only NASHA Dx (Solesta®) is approved in the United States (FDA approval in 2011). One study examining NASHA Dx demonstrated improved symptoms and more days without fecal incontinence but with more adverse effects [43]. There has been mixed enthusiasm for Solesta®, and it has limited utilization in the United States.

For a selected cohort of patients with intractable FI or extensive sphincter damage precluding sphincter repair, muscle transposition, or an artificial bowel sphincter are potential surgical solutions to incontinence. Because of the complication profile of these procedures, only motivated patients with favorable comorbidity profiles are candidates for these operations.

Muscle transposition to create an anal neosphincter has gone through significant evolution since it was first described in humans in 1952 by Pickrell [44]. Originally, the use of the gracilis muscle was proposed; however, utilization of the gluteus, rectus abdominus, and latissimus dorsi flaps have also been described in the literature.

One of the early setbacks for this procedure was that fast-twitch skeletal muscles were incapable of the prolonged, tonic contraction required of the anal sphincter. It was discovered that low-frequency electrical stimulation could transition the gracilis (and other fast twitch muscles) to a slow-twitch muscle [45]. Subsequently, Cavina et al. described graciloplasty with implantation of an electric stimulator as a solution [46]. Patients should be advised that the procedure requires a diverting stoma during healing. The gracilis is mobilized through an inner thigh incision. The main nerve to the gracilis is identified and confirmed via stimulation. An electrode is placed in the LLQ and tunneled down to the thigh wound and placed near the gracilis nerve. A stimulator is placed in a pocket in the LLQ. The wound covering the stimulator is closed. The muscle is then tunneled from the upper thigh to the perineum (using two curvilinear incisions around the anus) and brought around the anal canal and sutured to the underlying periosteum of the contralateral ischial tuberosity. The leg incision is closed. A diverting loop stoma is constructed. After recovering from surgery, the patient undergoes "training" of the muscle. A prospective multi-center trial evaluating stimulated dynamic muscleplasty for anal incontinence in 139 patients demonstrated that only 66% achieved a successful outcome (defined as 70% of reduction in solid stool incontinence), 30% had a major wound complication, and 41% had therapy failure [47]. As the complication profile is high and success is not certain [48], this operation is only utilized in motivated patients with end stage FI who prefer not to undergo placement of an artificial sphincter or a colostomy. Currently the procedure and device are not FDA-approved in the United States.

Another option for sphincter reconstruction is the use of an artificial sphincter. As the procedure implants a foreign body into the perianal tissue, only patients with healthy perineal tissue are candidates. Any patient with potential wound-healing difficulties including those with diabetes, pelvic radiation, or inflammatory bowel disease, should be excluded from this therapy. There are two devices available to patients in the United States: the artificial bowel sphincter (ABS) (Fig. 9.3) or Acticon Neosphincter® and the Fenix magnetic anal sphincter (MAS) (Figs. 9.4 and 9.5). Both of these devices require implantation and follow-up care by clinicians experienced in their use.

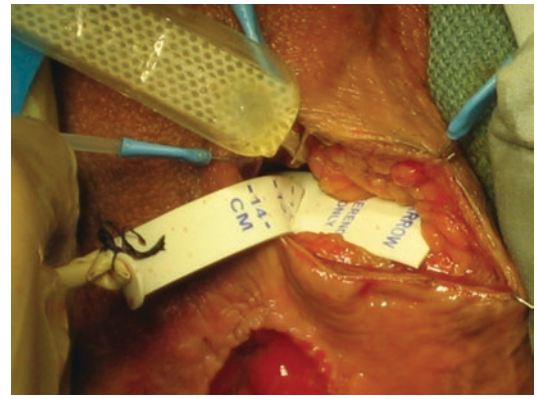


Fig. 9.3 Placement of artificial bowel sphincter cuff around anorectal junction in a patient in need of ABS replacement due to cuff leakage

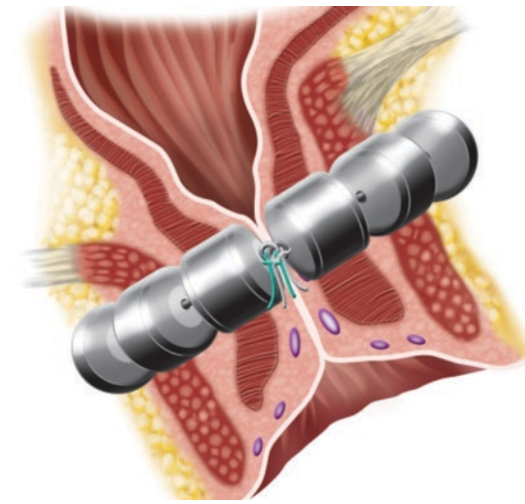


Fig. 9.4 Diagram of magnetic anal sphincter in situ

The ABS or Acticon Neosphincter® was available in the United States via a Humanitarian Device Exemption since 1999 with formal FDA approval in 2001. The device consists of a fluid-filled anal cuff, which is implanted around the anal sphincter, a pressure-regulating balloon,

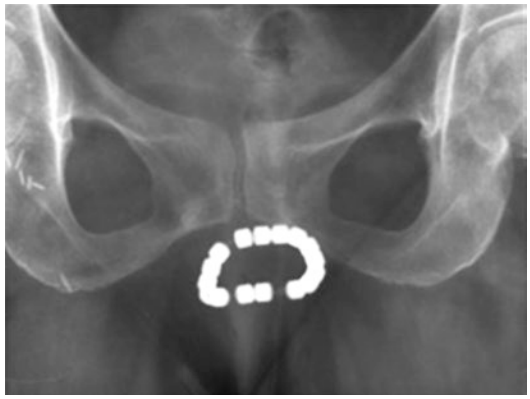


Fig. 9.5 Magnetic anal sphincter in situ with one to three beads open

which is placed in the space of Retzius, and a control pump, which is placed in the labia/scrotum. The device is implanted by an anterior perianal incision. A tunnel approximately 5–6 cm from the skin should be made around the ano-rectal junction (Fig. 9.3). A sizer is placed to aid in deciding cuff length (0–14 cm) and width (2 and 2.9 cm). A Pfannenstiel incision is then made to implant the pressure regulating balloon and control pump. A pocket is created in the labia/scrotum to accommodate the control pump. Tubing from the control pump is attached to the tube of the cuff and balloon (tunneled subcutaneously to the control pump pocket). The incisions are closed in multiple layers. During the procedure, it is important to maintain two separate surgical fields (anal and Pfannenstiel) so as to limit bacterial contamination [49]. When a patient wants to move their bowels, they activate the control pump, which opens the cuff to allow stool to pass. A multi-center cohort study evaluated 115 patients with the Acticon Neosphincter®. 25% of the patients had infections requiring revision of the device, 20% required a surgical revision due to erosion, and at 1 year 65% had a functioning device in place. Eighty-five percent of patients with a device had significant improvement in their fecal incontinence scores and quality of life [50]. One of the common complications of the therapy was fecal impaction requiring laxative use in the previously incontinent patient. A subsequent study showed a high rate of success but only in a small group of patients due to a high rate of complications including infection and explantation [51, 52].

The magnetic anal sphincter (MAS) or Fenix Continence Restoration System was approved by the FDA in 2015. This device consists of circular string of small titanium beads that open and close with magnetic force. The device is implanted around the anorectal junction immediately below the puborectalis via a perineal incision. The device is sized so that when the beads are touching, the anus is occluded (Figs. 9.4 and 9.5). The device allows a patient to defecate when an urge presents itself and then when the fecal bolus has passed to close the sphincter. Initial evaluation of the device demonstrated good improvement in fecal incontinence measures and quality of life scores [53, 54]. The complication profile is similar to that of the ABS including an estimated 11% infection rate, 11% erosion rate, and 23% explantation rate over 5 years [55]. A small study compared ten patients with the MAS to ten matched patients with an already implanted ABS. Both groups had significant improvements in incontinence symptoms and quality of life. The length of stay was significantly longer for the ABS group (10 vs. 4.5 days) but the complication rate was equal between the two groups [56]. Those with ABS did have increased incidence of constipation. Further experience and long-term results will help determine the role that this device will have in the treatment of FI in the future. Neither the ABS nor the MAS are commercially available at the time of publication.

Malone Antegrade Continence Enema

Another potential therapy for those who wish to avoid stoma is a reverse appendicostomy or tube cecostomy, which allows for administration of antegrade colonic enema (ACE) to clear the colon in a predictable fashion [57]. These procedures have been primarily described in the pediatric population; however, anecdotal evidence in adults is favorable.

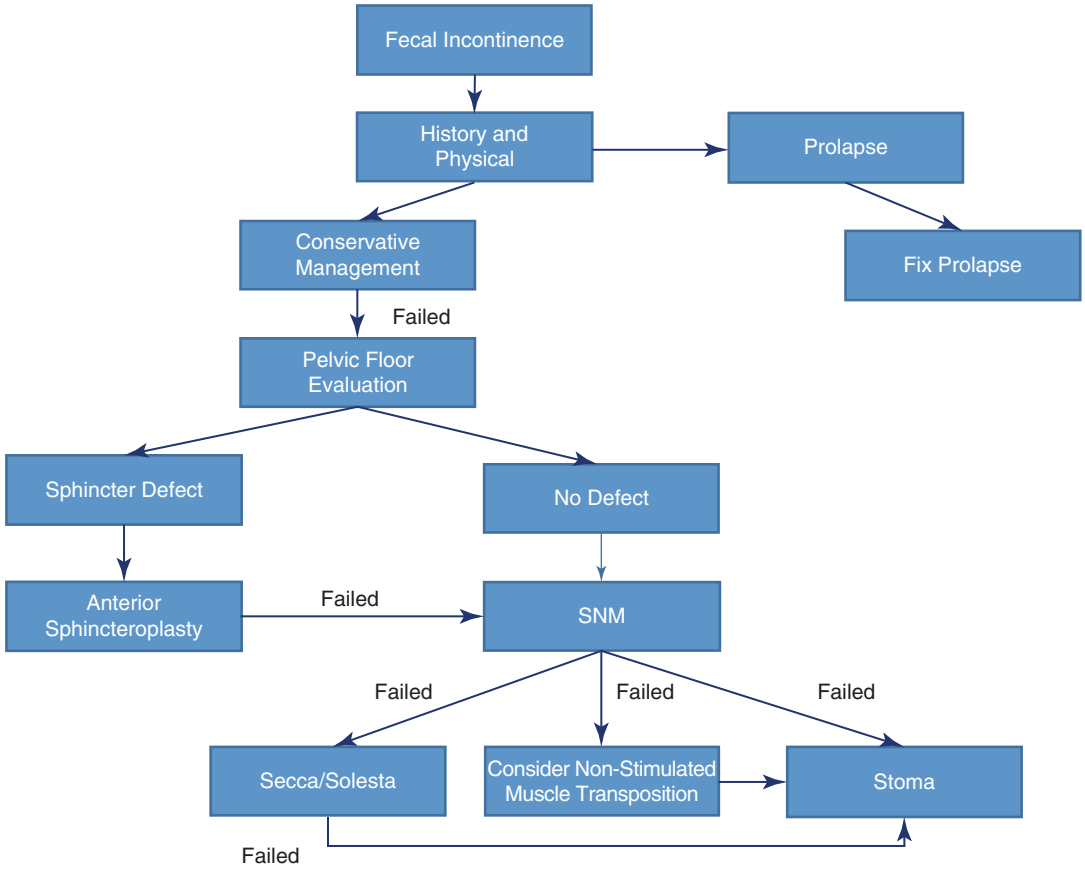


Fig. 9.6 Management algorithm. *ABS* artificial bowel sphincter; *SNM* Sacral neuromodulation; *MAS* magnetic artificial sphincter

Colostomy

For patients who have failed all other therapies, colostomy can offer significant improvement in quality of life. While most patients are hesitant to proceed to an ostomy, when questioned, 84% of patients who underwent a stoma creation would choose to have a stoma created again [58].

Conclusion

Fecal Incontinence is a common problem in the population. Assessment of FI includes a thorough history and physical with quantification and scoring of the severity of the FI followed by a trial of conservative therapy. If conservative therapy fails, the patient should proceed to a pelvic floor evaluation. For those patients discovered to have a sphincter disruption, an overlapping sphincteroplasty can provide significant improvement. A trial of sacral neuromodulation is merited for those patients without a sphincter defect or for those who fail sphincter repair. Finally, those patients who fail SNM should trial the variety of sphincter augmentation procedures including Secca® radiofrequency energy application, anal sphincter injectables, dynamic graciloplasty, the artificial bowel sphincter, or the magnetic anal sphincter. Permanent colostomy creation is always an option. An algorithm for evaluation and management of fecal incontinence is summarized in (Fig. 9.6).

References

1. Paquette IM, et al. The American Society of Colon and Rectal Surgeons' clinical practice guideline for the treatment of fecal incontinence. Dis Colon Rectum. 2015;58(7):623–36.
2. Sharma A, et al. Systematic review of the prevalence of faecal incontinence. Br J Surg. 2016;103(12):1589–97.
3. Brown HW, et al. Accidental bowel leakage in the mature women's health study: prevalence and predictors. Int J Clin Pract. 2012;66(11):1101–8.
4. Nelson R, Furner S, Jesudason V. Fecal incontinence in Wisconsin nursing homes: prevalence and associations. Dis Colon Rectum. 1998;41(10):1226–9.
5. Brown HW, Wexner SD, Lukacz ES. Factors associated with care seeking among women with accidental bowel leakage. Female Pelvic Med Reconstr Surg. 2013;19(2):66–71.
6. Parks AG. Royal Society of Medicine, Section of Proctology; Meeting 27 November 1974. President's address. Anorectal incontinence. Proc R Soc Med. 1975;68(11):681–90.
7. Steele SR, Hull TL, Read TE, Saclarides TJ, Senagore AJ, Whitlow CB, editors. The ASCRS textbook of colon and rectal surgery. New York: Springer; 2016.
8. Carlo R. Colon, rectum and anus : anatomic, physiologic and diagnostic bases for disease management. New York: Springer; 2016.
9. Jorge JM, Wexner SD. Etiology and management of fecal incontinence. Dis Colon Rectum. 1993;36(1):77–97. Review.
10. Rockwood TH, et al. Patient and surgeon ranking of the severity of symptoms associated with fecal incontinence: the fecal incontinence severity index. Dis Colon Rectum. 1999;42(12):1525–32.
11. Rockwood TH, et al. Fecal incontinence quality of life scale: quality of life instrument for patients with fecal incontinence. Dis Colon Rectum. 2000;43(1):9–16. discussion 16–7.
12. Faltin DL, et al. Diagnosis of anal sphincter tears by postpartum endosonography to predict fecal incontinence. Obstet Gynecol. 2000;95(5):643–7.
13. Pinsk I, Brown J, Phang PT. Assessment of sonographic quality of anal sphincter muscles in patients with faecal incontinence. Color Dis. 2009;11(9):933–40.
14. Felt-Bersma RJ, Klinkenberg-Knol EC, Meuwissen SG. Anorectal function investigations in incontinent and continent patients. Differences and discriminatory value. Dis Colon Rectum. 1990;33(6):479–85. discussion 485–6.
15. Lam TJ, Kuik DJ, Felt-Bersma RJ. Anorectal function evaluation and predictive factors for faecal incontinence in 600 patients. Color Dis. 2012;14(2):214–23.
16. Zutshi M, et al. Anal physiology testing in fecal incontinence: is it of any value? Int J Color Dis. 2010;25(2):277–82.
17. Birnbaum EH, et al. Pudendal nerve terminal motor latency influences surgical outcome in treatment of rectal prolapse. Dis Colon Rectum. 1996;39(11):1215–21.
18. Bliss DZ, et al. Dietary fiber supplementation for fecal incontinence: a randomized clinical trial. Res Nurs Health. 2014;37(5):367–78.
19. Markland AD, et al. Loperamide versus psyllium fiber for treatment of fecal incontinence: the fecal incontinence prescription (Rx) management (FIRM) randomized clinical trial. Dis Colon Rectum. 2015;58(10):983–93.
20. Santoro GA, et al. Open study of low-dose amitriptyline in the treatment of patients with idiopathic fecal incontinence. Dis Colon Rectum. 2000;43(12):676–81. discussion 1681–2.
21. Croswell E, Bliss DZ, Savik K. Diet and eating pattern modifications used by community-living adults to manage their fecal incontinence. J Wound Ostomy Continence Nurs. 2010;37(6):677–82.
22. Rao SS, et al. ANMS-ESNM position paper and consensus guidelines on biofeedback therapy for anorectal disorders. Neurogastroenterol Motil. 2015;27(5):594–609.
23. Heymen S, et al. Randomized controlled trial shows biofeedback to be superior to pelvic floor exercises for fecal incontinence. Dis Colon Rectum. 2009;52(10):1730–7.
24. Lukacz ES, Segall MM, Wexner SD. Evaluation of an anal insert device for the conservative management of fecal incontinence. Dis Colon Rectum. 2015;58(9):892–8.
25. Deutekom M, Dobben AC. Plugs for containing faecal incontinence. Cochrane Database Syst Rev. 2015;7:CD005086.
26. Varma A, et al. Obstetric anal sphincter injury: prospective evaluation of incidence. Dis Colon Rectum. 1999;42(12):1537–43.
27. Goetz LH, Lowry AC. Overlapping sphincteroplasty: is it the standard of care? Clin Colon Rectal Surg. 2005;18(1):22–31.
28. Mik M, et al. Anterior overlapping sphincteroplasty—who benefits from the surgery? Pol Przegl Chir. 2014;86(1):33–8.
29. Giordano P, et al. Previous sphincter repair does not affect the outcome of repeat repair. Dis Colon Rectum. 2002;45(5):635–40.
30. Shek KL, Guzman-Rojas R, Dietz HP. Residual defects of the external anal sphincter following primary repair: an observational study using transperineal ultrasound. Ultrasound Obstet Gynecol. 2014;44(6):704–9.
31. Mellgren A, et al. A posterior anal sling for fecal incontinence: results of a 152-patient prospective multicenter study. Am J Obstet Gynecol. 2016;214(3):349. e1–8.
32. Carrington EV, et al. A systematic review of sacral nerve stimulation mechanisms in the treatment of fecal incontinence and constipation. Neurogastroenterol Motil. 2014;26(9):1222–37.

33. Thin NN, et al. Systematic review of the clinical effectiveness of neuromodulation in the treatment of faecal incontinence. Br J Surg. 2013;100(11):1430–47.
34. Wexner SD, et al. Sacral nerve stimulation for fecal incontinence: results of a 120-patient prospective multicenter study. Ann Surg. 2010;251(3):441–9.
35. Hull T, et al. Long-term durability of sacral nerve stimulation therapy for chronic fecal incontinence. Dis Colon Rectum. 2013;56(2):234–45.
36. Matzel KE, et al. Sacral nerve stimulation for faecal incontinence: long-term outcome. Color Dis. 2009;11(6):636–41.
37. Tjandra JJ, et al. Sacral nerve stimulation is more effective than optimal medical therapy for severe fecal incontinence: a randomized, controlled study. Dis Colon Rectum. 2008;51(5):494–502.
38. Faucheron JL, Voirin D, Badic B. Sacral nerve stimulation for fecal incontinence: causes of surgical revision from a series of 87 consecutive patients operated on in a single institution. Dis Colon Rectum. 2010;53(11):1501–7.
39. van der Wilt AA, et al. Randomized clinical trial of percutaneous tibial nerve stimulation versus sham electrical stimulation in patients with faecal incontinence. Br J Surg. 2011;104(9):1167–76.
40. Knowles CH, et al. Percutaneous tibial nerve stimulation versus sham electrical stimulation for the treatment of faecal incontinence in adults (CONFIDeNT): a double-blind, multicentre, pragmatic, parallel-group, randomised controlled trial. Lancet. 2015; 386(10004):1640–8.
41. Herman RM, et al. Defining the histopathological changes induced by nonablative radiofrequency treatment of faecal incontinence—a blinded assessment in an animal model. Color Dis. 2015;17(5):433–40.
42. Ruiz D, et al. Does the radiofrequency procedure for fecal incontinence improve quality of life and incontinence at 1-year follow-up? Dis Colon Rectum. 2010;53(7):1041–6.
43. Maeda Y, Laurberg S, Norton C. Perianal injectable bulking agents as treatment for faecal incontinence in adults. Cochrane Database Syst Rev. 2013;2:CD007959.
44. Pickrell KL, et al. Construction of a rectal sphincter and restoration of anal continence by transplanting the gracilis muscle; a report of four cases in children. Ann Surg. 1952;135(6):853–62.
45. Salmons S, Henriksson J. The adaptive response of skeletal muscle to increased use. Muscle Nerve. 1981;4(2):94–105.
46. Cavina E, et al. Construction of a continent perineal colostomy by using electrostimulated gracilis muscles after abdominoperineal resection: personal technique and experience with 32 cases. Ital J Surg Sci. 1987;17(4):305–14.
47. Madoff RD, et al. Safety and efficacy of dynamic muscle plasty for anal incontinence: lessons from a prospective, multicenter trial. Gastroenterology. 1999;116(3):549–56.
48. Wexner SD, Baeten C, Bailey R, Bakka A, Belin B, Belliveau P, Berg E, Buie WD, Burnstein M, Christiansen J, Coller J, Galandiuk S, Lange J, Madoff R, Matzel KE, Påhlman L, Parc R, Reilly J, Seccia M, Thorson AG, Vernava AM 3rd. Long-term efficacy of dynamic graciloplasty for fecal incontinence. Dis Colon Rectum. 2002;45(6):809–18.
49. Gregorcyk SG. The current status of the Acticon Neosphincter. Clin Colon Rectal Surg. 2005;18(1):32–7.
50. Wong WD, et al. The safety and efficacy of the artificial bowel sphincter for fecal incontinence: results from a multicenter cohort study. Dis Colon Rectum. 2002;45(9):1139–53.
51. Gallas S, et al. Constipation in 44 patients implanted with an artificial bowel sphincter. Int J Color Dis. 2009;24(8):969–74.
52. Wexner SD, et al. Factors associated with failure of the artificial bowel sphincter: a study of over 50 cases from Cleveland Clinic Florida. Dis Colon Rectum. 2009;52(9):1550–7. https://doi.org/10.1007/DCR.0b013e3181af62f8.
53. Pakravan F, Helmes C. Magnetic anal sphincter augmentation in patients with severe fecal incontinence. Dis Colon Rectum. 2015;58(1):109–14.
54. Lehur PA, et al. Magnetic anal sphincter augmentation for the treatment of fecal incontinence: a preliminary report from a feasibility study. Dis Colon Rectum. 2010;53(12):1604–10.
55. Sugrue J, et al. Long-term experience of magnetic anal sphincter augmentation in patients with fecal incontinence. Dis Colon Rectum. 2017;60(1): 87–95.
56. Wong MT, et al. The magnetic anal sphincter versus the artificial bowel sphincter: a comparison of 2 treatments for fecal incontinence. Dis Colon Rectum. 2011;54(7):773–9.
57. Malone PS, Ransley PG, Kiely EM. Preliminary report: the antegrade continence enema. Lancet. 1990;336(8725):1217–8.
58. Norton C, Burch J, Kamm MA. Patients' views of a colostomy for fecal incontinence. Dis Colon Rectum. 2005;48(5):1062–9.

Anorectal Abscess and Fistula in Ano

10

Jon D. Vogel and Carol-Ann Vasilevsky

Introduction

Fistula-in-ano and anorectal abscesses represent different stages along the continuum of a common pathogenic spectrum. Although the abscess represents the acute inflammatory event, the fistula is representative of the chronic process. This chapter covers cryptoglandular anorectal abscess, fistula-in-ano, necrotizing perianal infection, anoperineal infection in neutropenic patients, and fistulizing perianal Crohn's disease. Rectovaginal fistula and perianal Crohn's disease are covered in separate chapters of this text.

Anatomy

Successful eradication of anorectal suppuration and fistula-in-ano requires an in-depth understanding of anorectal anatomy. Essential is an understanding of the existence of potential anorectal spaces (Fig. 10.1) [2]. The perianal space is located in the area of the anal verge. It becomes continuous with the ischiorectal fat laterally while it extends into the lower portion of the anal canal medially. It is continuous with the intersphincteric space. The ischiorectal space extends from the levator ani to the perineal skin. Anteriorly it is bounded by the transverse perineal muscles; the lower border of the gluteus maximus and the sacrotuberous ligament form its posterior border. The medial border is formed by the levator ani and external sphincter muscles; the obturator internus muscle forms the lateral border. The intersphincteric space lies between the internal and external sphincters and is continuous inferiorly with the perianal space and superiorly with the rectal wall. The supralevator space is bounded superiorly by peritoneum, laterally by the pelvic wall, medially by the rectal wall and inferiorly by the levator ani muscle. The deep postanal space is located between the tip of the coccyx posteriorly and the external anal sphincter anteriorly and lies between the anococcygeal ligament and the levator ani (Fig. 10.1b).

At the level of the dentate line, the ducts of the anal glands empty into the anal crypts.

Occasionally a duct may open at a higher level [3]. The glands enter the submucosa, two thirds enter the internal sphincter and half of these cross the intersphincteric space [4]. They do not penetrate the external sphincter and number from four to ten in a normal individual and are most concentrated posteriorly. Men have been found to have a higher incidence of intermuscular glands than women [5].

J. D. Vogel (✉)
Department of Surgery, University of Colorado, Aurora, CO, USA
e-mail: jon.vogel@ucdenver.edu

C.-A. Vasilevsky
Division of Colon and Rectal Surgery, Jewish General Hospital, Montreal, QC, Canada

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_10

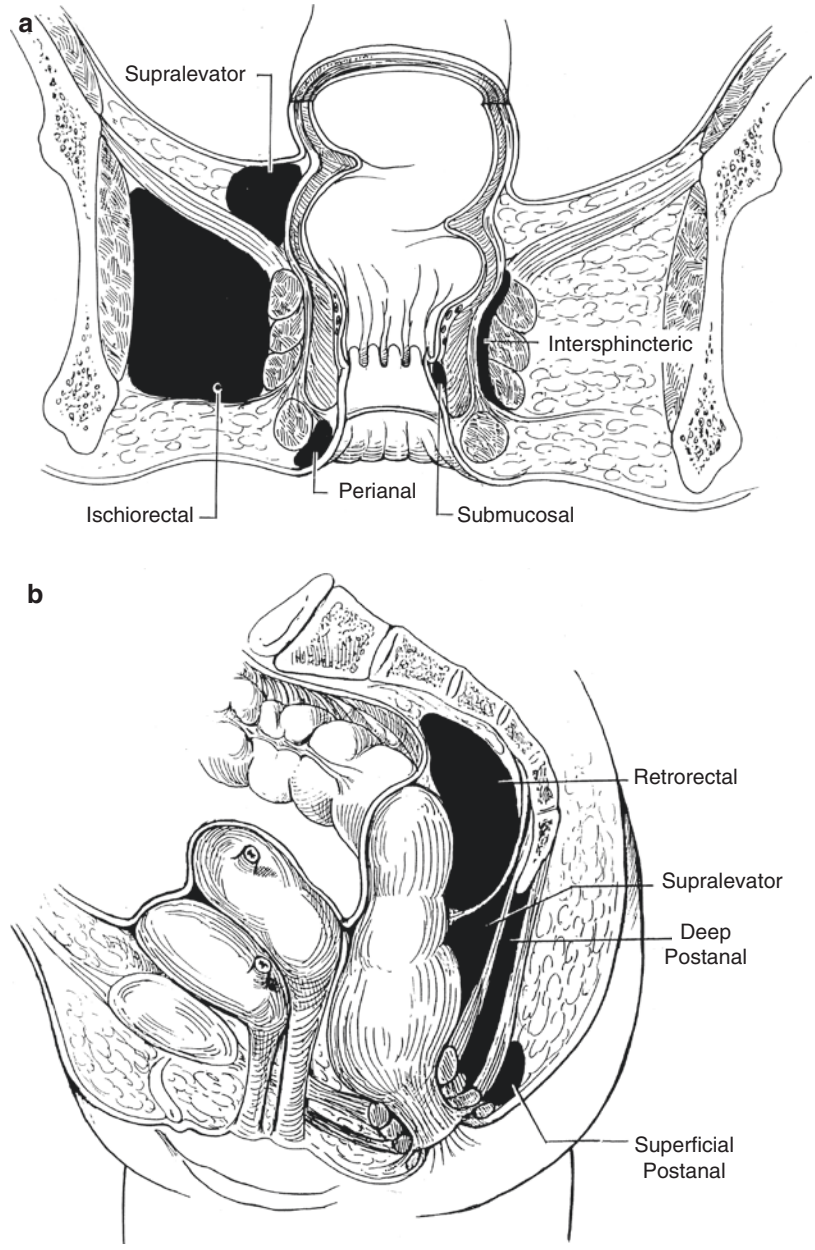


Fig. 10.1 Anorectal spaces. (**a**) Coronal section. (**b**) Sagittal section. From [1]. With permission from David E. Beck, MD

Abscess

Etiology and Pathophysiology

According to the cryptoglandular theory championed by Parks, abscesses result from obstruction of the anal glands and their ducts that drain into the anal crypts at the dentate line tract [6–8]. Obstruction of a duct may result in stasis, infection and formation of an abscess. Persistence of anal gland epithelium in part of the tract between the crypt and the blocked part of the duct results in the formation of a fistula.

Ninety percent of all anorectal abscesses result from non-specific cryptoglandular infec-

tion while the remainder result from the causes as listed in Table 10.1. Anorectal abscess occurs more often in males than females, and may occur at any age, with peak incidence among 20–40-year-olds [9–14].

Table 10.1 Etiology of anorectal abscess

Nonspecific
Cryptoglandular
Specific
Inflammatory bowel disease
Crohn's disease
Ulcerative colitis
Infection
Tuberculosis
Actinomycosis
Lymphogranuloma venereum
Trauma
Impalement
Foreign body
Surgery
Episiotomy
Hemorrhoidectomy
Prostatectomy
Malignancy
Carcinoma—anal, rectal, vaginal, prostate
Leukemia
Lymphoma
Chemotherapy-related immunocompromise
Radiation

Classification

Anorectal abscesses are classified by the anatomic space in which they develop. They are more common in the perianal and ischiorectal spaces and less common in the intersphincteric, supralevator, and submucosal locations (Fig. 10.2) [9, 11–13, 15]. Pus can also spread circumferentially through the intersphincteric, supralevator and ischiorectal spaces, resulting in a horseshoe abscess.

Evaluation

Symptoms

Perianal pain and swelling are common with superficial abscesses while drainage or fever occur less often [11–13, 16]. Deeper abscess, such as those that form in the supralevator or high ischiorectal space, may also present with pain that is sometimes referred to the perineum, low back, or buttocks [15, 17, 18]. Rectal bleeding has been reported. Severe rectal pain accompanied by urinary symptoms such as dysuria, retention or inability to void may be suggestive of an intersphincteric or supralevator abscess. It is always valuable to note the incontinence score prior to and after any fistula surgery [19].

Physical Examination

Physical examination may reveal superficial erythema and fluctuance with tenderness to pal-

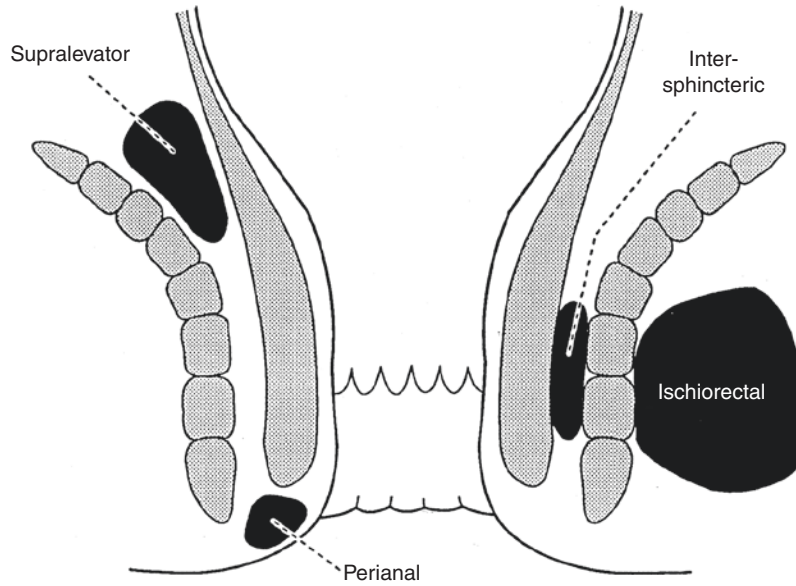


Fig. 10.2 Classification of anorectal abscess

pation or may be unrevealing in patients with deeper abscesses despite the patient's complaint of pain [13, 17, 20, 21]. An inspection will reveal erythema, swelling and possible fluctuance. It is crucial to recognize that visible external manifestations will often be absent with intersphincteric or supralevator abscesses despite the patient's complaint of pain [22]. Although digital examination may not be possible because of extreme tenderness, palpation, if possible, will demonstrate tenderness and a mass. With a supralevator abscess, a tender mass may be palpated on rectal or vaginal examination [2]. While anoscopy or sigmoidoscopy is typically unnecessary in the acute setting, sedation or anesthesia should be considered when these procedures are required. The differential diagnosis of anorectal abscess includes fissure, thrombosed hemorrhoid, pilonidal disease, hidradenitis, Crohn's disease and sexually transmitted infections [20, 21, 23].

Diagnostic Imaging

Superficial abscesses generally do not require diagnostic imaging to guide treatment. Alternatively, imaging with CT, MRI, or ultrasound has proven useful in the assessment of less obvious anorectal abscess, in patients with Crohn's disease, and in patients with recurrent fistulas who have undergone prior fistula surgery [24–27]. In a retrospective study, of patients with confirmed anorectal abscess, the sensitivity of CT was 77% and 70% in immunocompetent and immunocompromised patients, respectively [28]. MR imaging is helpful to define anorectal abscess and fistula. In a 2014 study, the presence and origin of a supralevator abscess was confirmed by MR in 13 patients prior to operation [24]. In another recent study, MR had a positive-predictive value (PPV) of 93% and a negative-predictive value of 90% for anorectal abscess and a sensitivity of over 90% for fistula-in-ano [29].

Representative studies of endoanal ultrasound (EUS), in 2 or 3-dimesions, with or without peroxide enhancement, indicate that this imaging modality is also useful in the diagnosis and classification of anorectal abscess and fistula-in-ano with concordance with operative findings in 73–100% of cases [30–33].

Treatment

General Principles

The cornerstone of treatment of an anorectal abscess is incision and drainage. Watchful waiting under the cover of antibiotics is usually inadequate and may allow the suppurative process to progress resulting in the creation of a more complicated abscess and thus possible injury to the sphincter mechanism. Rarely, delay in diagnosis and management of anorectal abscesses may result in life-threatening necrotizing infection and death [34].

Operative Management

Incision and Drainage

Perianal abscesses can be effectively drained under local anesthesia [2, 13]. The area surrounding the abscess is infiltrated with lidocaine or bupivacaine with epinephrine. A linear or cruciate incision is made and the edges are excised to prevent coaptation which may result in poor drainage or recurrence (Fig. 10.3). Randomized trials that have demonstrated equivalent or superior abscess resolution, with less pain and faster healing, in patients whose wounds are left unpacked [35–37].

Most ischiorectal abscesses can be incised and drained in a similar fashion with the site of incision shifted as close to the anal side of the abscess, minimizing the complexity of a subsequent fistula. Large ischiorectal abscesses may be better drained under general or regional anesthesia since loculations within the cavity can be more easily broken down.

Since the diagnosis of an intersphincteric abscess is entertained when the patient presents with pain out of proportion to the physical findings, an examination under anesthesia is generally required to completely assess the cause of the pain. Once the diagnosis is established, either by palpation of a protrusion into the anal canal or by needle aspiration in the intersphincteric plane, treatment consists of dividing the internal sphincter along the length of the abscess cavity. The wound is then marsupialized to allow adequate drainage and quicker healing.

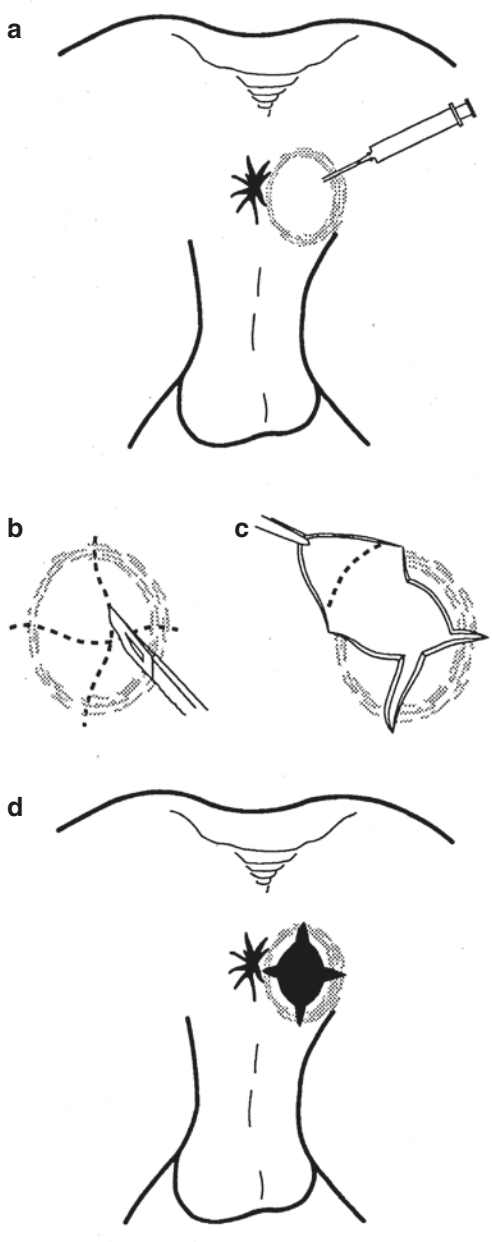


Fig. 10.3 Drainage of abscess. (**a**) Injection of local anesthesia. (**b**) Cruciate incision. (**c**) Excision of skin. (**d**) Drainage cavity

Prior to the treatment of a supralevator abscess, it is essential to determine its origin since it may arise from an upward extension of an intersphincteric or an ischiorectal abscess, or downward extension of a pelvic abscess [38]. The treatment in each case will be different. If the origin is an intersphincteric abscess, it should be drained through the rectum by dividing the internal sphincter and not through the ischiorectal fossa, since this will result in the creation of a suprasphincteric fistula. However, if it arises from an ischiorectal abscess, it should be drained as such and not through the rectum; otherwise an extrasphincteric fistula will occur (Fig. 10.4). This approach was followed by Prasad who, in 1981, reported his results with the treatment of 13 patients with supralevator abscess [15]. All four patients with supralevator abscess that resulted from intersphincteric extension were completely healed after trans-rectal drainage. Of the nine patients with a supralevator abscesses that originated from an ischiorectal source, transperineal drainage led to recurrent abscess in two and fistula in six patients, respectively. If the abscess is of pelvic origin, it may be drained through the rectum, ischiorectal fossa or abdominal wall via percutaneous drainage depending on the direction to which it is pointing.

Horseshoe abscesses should be drained with the patient under a regional or general anesthetic with the patient in the prone jackknife position. This type of abscess develops most often originate in the deep posterior anal space, but may also develop in the deep anterior anal space, and then progress with unilateral or bilateral extension into the ischiorectal spaces [17, 39]. The Hanley procedure, first described in 1965, is a technique for draining the deep post-anal space via major fistulotomy with additional incisions into the ischiorectal spaces as needed to completely drain the abscess [40]. While this procedure has proven effective in the treatment of the horseshoe abscess, it is debilitating, and comprehensive assessment of its impact on long-term anal sphincter function were not included in the larger reported series [17, 39]. A modified Hanley technique, in which a partial sphincterotomy is combined with a seton that is incrementally tightened, is a less destructive but similarly effective means of horseshoe abscess resolution with preservation of anal sphincter function (Fig. 10.5) [17, 41, 42].

Catheter Drainage

An alternative method of treatment for selected patients is catheter drainage. The patient is placed in the lithotomy, prone jackknife, or

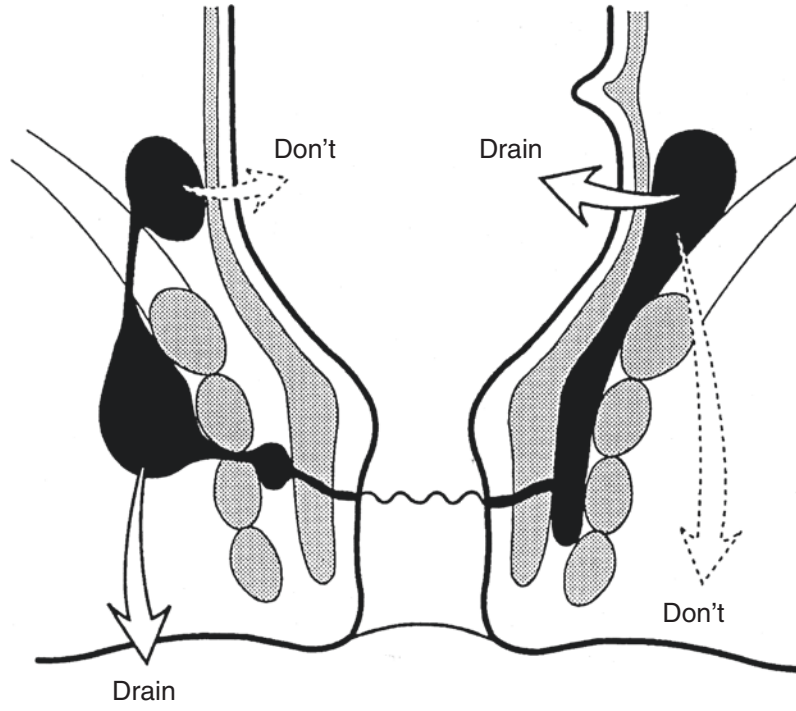


Fig. 10.4 Drainage of a supralevator abscess

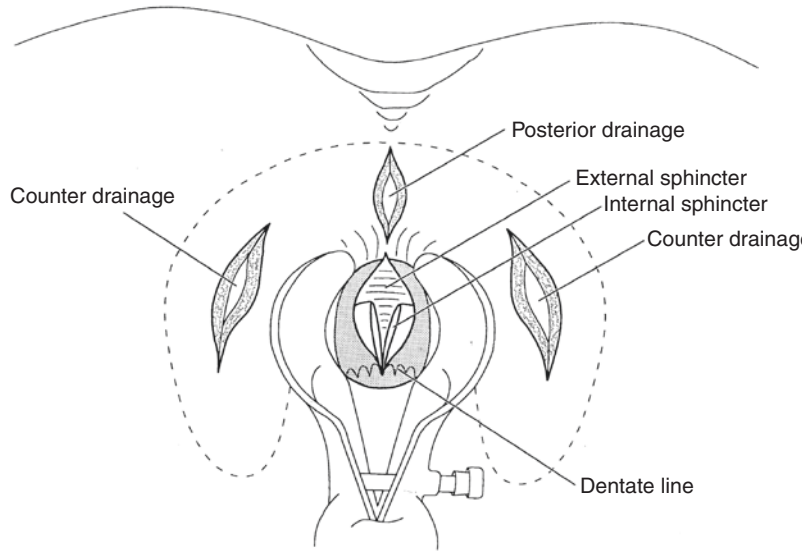


Fig. 10.5 Drainage of horseshoe abscess

lateral (Sim's) position. The skin is prepared with an iodine or alcohol solution and the fluctuant point of the abscess is identified. Local anesthesthetic with epinephrine is injected to create 1 cm wheel in the overlying skin and a 4–6 mm stab incision is made to drain the pus and insert the catheter (Fig. 10.6a). A 10–16 French soft latex mushroom catheter (e.g. Pezzer or Malecot) is inserted over a probe into the abscess cavity. When released, the shape of the catheter tip and the small incision will hold the catheter in place, obviating the need for sutures. The external portion of the catheter is shortened to leave 2–3 cm outside the skin with the tip in the depth of the

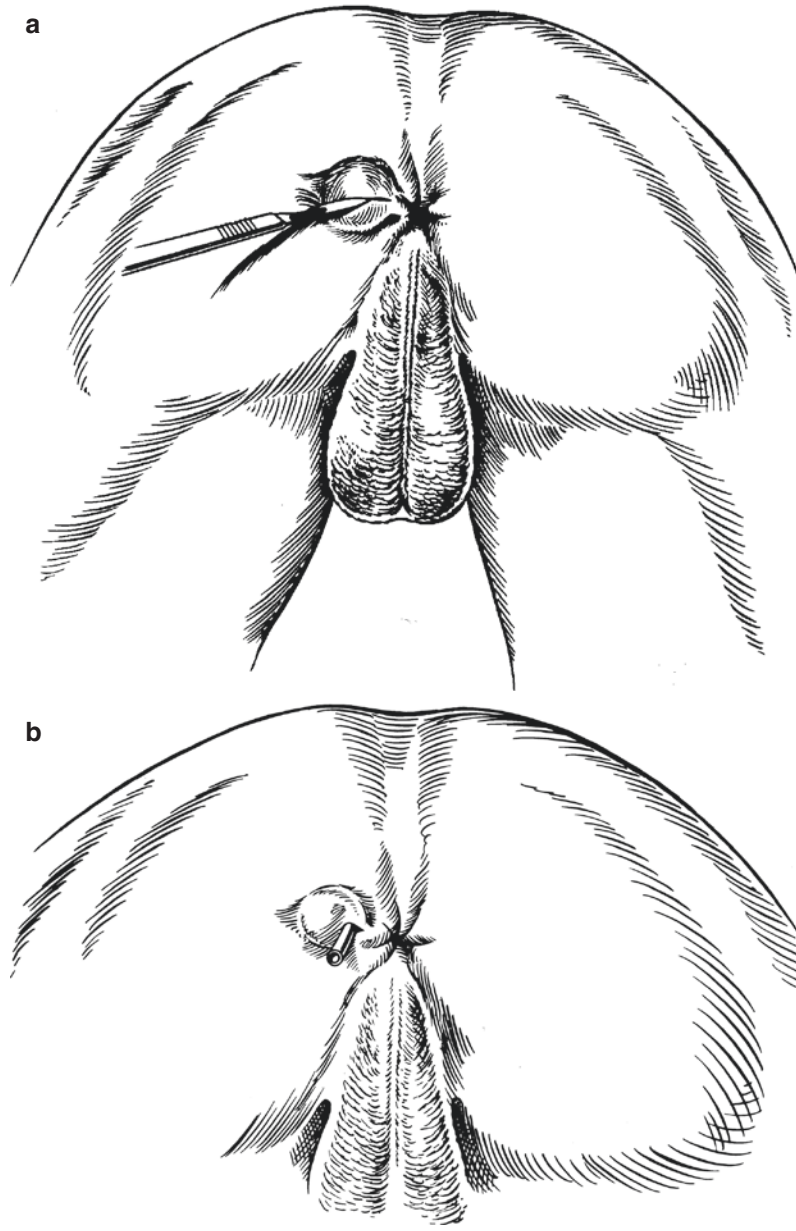


Fig. 10.6 Catheter drainage of an abscess. (**a**) Stab incision. (**b**) Catheter in abscess cavity

abscess cavity (Fig. 10.6b). A small bandage is placed over the catheter.

Several portions of this technique deserve further comment. First, the stab incision should be placed as close as possible to the anus, minimizing the amount of tissue that must be opened if a fistula is found following resolution of inflammation (Fig. 10.6a). Second, the size and length of the catheter should correspond to the size of the abscess cavity (Fig. 10.7a). A catheter that is too small or too short may fall into the wound (Fig. 10.7b). Third, the length of time that the catheter should be left in place requires clinical judgement. Factors involved in this decision should include the size of the original abscess cavity, the amount of granulation tissue around the catheter and the character and amount of drainage. If there is doubt, it is better to leave the catheter in place for a longer period of time. While this technique may not allow for com-

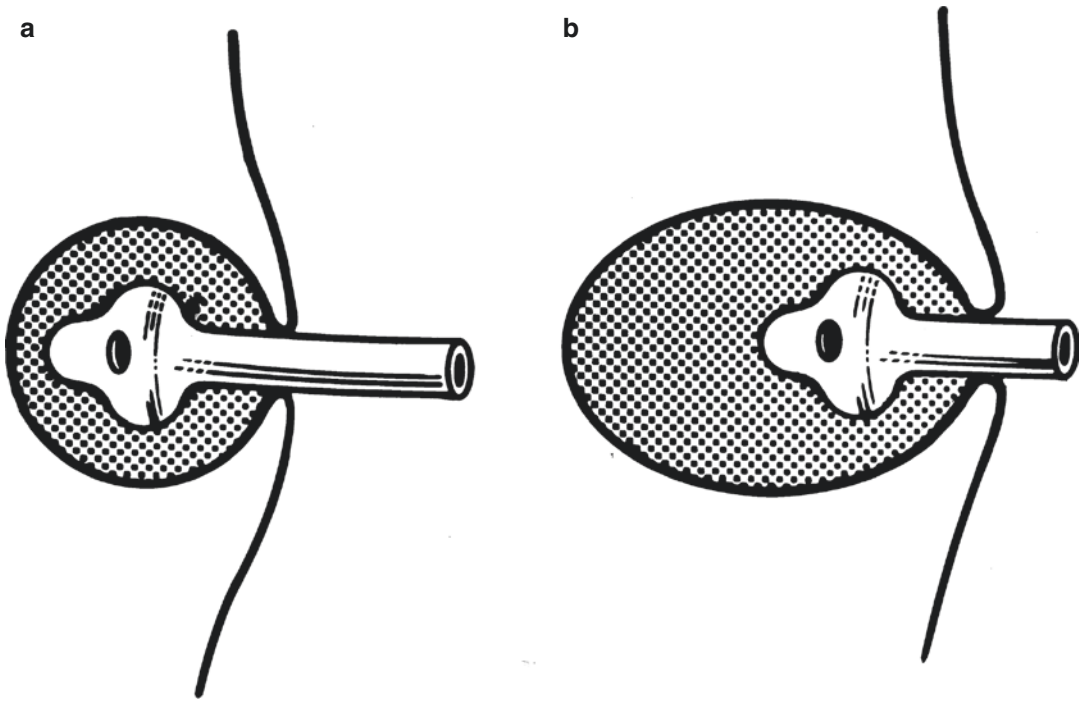


Fig. 10.7 Catheter in an abscess cavity. (**a**) Correct size and length of catheter. (**b**) Catheter too short

plete disruption of loculations within the abscess cavity and generally omits primary fistulotomy, comparative analyses of incision and percutaneous drainage of perianal and other soft-tissue abscess indicate equal efficacy of the two techniques [43–45].

Primary Fistulotomy

A point of controversy is whether primary fistulotomy should be performed at the time of initial abscess drainage. Advocates of this approach note a decreased incidence of recurrent abscess or fistula while opponents counter that division of the anal sphincter in the acute setting may be unnecessary and could result fecal incontinence [11, 46–49]. While fistulotomy would address the offending crypt, edema and inflammation may obscure the location of the internal opening and overzealous probing could create a false opening or a larger wound. In 1997, Ho reported a randomized, prospective trial of incision and drainage *vs.* incision, drainage, and fistulotomy in 52 patients with perianal abscess [47]. These patients underwent anorectal manometry before surgery and at 6 weeks and 12 weeks after surgery. Persistent fistulas developed in 25% of patients after incision and drainage alone and in none of the patients who underwent incision, drainage, and fistulotomy ($P = 0.009$). Further, all of the patients remained fully continent. Schouten also reported a significant decrease in recurrent abscess with primary fistulotomy compared to incision and drainage alone but with a twofold increase in continence disturbances in the fistulotomy patients [48]. A recent Cochrane Review that included 6 trials and 479 patients, demonstrated that sphincter division (fistulotomy or fistulectomy) at the time of incision and drainage was associated with a significant decrease in abscess recurrence, persistent fistula or abscess, and the need for subsequent surgery in comparison to patients who underwent anorectal abscess drainage alone (Relative Risk (RR) = 0.13, 95% CI 0.07–0.24) [50]. However, there was an increased, albeit statistically insignificant, incidence of continence disturbances at

1-year follow-up (RR = 3.06, 95% CI 0.7–13.45). With some evidence showing safety of primary fistulotomy and others undue risk, one may conclude that fistulotomy at the time of abscess incision and drainage can be cautiously performed by surgeons who have a sound understanding on the anorectal anatomy and the implications of fistulotomy. One reasonable approach would be that easily identifiable and superficial fistula tracts, in patients who are continent, are treated with primary fistulotomy. Alternatively, when deep fistula tracts are found, a draining seton, tied loosely in place, is likely a better choice [20].

Antibiotics

In general, the addition of antibiotics to routine incision and drainage of an uncomplicated anorectal abscess in healthy patients does not improve healing or reduce recurrence and is not generally recommended. However, selective use of antibiotics for patients with anorectal abscess complicated by cellulitis, systemic illness, or immunosuppression is recommended [13, 20, 51, 52]. Evidence supporting this approach may be gleaned from a recent retrospective study of 172 patients with uncomplicated anorectal abscess in which the outcomes of incision and drainage alone were compared with incision and drainage plus 5–7 days of oral antibiotic therapy [53]. Nine percent of patients had recurrent abscess, with no difference between the treatment groups. However, among patients with anorectal abscess complicated by surrounding cellulitis, induration or systemic sepsis, there was a twofold increase in recurrent abscess in patients who were not treated with antibiotics.

Postoperative Care

Patients are instructed to continue with a regular diet and to take a bulk-forming agent, narcotic analgesic as needed, and Sitz baths. Those patients in whom catheter drainage has been performed are seen within 7–10 days post procedure. If the cavity has closed around the catheter and drainage has ceased, the catheter is removed. If the cavity has not healed, the catheter is left in place or replaced with a smaller one. In all cases, patients are seen periodically until complete healing has occurred.

Complications

Recurrent Abscess

Recurrent abscess occurs in up to 44% of patients, most often within 1 year of initial treatment [13, 46, 48, 53–55]. Inadequate drainage, missed loculations, horseshoe type abscess, and failure to perform primary fistulotomy have been identified as risk factors for recurrent anorectal abscess [17, 48, 54]. In cases of recurrent abscess, extra-anal disease should be considered once the usual causes of recurrence have been ruled out. Hidradentis suppurativa and downward extension of a pilonidal abscess should be considered [2]. A prospective review of recurrent anorectal abscesses by Chrabot et al. reported hidradenitis in one third of patients with recurrent abscesses [16]. In addition the possibility of Crohn's disease should be suspected.

Incontinence

Incontinence may result after incision and drainage of an abscess either from iatrogenic damage to the sphincter or inappropriate wound care. Continence may be compromised if the superficial external sphincter is inadvertently divided during drainage of a perianal or deep postanal abscess in a patient with preoperative borderline continence. Drainage of a supralevator abscess may lead to incontinence if the puborectalis is inappropriately divided [56]. Prolonged packing of a drained abscess may impair continence by preventing the development of granulation tissue and promoting the formation of excess scar tissue [57].

Although advocated to decrease recurrence rates, primary fistulotomy may result in unnecessary division of sphincter muscle in acutely inflamed tissue. Schouten and van Vroonhoven reported a 39% rate of continence disturbances in a prospective randomized trial [48]. However, as described above, other reports and a recent meta-analysis reached different conclusions about primary fistulotomy and fecal incontinence.

Special Considerations

Necrotizing Anorectal Infection

Although initially described by Fournier in 1883 as the sudden onset of a rapid progression of gan-

grene without cause in healthy young men, the definition has been expanded to include a synergistic necrotizing fasciitis of the perineum, external genitalia and perianal area affecting men women and rarely children [58]. In fact, recent reports have noted an increasing age in patients with Fournier's gangrene [59]. Contrary to the original description, the septic focus can usually be traced to the urinary tract, anorectal area or local skin trauma [58]. Perianal and rectal causes have been found in one study to be the most common sites of origin [60]. Anorectal abscess, hemorrhoid banding, rectal carcinoma in association with radiotherapy, anal dilatation, rectal biopsy and rectal perforation by foreign body have been implicated as antecedent events [58, 60]. Pre-disposing co-morbidities such as diabetes, alcohol abuse, obesity, hypertension, renal insufficiency, malnutrition, leukemia and HIV infection have been associated with this infection. It is thought that impaired cellular immunity and thus impaired host resistance to invasion by polymicrobial organisms and their produced exotoxins result in tissue necrosis [58]. This in conjunction with thrombosis of small superficial blood vessels subsequently result in gangrene of the overlying skin [61].

Symptoms and Signs

Spreading soft tissue infection of the perineum can be classified into two groups [62]. The first group includes anorectal sepsis in which the infection extends superficially around the perineum resulting in necrosis of skin, subcutaneous tissue, fascia or muscle. Perianal crepitation, erythematous, indurated skin, blistering or gangrene may be present. A black spot may appear early and indicates a necrotizing infection (Fig. 10.8) [63]. The second group includes sepsis in which the preperitoneal or retroperitoneal spaces have become involved. Subtle signs may be present which include abdominal wall induration, tenderness or a vague mass. It is important to realize that systemic symptoms of septic shock may precede the appearance of overt signs of infection [64]. CT scan is an excellent diagnostic modality since it demonstrates the origin as well as the extent of infection [65].

Treatment

Early recognition and aggressive surgical debridement as well as selection of the appropriate antibiotics result in a decrease in mortality [66]. The mean interval from onset of symptoms to surgical intervention is seen as the most important prognostic factor with a significant impact on outcome [66]. Patients should be resuscitated in an ICU setting with vigorous intravenous fluid hydration, restoration of electrolyte balance and insertion of a Foley catheter. Accompanying coagulopathy, respiratory insufficiency and renal failure must be aggressively treated. Invasive monitoring and ventilatory support may be necessary [67]. Pus or necrotic tissue from the infected region must be cultured for aerobes and anaerobes. A Gram stain can be used to distinguish between the presence of clostridial and non-clostridial organisms [68]. Empiric broad-spectrum antibiotic therapy should be instituted regardless of Gram stain and culture results. The chosen antibiotic regimen should be effective against staphylococci and streptococci, gram-negative coliforms, Pseudomonas, Bacteroides and Clostridium. Recently Methicillin-resistant S aureus has emerged as an etiological microbe associated with a severe clinical course and fulminant sepsis [59]. A multi-antibiotic regimen including a carbapenem or beta lactam beta lacatamase inhibitor (e.g. piperacillin-tazobactam), clindamycin, and an anti-MRSA antibiotic (e.g. vancomycin) should be used until cultures dictate otherwise [69]. Tetanus toxoid should also be considered [67].

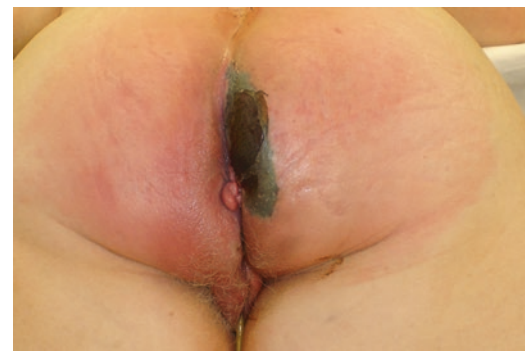


Fig. 10.8 Necrotising anorectal infection

Surgical treatment must be prompt and aggressive consisting of wide radical debridement until healthy tissue is encountered. The goals of surgical debridement are to remove all nonviable tissue, halt the progression of infection and alleviate the systemic toxicity [64]. It is crucial to realize that the preoperative skin changes may be minimal compared to the operative findings which may include edema, liquefactive necrosis of subcutaneous tissues, watery pus formation and extensive necrosis of underlying fascia [67]. Re-examination under anesthesia is usually necessary to ensure that all devascularized tissue has been removed since this is the only manner by which adequate wound examination can be conducted [67]. Vacuum assisted closure of the resulting wounds may be a useful adjunct in healing of these wounds which may be rather extensive [70]. The use of multiple radial incisions and placement of loose draining setons has been proposed to avoid the massive excision of tissue and resulting deformities that may occur with recovery [71]. The need for colostomy is a debatable issue and has been recommended if the sphincter muscle is grossly infected, if there is colonic or rectal perforation, if the rectal wound is large, if the patient is immunocompromised or if incontinence is present [62, 64]. While some authors [68] feel that colostomy creation is seldom necessary, a "medical colostomy" consisting of enteral or parenteral nutrition in addition to the careful placement of a sealed rectal catheter drainage may be adequate. Controversy also exists with regards to the need for urinary diversion by suprapubic catheterization. It has been suggested that this may be indicated in the presence of known stricture and urinary extravasation with phlegmon.

Although antibiotics and aggressive surgical drainage are the mainstay of treatment, the use of hyperbaric oxygen (HBO) has been advocated as an adjunct particularly in patients with diffuse spreading infections who do not have chronic obstructive pulmonary disease [72]. While it is postulated that HBO has a direct antibacterial effect on anaerobic bacteria, diminishing the effect of endotoxins, optimizing leukocyte phagocytic function [63] and promoting healing by facilitating fibroblast proliferation [72], its use remains controversial [60]. It is expensive, not readily available and has not shown to be advantageous in terms of reducing morbidity and mortality [58].

Despite aggressive surgical and multidisciplinary management of anorectal sepsis, mortality rates as few as 3% to as many as 45% have been reported [58, 73]. Retrospective studies have suggested that poor prognosis could be correlated with increasing age, diabetes, delay in presentation and treatment and extent of soft tissue involvement [58, 64]. The Fournier's Gangrene Severity Index (FGSI) was developed to stratify risk in this patient population. This is a numerical score that combines nine physiological parameters such as temperature, heart rate, respiratory rate, and serum levels of sodium, potassium, creatinine, white blood cell count, hematocrit and sodium bicarbonate. A FGSI greater than 9 was predictive of a 75% probability of mortality while a score of less than 9 predicted a 78% probability of survival [73]. This was corroborated by another study which also found that extent of disease beyond the perineum as well as serum creatinine, bicarbonate, lactate and calcium were associated with a poor prognosis [61]. This high mortality rate is due in part to the aggressive nature of the infection and to the underlying co-morbid diseases that are present in these patients [64].

Anal Infection and Hematologic Diseases

The reported incidence of perianal sepsis in patients with hematological diseases ranges from 5–10% [74–76]. The most significant risk factor for the development of perianal infection is a low neutrophil count [74]. Although the underlying pathophysiology relating to cryptoglandular infection is the same as in the immunocompetent patient, the lack of neutrophils impairs the formation of pus and as a result, the clinical manifestations may be modified. Thus, rather than present with fluctuance, these patients will present with diffuse swelling, edema and erythema in addition to pain. Perianal infection in neutropenic (ANC < 500 cells/mm^3) patients has been

found to occur more often in males younger than 40 years of age [77]. These infections are often difficult to diagnose due to lack of typical findings. In addition, consensus guidelines generally prohibit digital rectal examination in neutropenic patients thus causing clinicians to be reluctant to examine the anorectal area for occult infection for fear of provoking bacteremia [78]. As a result an accurate diagnosis is made only in 50% of patients [34]. Untreated sepsis leads to high mortality rates reportedly as high as 59% [79]. The use of CT and MR imaging have been advocated as useful adjuncts to confirm the presence of occult infection [80]. A greater local inflammatory reaction has been found in association with perianal sepsis in the immunocompromised patient on MR [80]. In the absence of clinical features of abscess, imaging studies serve as a guide to management [74].

Management

Neutropenic patients with perianal pain are assumed to have perianal infection and are started on precautionary measures which consist of no digital rectal examinations, suppositories, or enemas [78, 81]. Sitz baths, stool softeners, bulk agents and analgesia are advised. Acutely ill or otherwise high-risk patients are treated empirically with an anti-pseudomonal beta-lactam drug such as cefepime, a carbapenem, or piperacillin-tazobactam with the addition of other antibiotics as dictated by the results of microbiology cultures or in response to other clinical clues [78].

Since these infections have been found to be due to E. Coli and group D streptococcus [82] they are best managed with a third-generation cephalosporin combined with anaerobic coverage or an extended spectrum penicillin in combination with an aminoglycoside and an anti-anaerobic antibiotic. This combination has been associated with an 88% success rate [82]. Although in the past, an aggressive surgical approach has been advocated [75], subsequent studies have demonstrated a poorer outcome following surgical treatment of anorectal sepsis in the neutropenic patient [79] associating this approach with poor wound healing, expanding soft tissue infection or recurrence [82]. Thus a highly selective approach is advocated reserving surgery for those patients with fluctuance, non-improvement with conservative treatment and in those patients who deteriorate developing soft tissue necrosis [74].

Patients managed conservatively require close monitoring until they improve or develop fluctuance at which time they should be drained in order to avoid the rare development of necrotizing fasciitis [83].

In the past, radiation therapy has been mentioned in the treatment of perianal sepsis in the severely neutropenic patient [81]. However a randomized controlled study failed to confirm the utility of this approach [84].

Fistula-in-Ano

Pathophysiology

Etiology

A fistula is defined as an abnormal communication between any two epithelium-lined surfaces. A fistula-in-ano is an abnormal tract or cavity communicating with the rectum or anal canal by an identifiable internal opening. As outlined previously, most fistulas are thought to arise due to cryptoglandular infection.

Classification

A simple and often used classification of fistula-in-ano is that described by Parks et al. [38]. Intersphincteric and transphincteric fistulae are more frequently encountered than suprasphincteric, extrasphincteric, and submucosal types [12, 38, 85, 86]. Intersphincteric fistula are the sequelae of a perianal abscess. The tract passes within the intersphincteric space (Fig. 10.9a). Transphincteric fistula-in-ano develop from an ischiorectal abscess. The tract passes from the internal opening through the internal and external sphincters to the ischiorectal fossa (Fig. 10.9b). Suprasphincteric Fistula-in-Ano results from a supralevator abscess. The tract passes above the puborectalis after arising as an intersphincteric abscess. The tract curves downward lateral to the external sphincter in the ischiorectal space to the perianal skin (Fig. 10.9c). A high blind

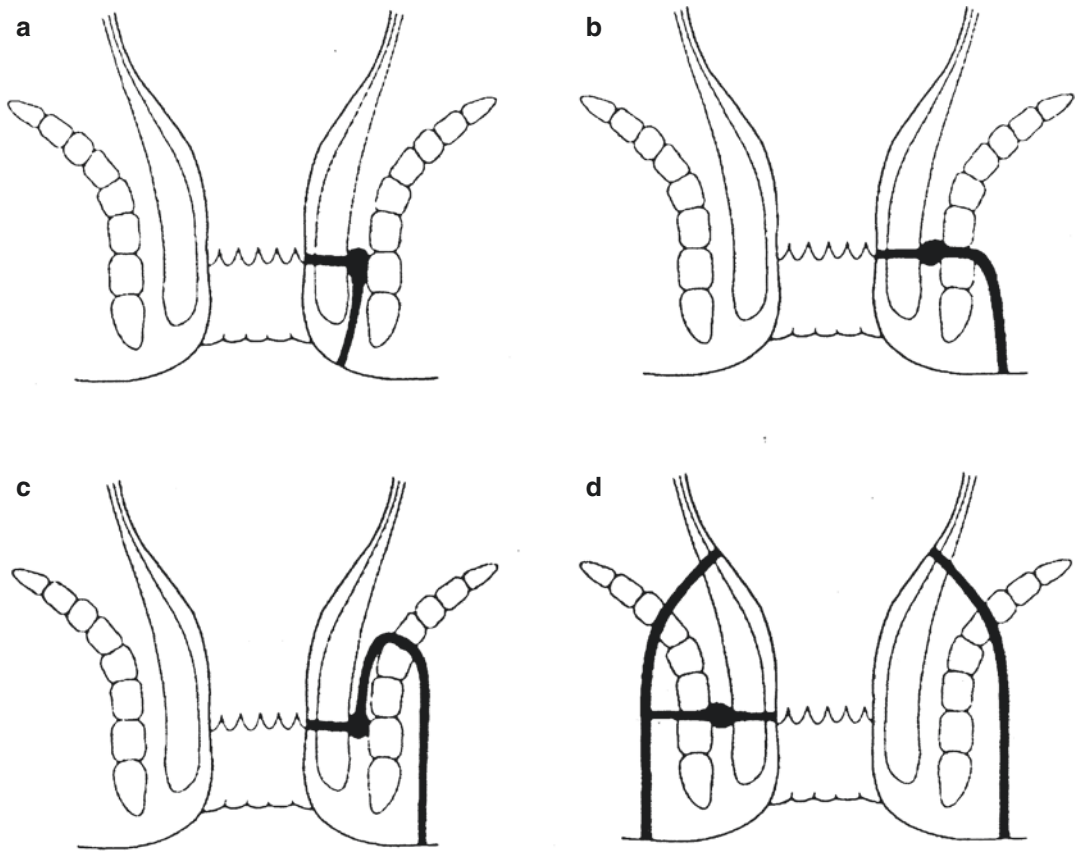


Fig. 10.9 Classification of fistula-in-ano. (**a**) Intersphincteric. (**b**) Transsphincteric. (**c**) Suprasphincteric. (**d**) Extrasphincteric

tract may also occur in this variety and result in a horseshoe extension. Extrasphincteric Fistula-in-ano pass from the rectum above the levators and through them to the perianal skin via the ischiorectal space (Fig. 10.9d). This fistula may result from foreign body penetration of the rectum with drainage through the levators, from penetrating injury to the perineum, or from Crohn's disease or carcinoma or its treatment. However, the most common cause may be iatrogenic secondary to vigorous probing during fistula surgery.

Fistula-in-ano may also be classified as "simple" or "complex". Complex anal fistula include transphincteric fistula that involve greater than 30% of the external sphincter, suprasphincteric, extrasphincteric, or horseshoe fistula, and anal fistula associated with inflammatory bowel disease, radiation, malignancy, preexisting fecal incontinence, or chronic diarrhea [38, 87–91]. Simple anal fistulae have none of these complex features and generally include intersphincteric and low transphincteric fistula that involve <30% of the sphincter complex. Given the attenuated nature of the anterior sphincter complex in women, fistulae in this location deserve special consideration and may also be considered complex.

Evaluation

Symptoms

A patient with a fistula-in-ano will often recount a history of an abscess that has been drained either surgically or spontaneously. Patients may complain of drainage, pain with defecation, bleeding due to the presence of granulation tissue at the internal opening, swelling or decrease in

pain with drainage. Additional bowel symptoms may be present when the fistula is secondary to proctocolitis, Crohn's disease, actinomycosis or anorectal carcinoma [92].

Physical Examination

The external or secondary opening may be seen as an elevation of granulation tissue discharging pus. This may be elicited on digital rectal examination. In most cases, the internal or primary opening is not apparent. The number of external openings and their location may be helpful in identifying the primary opening. According to Goodsall's rule (Fig. 10.10), an opening seen posterior to a line drawn transversely across the perineum will originate from an internal opening in the posterior midline. An anterior external opening will originate in the nearest crypt. Generally, the greater the distance from the anal margin, the greater the probability of a complicated upward extension. Cirocco found that Goodsall's rule was accurate in describing the course of anal fistulas with a posterior external opening [93]. It was inaccurate in patients with anterior external openings since 71% of these fistulas tracked to a midline anterior primary opening. This was especially true in women in whom fistulas with anterior external openings tracked in a radial fashion in only 31%.

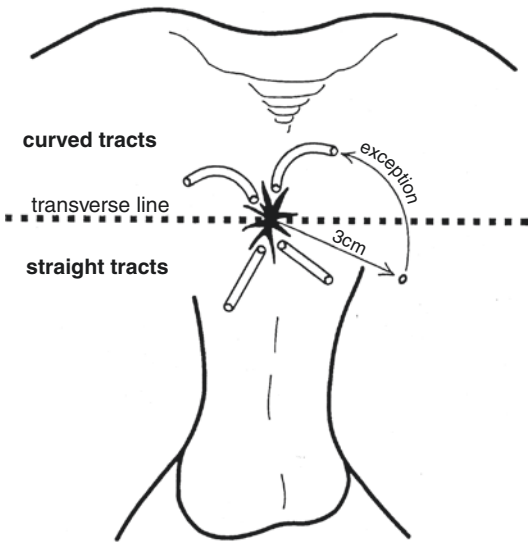


Fig. 10.10 Goodsall's rule

Digital rectal examination may reveal an indurated cord-like structure beneath the skin in the direction of the internal opening with asymmetry between right and left sides. Internal openings may be felt as indurated nodules or pits leading to an indurated tract. Posterior or lateral induration may be palpable indicating fistulas deep in the postanal space or horseshoe fistulas. Bidigital rectal examination will define the relationship of the tract to the sphincter muscles and provides information as to preoperative sphincter tone, bulk and voluntary squeeze pressure which need to be assessed preoperatively because of a possible risk of incontinence with sphincter division. Anoproctoscopy should be done prior to operation in an attempt to identify the primary opening. Sigmoidoscopy, colonoscopy, and CT, MR, or ultrasound imaging should be considered in patients who have symptoms suggestive of inflammatory bowel disease and in patients with multiple or recurrent fistulas. Although anal manometry is not generally required, it may be useful as an adjunct to planning the operative approach in a women with previous obstetric trauma, in an elderly patient, a patient with Crohn's disease or AIDS, or in a patient with a recurrent fistula [94].

Imaging

Simple fistula-in-ano generally do not require diagnostic imaging to guide treatment. Alternatively, ultrasound, MRI, or fistulography, has proven useful in the assessment of occult anorectal complex or, in patients with Crohn's disease, and in patients with recurrent fistulas who have undergone prior fistula surgery [24–27, 95]. In a study of 54 patients with perianal Crohn's disease in which MRI and operative/clinical findings were compared, all of the abscesses and 82% of the fistulas were correctly identified by MRI [96]. In another 2014 study, MRI had a positive-predictive value (PPV) of 93% and a negative-predictive value of 90% for anorectal abscess and a sensitivity of over 90% for fistula-in-ano [29].

Representative studies of endoanal ultrasound (EUS), in 2 or 3-dimesions, with or without peroxide enhancement, indicate that this imaging modality is also useful in the diagnosis and classification of anorectal abscess and fistula-in-ano

with concordance with operative findings in 73–100% of cases (Fig. 10.11) [30–33, 97]. Transperineal ultrasound (TPUS), a non-invasive alternative to EUS, has been shown to accurately identify the presence of in anorectal abscess and fistula [98–101].

In 2004, Buchanan performed a comparison of limited clinical examination (awake, no probing), EUS, and MRI in patients with fistula-in-ano and determined that these modalities accurately classified the fistula in 61%, 81%, and 90% of patients, respectively [30]. A meta-analysis of MRI and EUS for the assessment of fistula-in-ano indicated that the sensitivity of MRI and EUS were 87% and 87% and their specificity were 69% and 43%, respectively [102].

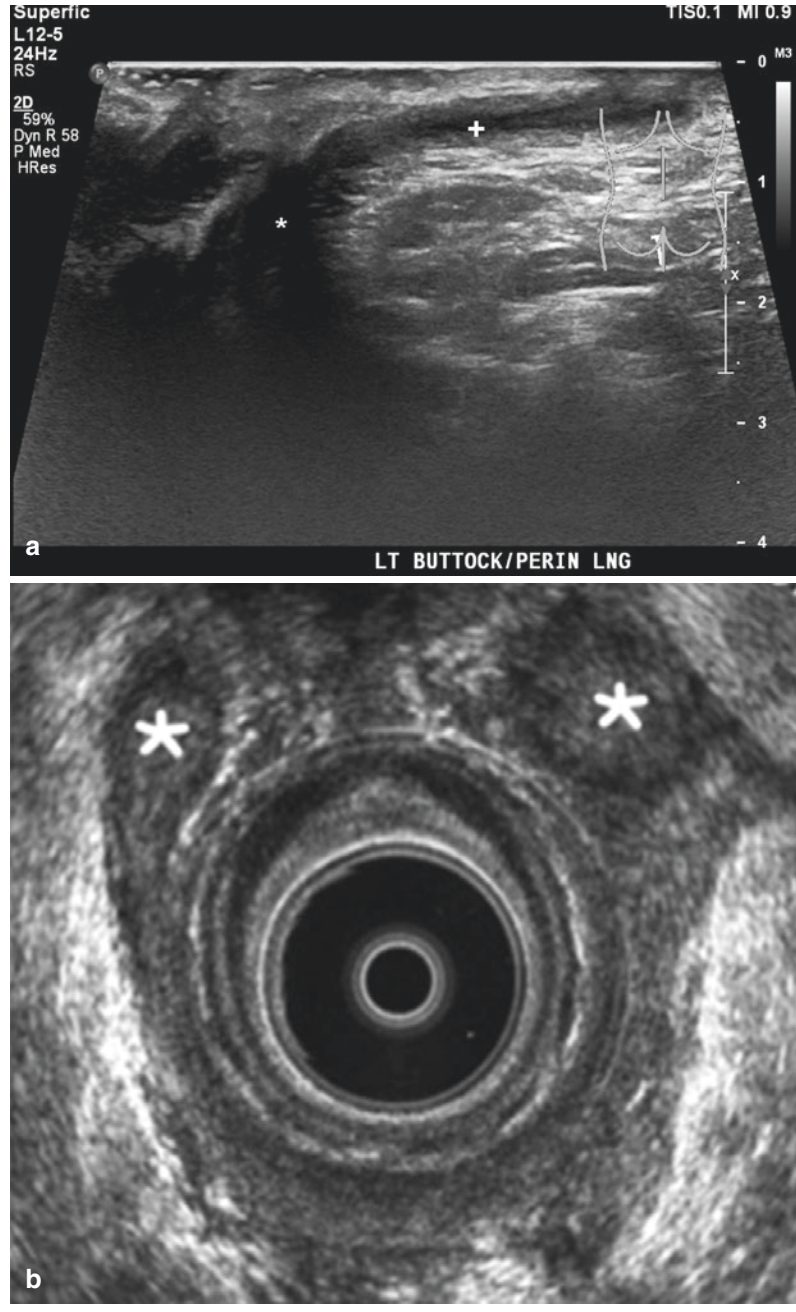


Fig. 10.11 Anal endosonogram. (**a**) Longitudinal ultrasound image of the medial left buttock; * denotes air in the anus; + denotes a hypoechoic perianal fistula extending to the skin surface caudad to anus. (**b**) Horseshoe abscess. * Presence of horseshoe abscess around the anal canal

Fistulography, contrast injection of the fistula under fluoroscopy, may also be an effective means of studying an anal fistula with concordance with operative findings demonstrated in 89% of cases [103]. In a recent study, fistulography accurately identified the primary fistula tract, internal opening, secondary tracts, and associated abscess in 100%, 74%, 92%, and 88% of patients, respectively [32]. Finally, the added value of combining diagnostic modalities to enhance the accuracy of anal fistula assessment was exemplified in a 2001 study of 34 patients with perianal Crohn's disease in which EUS, MRI, and exam under anesthesia were accurate in 91%, 87%, and 91% of patients, respectively, whereas 100% accuracy was achieved with the combination of any two techniques [26].

Treatment

General Principles

The principles of fistula surgery are to eliminate the fistula, prevent recurrence, and preserve sphincter function. Success is usually determined by identification of the primary opening and dividing the least amount of muscle possible. Defining the anatomy of the fistula tract may be facilitated by inspection and palpation, passage of a probe or probes from the external opening to the internal opening or vice-versa injection of a dye such as dilute solution of methylene blue or hydrogen peroxide and noting their appearance at the dentate line. Cut through the skin and subcutaneous fat overlying the tract and lateral to the sphincter complex and then following the tract medially [92]. In addition, attention to preoperative imaging studies, such as with MR, have been shown to complement the examination findings and result in improved outcomes of anal fistula surgery [30].

Operative Management

Fistulotomy

Fistulotomy is an effective and appropriate treatment for most simple anal fistula and results in healing in over 90% of patients [85, 86, 104, 105]. Fistulotomy failures have been associated with complex types of fistula, failure to identify the internal opening, and Crohn's disease [105, 106]. Recent, prospective multicenter studies indicate that when fistulotomy is used for simple (low) anal fistula, in properly selected patients, the risk of fecal incontinence is minimal or none [85, 86, 104]. Risk factors for post-operative anal sphincter dysfunction include pre-operative incontinence, recurrent disease, female gender, complex fistulas, and prior fistula or anorectal surgery [105, 107–109]. Interventions *other* than fistulotomy are generally recommended in patients with anal fistula and these risk factors.

Preparation for fistulotomy surgery is minimal and may include an enema cleansing of the distal colon and rectum immediately before the operation. Fistulotomy is performed with the patient positioned in the prone jackknife or high lithotomy position following induction of a regional anesthetic. Local anesthetic (e.g. bupivacaine with epinephrine) is injected along the fistula tract. Digital rectal examination and anoproctoscopy are performed. A probe is inserted from the external opening along the tract to the internal opening at the dentate line. The amount of sphincter muscle overlying the fistula tract is assessed. If, in fact, less than one-third of the sphincter will divided with a fistulotomy, the tissue overlying the probe is incised and the granulation tissue curetted and sent for pathologic evaluation. A gentle probe is used to identify any high blind tracts or extensions, which are unroofed, if found. If desired, the wound may be marsupialized on either edge by sewing the edges of the incision to the tract with a running locked absorbable suture. Marsupialization of the wound edges after fistulotomy has been associated with less post-operative bleeding and accelerated wound healing [110, 111]. Marsupialization may also reduce the need for post-operative analgesics [112]. There is no need to insert packing if an adequate unroofing has been accomplished (Fig. 10.12a–c). In recent, large studies, perioperative complications of fistulotomy occurred in 25–9% of patients, most often limited to minor infection, urinary retention, or bleeding [85, 86, 104].

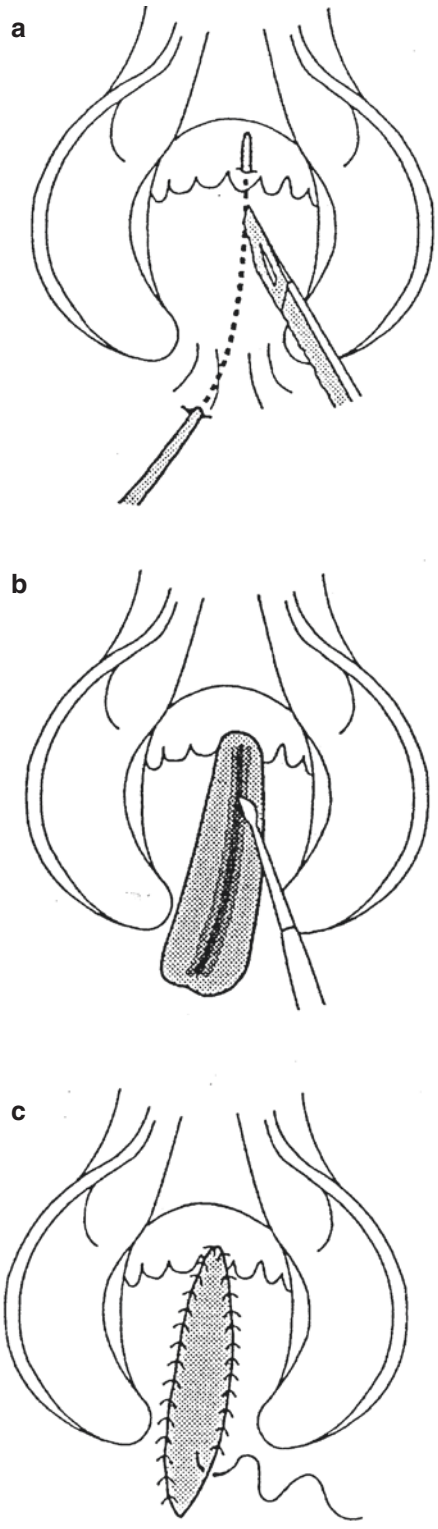


Fig. 10.12 Anal fistulotomy. (**a**) Insertion of probe and incision of tissue overlying probe. (**b**) Curettage of granulation tissue. (**c**) Marsupialization of wound edges

The reported incidence of fecal incontinence after fistulotomy is quite variable, from very few patients to as many as 80% and depends on many factors including baseline anal sphincter function, prior anorectal surgeries, fistula type, and amount of sphincter muscle that is divided [49, 85, 86, 104, 105, 107, 109, 113]. In 2014, the results of a 2014, multicenter, retrospective study, that included 537 patients with a "low perineal fistula" (less than one-third of the sphincter complex involved), who underwent fistulotomy, reported major post-procedure fecal incontinence in 28% of patients [113]. On the contrary, recent prospective multicenter studies indicate that when fistulotomy is used for simple (low) anal fistula, in properly selected patients, the risk of fecal incontinence is minimal or none [85, 86, 104].

Staged Fistulotomy

Staged fistulotomy involves the use of a draining or cutting seton (e.g. silk suture, silastic vessel loop) to gradually divide the fistula tract is an alternative to one-stage fistulotomy that may also be considered (Fig. 10.13). This technique was used in a recently reported series of 200 patients in whom a suture seton was tightened every 6–8 weeks, in preparation for a superficial or "controlled" fistulotomy [114]. Healing occurred in 94% of patients with only minor disturbances in anal sphincter function in 4% of patients. Additional, recent retrospective studies of cutting setons for transphincteric or other complex cryptoglandular fistula have also demonstrated fistula healing in over 90% of patients and preservation of anal sphincter function in the majority of patients [115, 116]. Horseshoe abscess and fistulae that arise from them are well treated with the staged fistulotomy technique. Treatment consists of identification of the internal opening and proper drainage of the postanal space as was previously described. The horseshoe extensions are enlarged for counter-drainage and the granulation tissue is curetted. The Hanley procedure, first described in 1965, is a technique for draining the deep post-anal space via major fistulotomy with additional incisions into the ischiorectal spaces as needed to completely drain the abscess [40]. While this procedure has proven effective in the treatment of the horseshoe abscess, it is

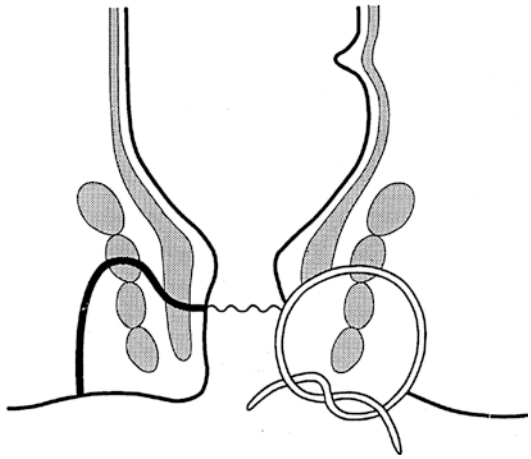


Fig. 10.13 Anal seton

debilitating, and comprehensive assessment of its impact on long-term anal sphincter function were not included in the larger reported series [17, 39]. A modified Hanley technique, in which a partial sphincterotomy is combined with a seton that is incrementally tightened, is a less destructive but similarly effective means of horseshoe abscess resolution with preservation of anal sphincter function [17, 41, 42].

Endoanal Advancement Flap

Endoanal advancement flap (Fig. 10.14a–d) is a sphincter-sparing technique that consists of curettage of the fistula tract, suture closure of the internal opening, and mobilization of a segment of proxi-

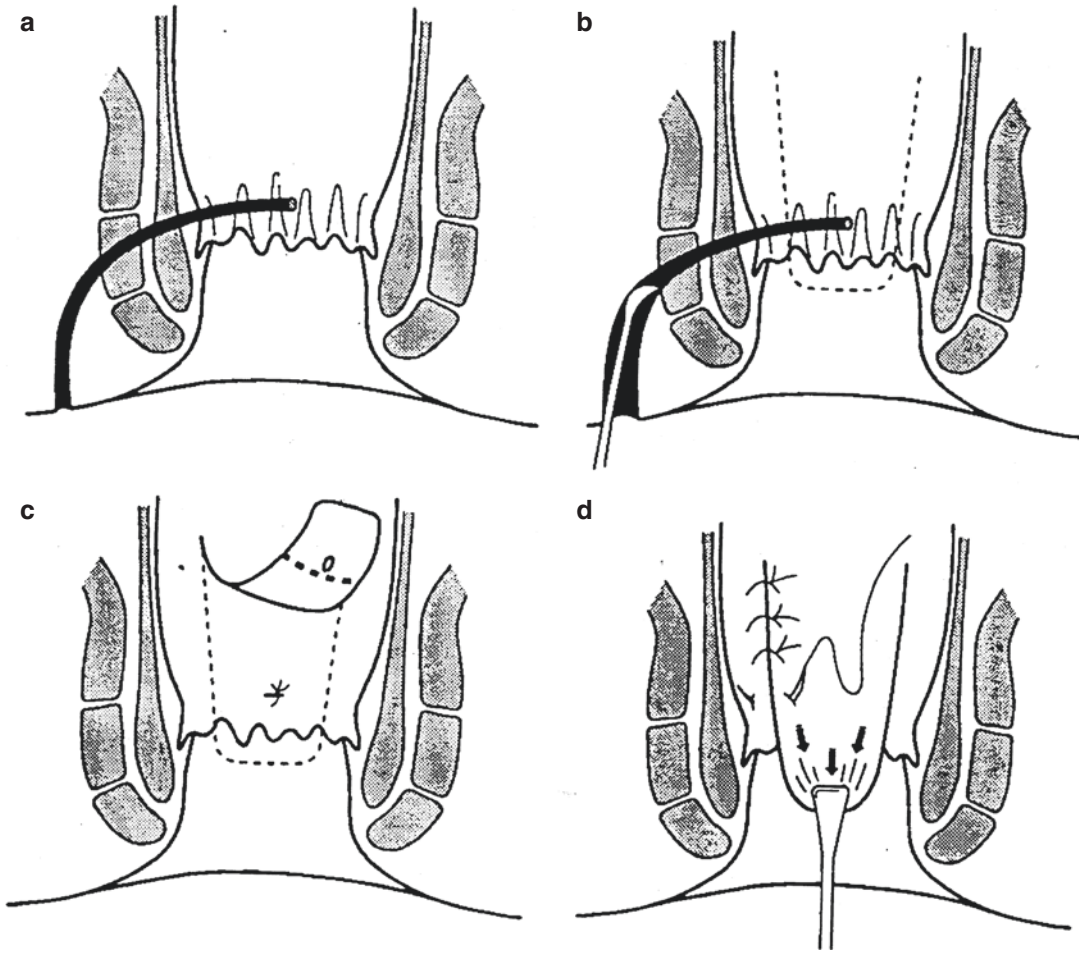


Fig. 10.14 Endorectal advancement flap, (**a**) Transphincteric fistula-in-ano. (**b**) Enlargement of external opening. (**c**) Flap of muscle and muscle is mobilized. (**d**) Flap is advanced, the distal tip is removed, and the flap is sutured in place

mal healthy anorectal mucosa, submucosa, and muscle to cover the site. Preoperative mechanical bowel preparation is usually performed. Patients are positioned in the lithotomy or prone-jackknife position depending on the location of the fistula. Perioperative prophylactic broad-spectrum antibiotics are used. With endoanal flap creation, the aim is to create a well-perfused, tension-free flap that covers the closed internal opening. Width of the flap base two to three times greater than the width of the flap apex has been recommended to ensure adequacy of flap perfusion [117]. It is the preference of one of the editors (SDW) to perform an elliptical sliding flap rather than incising the sides of the flap. Postoperative antibiotic use and dietary and activity restrictions aimed at improving healing are advocated by some surgeons but not by others without good evidence to support either approach [118–120]. Reports indicate healing in 66–87% after initial endoanal advancement flap for cryptogalndular fistula [108, 118, 119, 121–123]. Among those patients with recurrence, successful healing may be achieved with repeat advancement flap procedures [118]. Factors associated with failed repair include prior radiation, underlying Crohn's disease, active proctitis, rectovaginal fistula, malignancy, obesity, and the number of prior attempted repairs [88, 105, 120, 122, 124–127]. Complications of endoanal advancement flap, such as flap disruption or urinary retention, are infrequently reported and may be expected to occur in 3–12% of patients [118, 121, 128]. Although the sphincter is not divided per se during flap formation, internal sphincter fibers may be included in the flap and mild to moderate incontinence is reported in the range of 0–35% of patients, with an average incidence of 12% in a 2010 systematic review of 35 studies [123]. One of the editors (SDW) prefers an elliptical flap without corners (Fig. 10.15).

Ligation of the Intersphincteric Tract (LIFT) Procedure

The ligation of the intersphincteric fistula tract (LIFT) procedure is a sphincter-preserving technique that is used mainly for the treatment of trans-sphincteric fistula-in-ano [129]. With this procedure, eradication of the fistula is achieved without division of the anal sphincter muscle. A draining seton may be used before the LIFT procedure to promote fibrosis of the tract which may facilitate the procedure but has not been shown to enhance its success [130]. Preparation for the LIFT procedure typically includes enema cleansing of the rectum in the immediate preoperative period. Prone jack-knife or lithotomy positioning is used. If a seton is present it is removed. The anatomy of the fistula is evaluated by anoscopy, injection of water or dilute hydrogen peroxide into the external opening, or by gentle probing of the tract via the external opening. When the LIFT procedure is judged to be appropriate, a 1.5–2 cm incision is made in the skin covering the intersphincteric grove. The internal and external anal sphincters are separated to expose the intersphincteric portion of the fistula tract. At this point, the tract may be encircled with a right-angle clamp and ligated alongside the internal and external anal sphincters or simply divided and then suture ligated against the internal and external anal sphincter (Fig. 10.16) [129]. Rojanasakul, the LIFT procedure pioneer, noted that closure of the fistula tract at the lateral edge of the internal anal sphincter, close to the internal opening of the fistula tract, is the "key to success" of this procedure [131]. The portion of the fistula tract lateral to the external anal sphincter is then "cored out" or curetted. The external skin opening is left open to drain. The defect in the intersphincteric groove is loosely closed with fine absorbable sutures. Complications of the LIFT procedure are uncommon with reported incidence in the range of 0–5% of patients [121, 132, 133]. Postoperative care included 1–2 weeks of broad-spectrum oral antibiotics, stool softeners, and frequent water-cleansing of the operative site [117, 131–133].

Meta-analyses of published data report that the standard or "classic" LIFT has resulted in fistula healing in 61–94% of patients, with little morbidity, a healing time of 4–8 weeks, and only rare alterations in fecal continence [130, 134–137]. Modifications to the LIFT procedure that include omission of fistula tract division, excision of the lateral aspect of the tract, and the combined use of a seton, fistula plug, or biologic mesh interposition have also been described with limited data indicating successful healing and preservation of

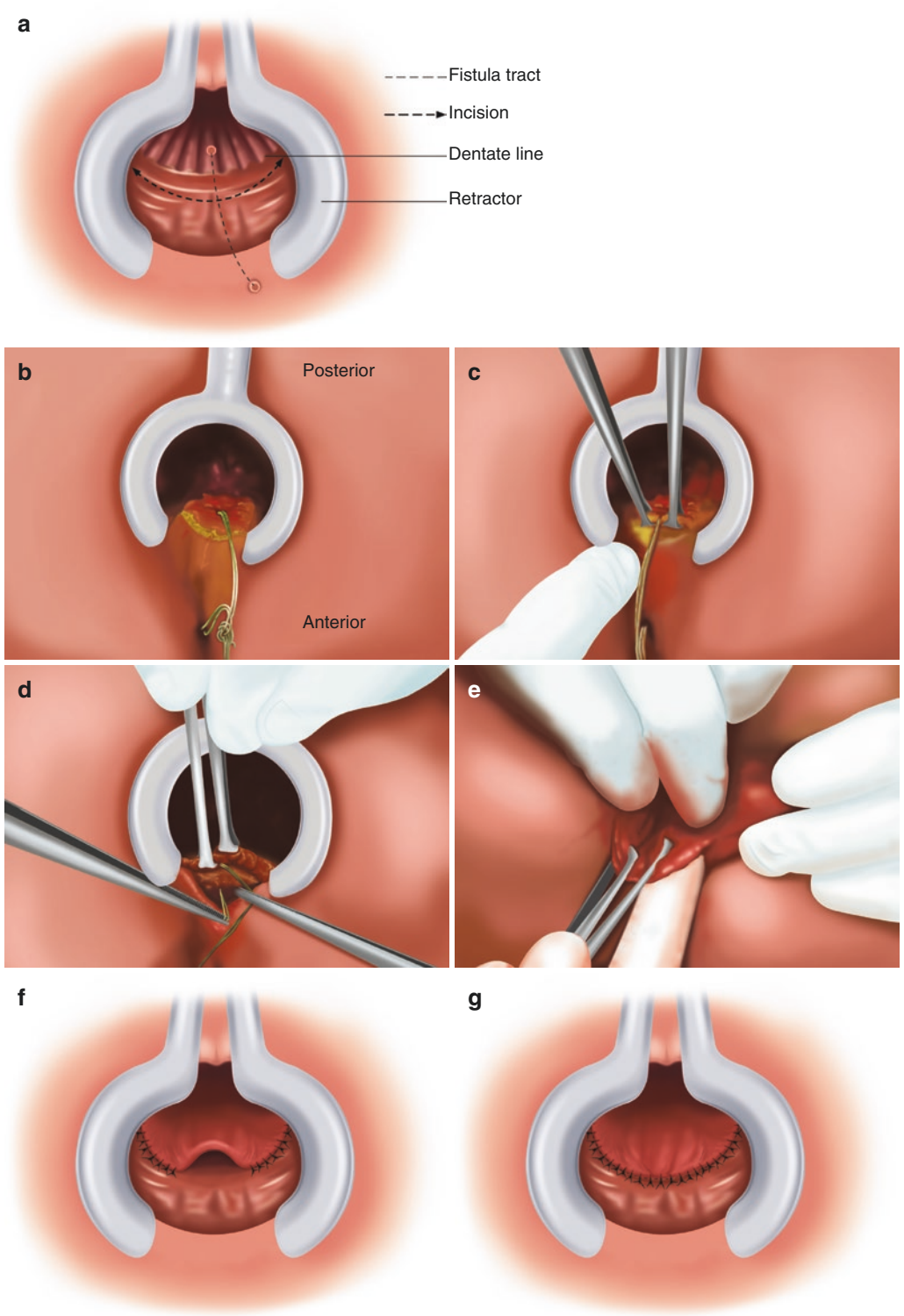


Fig. 10.15 (**a**–**g**) Endorectal advancement flap technique. With permission from Maron DJ, Wexner SD. Fissure-In-Ano and Anal Stenosis. In: Beck DE, Wexner SD, Rafferty JF. Gordon and Nivatvongs' Principles and Practice of Surgery for the Colon, Rectum, and Anus, 4th Ed. Thieme, New York, 2019 (in press)

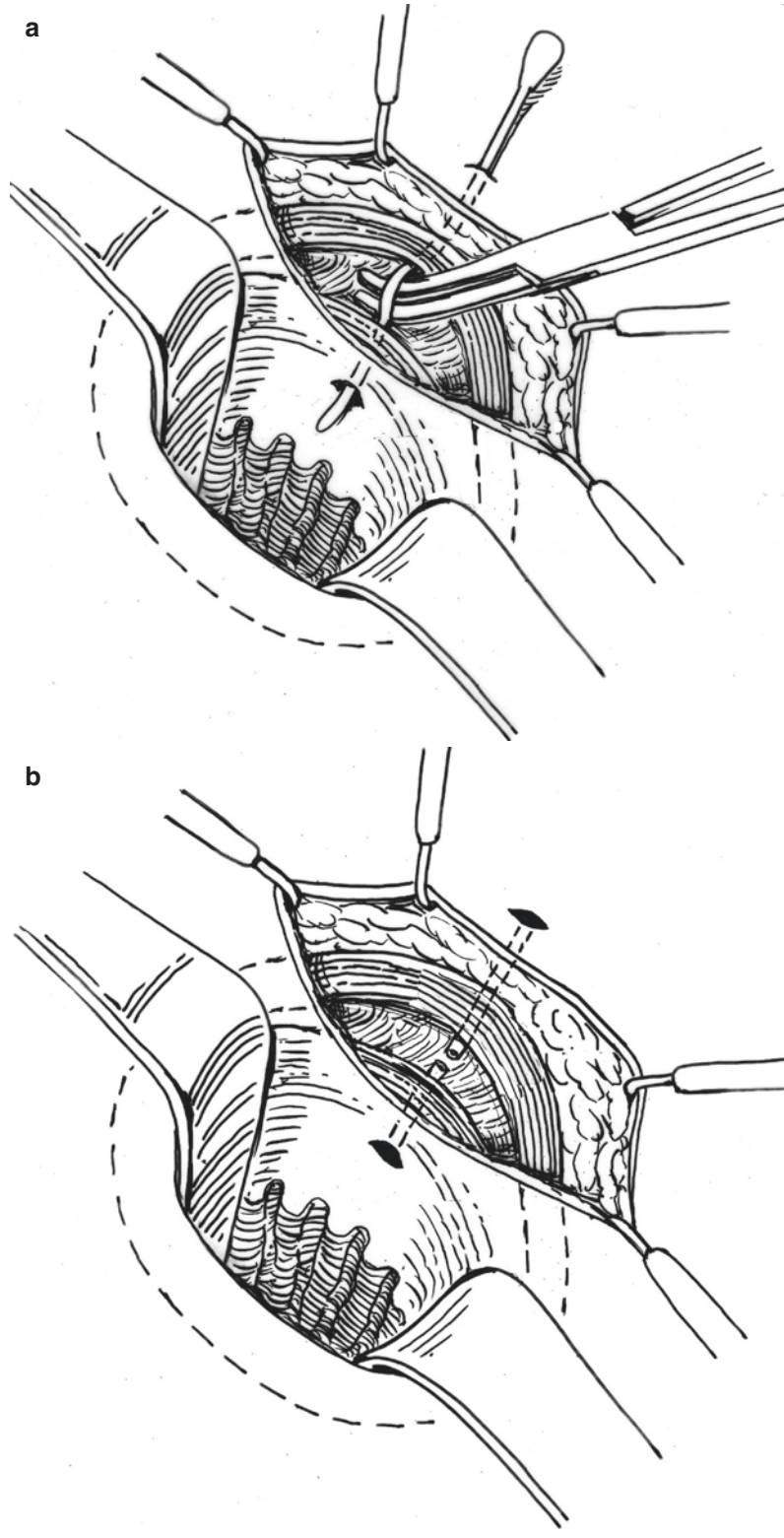


Fig. 10.16 Ligation of intersphincteric Tract (LIFT) . (**a**) Incision in the intersphincteric groove to expose fistula tract containing a flexible probe. (**b**) Tract is ligated

anal sphincter function both on par with the classic LIFT [134–138]. The LIFT procedure may be used for both simple and complex transphincteric fistulae. A recent, prospective, multicenter study of anal fistula treatment included a total of 43 LIFT procedures with healing rate of 79% and an overall improvement in anal sphincter functional scores. Among the 17 patients with a simple/low anal fistula, 82% were healed at 3 months follow-up [85]. Interestingly, the post-LIFT procedure fecal incontinence severity scores improved in Hall's study. Fistula tract length >3 cm, previous procedures to eradicate the fistula, and obesity have each been associated with LIFT failure [132, 134].

Anal Fistula Plug

The anal fistula plug is an acellular collagen matrix or a non-woven web of polyglycolic acid:trimethylene carbonate (PGA:TMC) fibers used to close the primary internal anal opening and to provide a scaffold for native tissue in-growth that will obliterate the fistula tract. Although early data demonstrated 70–100% success with the plug in low-lying fistulas [139, 140], more recent outcomes in complex disease have been less promising with healing rates under 50% [141–145].

In preparation for the anal fistula plug procedure, a draining seton may be used to facilitate resolution of associated infection and to otherwise prepare the tract for plug insertion [146, 147]. Mechanical bowel preparation and perioperative prophylactic antibiotics are generally recommended [139, 145, 147]. The procedure is performed in the lithotomy, prone jack-knife, or left lateral position. As a first step, hydrogen peroxide or saline irrigation and/or curettage of the fistula tract is typically performed. The plug is then inserted into the internal opening and pulled through the tract with a suture until it is snug (Fig. 10.17). The plug is then trimmed, secured to the internal anal sphincter with an absorbable suture, and loosely sutured to the skin at the external opening without closing the external opening. Post-procedural protocols are variable but in general include limited activity for several days [139, 145, 147]. In a recent, prospective multicenter trial, with 93 patients, infection at the plug site occurred in 12%, plug extrusion in 14%, healing at 12 months in 49%, and decrease anal sphincter function in 11% of patients, respectively [148]. Reasons for early failure are typically sepsis or plug dislodgement, and failure is more common in patients with Crohn's disease, anovaginal fistula, recurrent fistula, or active smoking. Individual studies have reported similar rates of post-plug insertion complications [145, 146].

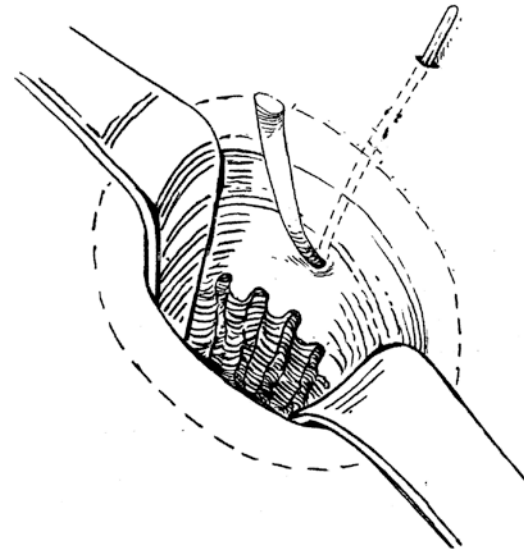


Fig. 10.17 Fistula plug

Fibrin Glue

Fibrin glue is another sphincter-preserving technique that has been used with variable success in the treatment of fistula-in-ano. In preparation for this procedure, a mechanical bowel preparation and prophylactic antibiotics are commonly administered [91, 149, 150]. The fistula tract is irrigated with saline or hydrogen peroxide and may be curetted prior to glue instillation. An angiocath is used to fill the fistula tract with 2–5 mL of commercially available fibrin glue solution (Fig. 10.18). After waiting a few minutes for the glue to harden it is trimmed at the internal and external openings. Patients are typically discharged after the procedure with recommendations for light activity for several days. Complications of fibrin glue therapy may occur in as many as 50% of patients, but are most often of mild severity and self-limited [91]. A tract

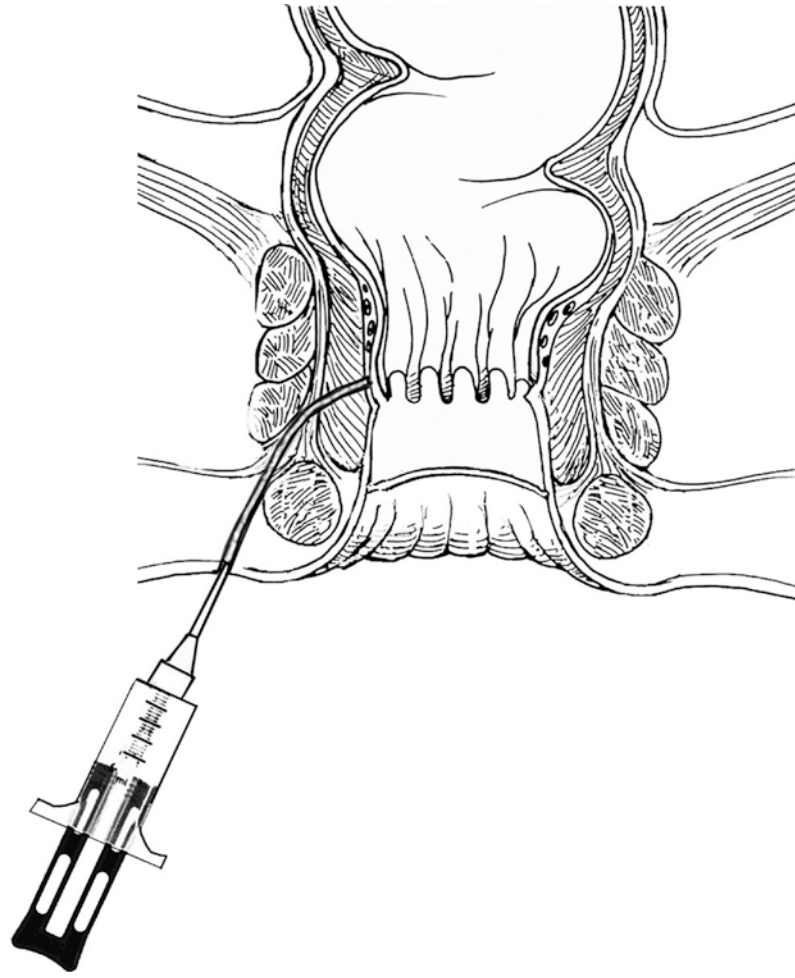


Fig. 10.18 Fibrin glue

abscess was observed in 4 (10%) of 40 glue events [150]. Baseline anal sphincter function is preserved after fibrin glue therapy [91, 150–152]. A representative sample of published studies indicate healing in the range of 14–63% of patients [149, 150, 152–158]. A series of patients followed by Zmora and colleagues noted healing at 6 months in 32 (53%) of patients of whom approximately one-fourth had recurrent fistula with long-term follow-up [159]. A 2015 systematic review indicated the absence of a consistent association between fistula etiology, complexity, tract length, or the use of a mechanical bowel prep and successful fibrin glue therapy [160]. Despite the variability in healing of fistula-in-ano with fibrin glue therapy, the real possibility of success coupled with its being a sphincter-preserving technique allows this therapy to remain an option that may be considered for the treatment of fistula-in-ano.

Stem Cells

Mesenchymal stem cells are an emerging therapy for Crohn's disease-related and cryptoglandular anal fistula. The stem cells are harvested from patient or donor adipose tissue or bone marrow, expanded with cell culture techniques, and then prepared for injection into the fistula tract. The stem cells are believed to effect healing through immunomodulatory and anti-inflammatory pathways. A randomized placebo controlled trial, in patients with Crohn's disease and complex peri-

anal fistula, demonstrated "combined remission", defined as clinical and radiological fistula healing, at 24 weeks, in 51% and 36% of patients who were treated with mesenchymal stem cells or placebo, respectively ($p = 0.021$) [161]. At 52 weeks follow-up, combined remission was observed in 56% and 39% of patients, respectively ($p = 0.013$) [162]. In another trial, patients with cryptoglandular or Crohn's-related complex anal fistula were randomized to treatment with fibrin glue or fibrin glue plus adipose-derived mesenchymal stem cells. Fistula healing at 8 weeks occurred in 71% of patients treated with fibrin glue plus stem cells and 16% of patients who received fibrin glue alone ($p < 0.001$) [163]. An earlier randomized trial [164] and a recent review [165] provide additional evidence to support the use mesenchymal stem cells for the treatment of complex fistula-in-ano in patients with Crohn's disease.

Summary

Understanding anorectal anatomy is essential to successfully managing anorectal abscesses and fistulas.

References

1. Vasilevsky CA. Anorectal abscess and fistula-in ano. In: Beck DE, editor. Handbook of colorectal surgery. St Louis: Quality Medical Publishing; 1997.
2. Gordon PH, Nivatvongs S. Principles and practice of surgery for the colon, rectum, and anus. 2nd ed. St. Louis: Quality Medical Publishing; 1999.
3. Walls EW. Observations on the microscopic anatomy of the human anal canal. Br J Surg. 1958;45:504–12.
4. Morson BC, Dawson IMP. Gastrointestinal pathology. London: Blackwell Scientific; 1979. p. 715–8.
5. Lilius HG. Fistula-in-ano, an investigation of human foetal anal ducts and intramuscular glands and a clinical study of 150 patients. Acta Chir Scand Suppl. 1968;383:7–88.
6. Eisenhammer S. The internal anal sphincter and the anorectal abscess. Surg Gynecol Obstet. 1956;103:501–6.
7. Gosselink MP, van Onkelen RS, Schouten WR. The cryptoglandular theory revisited. Color Dis. 2015;17:1041–3.
8. Parks AG. Pathogenesis and treatment of fistuila-in-ano. Br Med J. 1961;1:463–9.
9. McElwain JW, MacLean MD, Alexander RM, Hoexter B, Guthrie JF. Anorectal prlblems: experience with primary fistulectomy for anorectal abscess, a report of 1,000 cases. Dis Colon Rectum. 1975;18:646–9.
10. Ommer A, Herold A, Berg E, Furst A, Schiedeck T, Sailer M. German S3-Guideline: rectovaginal fistula. Ger Med Sci. 2012;10:Doc15.
11. Ramanujam PS, Prasad ML, Abcarian H, Tan AB. Perianal abscesses and fistulas. A study of 1023 patients. Dis Colon Rectum. 1984;27:593–7.
12. Read DR, Abcarian H. A prospective survey of 474 patients with anorectal abscess. Dis Colon Rectum. 1979;22:566–8.
13. Vasilevsky CA, Gordon PH. The incidence of recurrent abscesses or fistula-in-ano following anorectal suppuration. Dis Colon Rectum. 1984;27:126–30.
14. Wang D, Yang G, Qiu J, et al. Risk factors for anal fistula: a case-control study. Tech Coloproctol. 2014;18:635–9.
15. Prasad ML, Read DR, Abcarian H. Supralevator abscess: diagnosis and treatment. Dis Colon Rectum. 1981;24:456–61.
16. Chrabot CM, Prasad ML, Abcarian H. Recurrent anorectal abscesses. Dis Colon Rectum. 1983;26:105–8.
17. Held D, Khubchandani I, Sheets J, Stasik J, Rosen L, Riether R. Management of anorectal horseshoe abscess and fistula. Dis Colon Rectum. 1986;29:793–7.
18. Herr CH, Williams JC. Supralevator anorectal abscess presenting as acute low back pain and sciatica. Ann Emerg Med. 1994;23:132–5.
19. Jorge JM, Wexner SD. Etiology and management of fecal incontinence. Dis Colon Rectum. 1993;36(1):77–97.
20. Abcarian H. Anorectal infection: abscess-fistula. Clin Colon Rectal Surg. 2011;24:14–21.
21. Sneider EB, Maykel JA. Anal abscess and fistula. Gastroenterol Clin N Am. 2013;42:773–84.
22. Parks AG, Thomson JP. Intersphincteric abscess. Br Med J. 1973;2:537–9.
23. Klein JW. Common anal problems. Med Clin North Am. 2014;98:609–23.
24. Garcia-Granero A, Granero-Castro P, Frasson M, et al. Management of cryptoglandular supralevator abscesses in the magnetic resonance imaging era: a case series. Int J Color Dis. 2014;29:1557–64.
25. Orsoni P, Barthet M, Portier F, Panuel M, Desjeux A, Grimaud JC. Prospective comparison of endosonography, magnetic resonance imaging and surgical findings in anorectal fistula and abscess complicating Crohn's disease. Br J Surg. 1999;86:360–4.
26. Schwartz DA, Wiersema MJ, Dudiak KM, et al. A comparison of endoscopic ultrasound, magnetic resonance imaging, and exam under anesthesia for evaluation of Crohn's perianal fistulas. Gastroenterology. 2001;121:1064–72.

27. Wise PE, Schwartz DA. The evaluation and treatment of Crohn perianal fistulae: EUA, EUS, MRI, and other imaging modalities. Gastroenterol Clin N Am. 2012;41:379–91.
28. Caliste X, Nazir S, Goode T, et al. Sensitivity of computed tomography in detection of perirectal abscess. Am Surg. 2011;77:166–8.
29. Dohan A, Eveno C, Oprea R, Pautrat K, Placé V, Pocard M, Hoeffel C, Boudiaf M, Soyer P. Diffusion-weighted MR imaging for the diagnosis of abscess complicating fistula-in-ano: preliminary experience. Eur Radiol. 2014;24(11):2906–15.
30. Buchanan GN, Halligan S, Bartram CI, Williams AB, Tarroni D, Cohen CR. Clinical examination, endosonography, and MR imaging in preoperative assessment of fistula in ano: comparison with outcome-based reference standard. Radiology. 2004;233:674–81.
31. Poen AC, Felt-Bersma RJ, Eijsbouts QA, Cuesta MA, Meuwissen SG. Hydrogen peroxide-enhanced transanal ultrasound in the assessment of fistula-in-ano. Dis Colon Rectum. 1998;41:1147–52.
32. Pomerri F, Dodi G, Pintacuda G, Amadio L, Muzzio PC. Anal endosonography and fistulography for fistula-in-ano. Radiol Med. 2010;115:771–83.
33. Weisman N, Abbas MA. Prognostic value of endoanal ultrasound for fistula-in-ano: a retrospective analysis. Dis Colon Rectum. 2008;51:1089–92.
34. Bode WE, Ramos R, Page CP. Invasive necrotizing infection secondary to anorectal abscess. Dis Colon Rectum. 1982;25:416–9.
35. O'Malley GF, Dominici P, Giraldo P, et al. Routine packing of simple cutaneous abscesses is painful and probably unnecessary. Acad Emerg Med. 2009;16:470–3.
36. Perera AP, Howell AM, Sodergren MH, et al. A pilot randomised controlled trial evaluating postoperative packing of the perianal abscess. Langenbeck's Arch Surg. 2015;400:267–71.
37. Tonkin DM, Murphy E, Brooke-Smith M, et al. Perianal abscess: a pilot study comparing packing with nonpacking of the abscess cavity. Dis Colon Rectum. 2004;47:1510–4.
38. Parks AG, Gordon PH, Hardcastle JD. A classification of fistula-in-ano. Br J Surg. 1976;63:1–12.
39. Hanley PH, Ray JE, Pennington EE, Grablowsky OM. Fistula-in-ano: a ten-year follow-up study of horseshoe-abscess fistula-in-ano. Dis Colon Rectum. 1976;19:507–15.
40. Hanley PH. Conservative surgical correction of horseshoe abscess and fistula. Dis Colon Rectum. 1965;8:364–8.
41. Browder LK, Sweet S, Kaiser AM. Modified Hanley procedure for management of complex horseshoe fistulae. Tech Coloproctol. 2009;13:301–6.
42. Ustynoski K, Rosen L, Stasik J, Riether R, Sheets J, Khubchandani IT. Horseshoe abscess fistula. Seton treatment. Dis Colon Rectum. 1990;33:602–5.
43. Alder AC, Thornton J, McHard K, Buckins L, Barber R, Skinner MA. A comparison of traditional incision and drainage versus catheter drainage of soft tissue abscesses in children. J Pediatr Surg. 2011;46:1942–7.
44. Isbister WH. A simple method for the management of anorectal abscess. Aust N Z J Surg. 1987;57:771–4.
45. Ladd AP, Levy MS, Quilty J. Minimally invasive technique in treatment of complex, subcutaneous abscesses in children. J Pediatr Surg. 2010;45:1562–6.
46. Cox SW, Senagore AJ, Luchtefeld MA, Mazier WP. Outcome after incision and drainage with fistulotomy for ischiorectal abscess. Am Surg. 1997;63:686–9.
47. Ho YH, Tan M, Chui CH, Leong A, Eu KW, Seow-Choen F. Randomized controlled trial of primary fistulotomy with drainage alone for perianal abscesses. Dis Colon Rectum. 1997;40:1435–8.
48. Schouten WR, van Vroonhoven TJ. Treatment of anorectal abscess with or without primary fistulectomy. Results of a prospective randomized trial. Dis Colon Rectum. 1991;34:60–3.
49. Bokhari S, Lindsey I. Incontinence following sphincter division for treatment of anal fistula. Color Dis. 2010;12:e135–9.
50. Malik AI, Nelson RL, Tou S. Incision and drainage of perianal abscess with or without treatment of anal fistula. Cochrane Database Syst Rev. 2010;7:CD006827.
51. Llera JL, Levy RC. Treatment of cutaneous abscess: a double-blind clinical study. Ann Emerg Med. 1985;14:15–9.
52. Sozener U, Gedik E, Kessaf Aslar A, et al. Does adjuvant antibiotic treatment after drainage of anorectal abscess prevent development of anal fistulas? A randomized, placebo-controlled, double-blind, multicenter study. Dis Colon Rectum. 2011;54:923–9.
53. Seow-En I, Ngu J. Routine operative swab cultures and post-operative antibiotic use for uncomplicated perianal abscesses are unnecessary. ANZ J Surg. 2017;87:356–9.
54. Onaca N, Hirshberg A, Adar R. Early reoperation for perirectal abscess: a preventable complication. Dis Colon Rectum. 2001;44:1469–73.
55. Yano T, Asano M, Matsuda Y, Kawakami K, Nakai K, Nonaka M. Prognostic factors for recurrence following the initial drainage of an anorectal abscess. Int J Color Dis. 2010;25:1495–8.
56. Seow-Choen F, Nicholls RJ. Anal fistula. Br J Surg. 1992;79:197–205.
57. Mazier WP, Senagore AJ, Schiesel EC. Operative repair of anovaginal and rectovaginal fistulas. Dis Colon Rectum. 1995;38:4–6.
58. Eke N. Fournier's gangrene: a review of 1726 cases. Br J Surg. 2000;87:718–28.
59. Wroblewska M, Kuzaka B, Borkowski T, Kuzaka P, Kawecki D, Radziszewski P. Fournier's gangrene—current concepts. Pol J Microbiol. 2014;63:267–73.
60. Czymek R, Schmidt A, Eckmann C, et al. Fournier's gangrene: vacuum-assisted closure versus conventional dressings. Am J Surg. 2009;197:168–76.

61. Corcoran AT, Smaldone MC, Gibbons EP, Walsh TJ, Davies BJ. Validation of the Fournier's gangrene severity index in a large contemporary series. J Urol. 2008;180:944–8.
62. Huber P Jr, Kissack AS, Simonton CT. Necrotizing soft-tissue infection from rectal abscess. Dis Colon Rectum. 1983;26:507–11.
63. Bubrick MP, Hitchcock CR. Necrotizing anorectal and perineal infections. Surgery. 1979;86:655–62.
64. Laucks SS 2nd. Fournier's gangrene. Surg Clin North Am. 1994;74:1339–52.
65. Yague Romeo D, Angulo Hervias E, Bernal Lafuente C, Marcuello Pena MT, Mayayo Sinues E, Sarria Octavio de Toledo L. Fournier's gangrene in a 44-year-old woman: CT scan findings. Arch Esp Urol. 2009;62:483–5.
66. Kara E, Muezzinoglu T, Temeltas G, et al. Evaluation of risk factors and severity of a life threatening surgical emergency: Fournier's gangrene (a report of 15 cases). Acta Chir Belg. 2009;109:191–7.
67. Kovalcik PJ, Jones J. Necrotizing perineal infections. Am Surg. 1983;49:163–6.
68. Abcarian H, Eftaiha M. Floating free-standing anus. A complication of massive anorectal infection. Dis Colon Rectum. 1983;26:516–21.
69. Anaya DA, Dellinger EP. Necrotizing soft-tissue infection: diagnosis and management. Clin Infect Dis. 2007;44:705–10.
70. Cuccia G, Mucciardi G, Morgia G, et al. Vacuum-assisted closure for the treatment of Fournier's gangrene. Urol Int. 2009;82:426–31.
71. Yang BL, Lin Q, Chen HJ, et al. Perianal necrotizing fasciitis treated with a loose-seton technique. Color Dis. 2012;14:e422–4.
72. Lucca M, Unger HD, Devenny AM. Treatment of Fournier's gangrene with adjunctive hyperbaric oxygen therapy. Am J Emerg Med. 1990;8:385–7.
73. Laor E, Palmer LS, Tolia BM, Reid RE, Winter HI. Outcome prediction in patients with Fournier's gangrene. J Urol. 1995;154:89–92.
74. Baker B, Al-Salman M, Daoud F. Management of acute perianal sepsis in neutropenic patients with hematological malignancy. Tech Coloproctol. 2014;18:327–33.
75. Barnes SG, Sattler FR, Ballard JO. Perirectal infections in acute leukemia. Improved survival after incision and debridement. Ann Intern Med. 1984;100:515–8.
76. Vanhueverzwyn R, Delannoy A, Michaux JL, Dive C. Anal lesions in hematologic diseases. Dis Colon Rectum. 1980;23:310–2.
77. Morcos B, Amarin R, Abu Sba A, Al-Ramahi R, Abu Alrub Z, Salhab M. Contemporary management of perianal conditions in febrile neutropenic patients. Eur J Surg Oncol. 2013;39:404–7.
78. Freifeld AG, Bow EJ, Sepkowitz KA, et al. Clinical practice guideline for the use of antimicrobial agents in neutropenic patients with cancer: 2010 update by the Infectious Diseases Society of America. Clin Infect Dis. 2011;52:427–31.
79. Musa MB, Katakkar SB, Khaliq A. Anorectal and perianal complications of hematologic malignant neoplasms. Can J Surg. 1975;18:579–83.
80. Plumb AA, Halligan S, Bhatnagar G, Taylor SA. Perianal sepsis in hematologic malignancy: MR imaging appearances and distinction from cryptoglandular infection in immunocompetent patients. Radiology. 2015;276:147–55.
81. Sehdev MK, Dowling MD Jr, Seal SH, Stearns MW Jr. Perianal and anorectal complications in leukemia. Cancer. 1973;31:149–52.
82. Glenn J, Cotton D, Wesley R, Pizzo P. Anorectal infections in patients with malignant diseases. Rev Infect Dis. 1988;10:42–52.
83. Badgwell BD, Chang GJ, Rodriguez-Bigas MA, et al. Management and outcomes of anorectal infection in the cancer patient. Ann Surg Oncol. 2009;16:2752–8.
84. Levi JA, Schimpff SC, Slawson RG, Wiernik PH. Evaluation of radiotherapy for localized inflammatory skin and perianal lesions in adult leukemia: a prospectively randomized double blind study. Cancer Treat Rep. 1977;61:1301–5.
85. Hall JF, Bordeianou L, Hyman N, et al. Outcomes after operations for anal fistula: results of a prospective, multicenter, regional study. Dis Colon Rectum. 2014;57:1304–8.
86. Hyman N, O'Brien S, Osler T. Outcomes after fistulotomy: results of a prospective, multicenter regional study. Dis Colon Rectum. 2009;52:2022–7.
87. Fazio VW. Complex anal fistulae. Gastroenterol Clin N Am. 1987;16:93–114.
88. Mizrahi N, Wexner SD, Zmora O, et al. Endorectal advancement flap: are there predictors of failure? Dis Colon Rectum. 2002;45:1616–21.
89. Kondylis PD, Shalabi A, Kondylis LA, Reilly JC. Male cryptoglandular fistula surgery outcomes: a retrospective analysis. Am J Surg. 2009;197:325–30.
90. Sangwan YP, Rosen L, Riether RD, Stasik JJ, Sheets JA, Khubchandani IT. Is simple fistula-in-ano simple? Dis Colon Rectum. 1994;37:885–9.
91. Zmora O, Neufeld D, Ziv Y, et al. Prospective, multicenter evaluation of highly concentrated fibrin glue in the treatment of complex cryptogenic perianal fistulas. Dis Colon Rectum. 2005;48:2167–72.
92. Steele SR, Kumar R, Feingold DL, et al. Practice parameters for the management of perianal abscess and fistula-in-ano. Dis Colon Rectum. 2011;54:1465–74.
93. Cirocco WC, Reilly JC. Challenging the predictive accuracy of Goodsall's rule for anal fistulas. Dis Colon Rectum. 1992;35:537–42.
94. Roig JV, Jordan J, Garcia-Armengol J, Esclapez P, Solana A. Changes in anorectal morphologic and functional parameters after fistula-in-ano surgery. Dis Colon Rectum. 2009;52:1462–9.
95. Buchanan G, Halligan S, Williams A, et al. Effect of MRI on clinical outcome of recurrent fistula-in-ano. Lancet. 2002;360:1661–2.

96. Makowiec F, Laniado M, Jehle EC, Claussen CD, Starlinger M. Magnetic resonance imaging in perianal Crohn's disease. Inflamm Bowel Dis. 1995;1:256–65.
97. Ratto C, Litta F, Parello A, Donisi L, Zaccone G, De Simone V. Gore Bio-A(R) Fistula Plug: a new sphincter-sparing procedure for complex anal fistula. Color Dis. 2012;14:e264–9.
98. Maconi G, Ardizzone S, Greco S, Radice E, Bezzio C, Bianchi Porro G. Transperineal ultrasound in the detection of perianal and rectovaginal fistulae in Crohn's disease. Am J Gastroenterol. 2007;102:2214–9.
99. Maconi G, Tonolini M, Monteleone M, et al. Transperineal perineal ultrasound versus magnetic resonance imaging in the assessment of perianal Crohn's disease. Inflamm Bowel Dis. 2013;19:2737–43.
100. Nevler A, Beer-Gabel M, Lebedyev A, et al. Transperineal ultrasonography in perianal Crohn's disease and recurrent cryptogenic fistula-in-ano. Color Dis. 2013;15:1011–8.
101. Plaikner M, Loizides A, Peer S, et al. Transperineal ultrasonography as a complementary diagnostic tool in identifying acute perianal sepsis. Tech Coloproctol. 2014;18:165–71.
102. Siddiqui MR, Ashrafian H, Tozer P, et al. A diagnostic accuracy meta-analysis of endoanal ultrasound and MRI for perianal fistula assessment. Dis Colon Rectum. 2012;55:576–85.
103. Weisman RI, Orsay CP, Pearl RK, Abcarian H. The role of fistulography in fistula-in-ano. Report of five cases. Dis Colon Rectum. 1991;34:181–4.
104. Abramowitz L, Soudan D, Souffran M, et al. The outcome of fistulotomy for anal fistula at 1 year: a prospective multicentre French study. Color Dis. 2016;18:279–85.
105. Garcia-Aguilar J, Belmonte C, Wong WD, Goldberg SM, Madoff RD. Anal fistula surgery. Factors associated with recurrence and incontinence. Dis Colon Rectum. 1996;39:723–9.
106. Davies M, Harris D, Lohana P, et al. The surgical management of fistula-in-ano in a specialist colorectal unit. Int J Color Dis. 2008;23:833–8.
107. Jordan J, Roig JV, Garcia-Armengol J, Garcia-Granero E, Solana A, Lledo S. Risk factors for recurrence and incontinence after anal fistula surgery. Color Dis. 2010;12:254–60.
108. van Koperen PJ, Wind J, Bemelman WA, Slors JF. Fibrin glue and transanal rectal advancement flap for high transsphincteric perianal fistulas; is there any advantage? Int J Color Dis. 2008;23:697–701.
109. van Tets WF, Kuijpers HC. Continence disorders after anal fistulotomy. Dis Colon Rectum. 1994;37:1194–7.
110. Ho YH, Tan M, Leong AF, Seow-Choen F. Marsupialization of fistulotomy wounds improves healing: a randomized controlled trial. Br J Surg. 1998;85:105–7.
111. Pescatori M, Ayabaca SM, Cafaro D, Iannello A, Magrini S. Marsupialization of fistulotomy and fistulectomy wounds improves healing and decreases bleeding: a randomized controlled trial. Color Dis. 2006;8:11–4.
112. Jain BK, Vaibhaw K, Garg PK, Gupta S, Mohanty D. Comparison of a fistulectomy and a fistulotomy with marsupialization in the management of a simple anal fistula: a randomized, controlled pilot trial. J Korean Soc Coloproctol. 2012;28:78–82.
113. Gottgens KW, Janssen PT, Heemskerk J, et al. Long-term outcome of low perianal fistulas treated by fistulotomy: a multicenter study. Int J Color Dis. 2015;30:213–9.
114. Kelly ME, Heneghan HM, McDermott FD, et al. The role of loose seton in the management of anal fistula: a multicenter study of 200 patients. Tech Coloproctol. 2014;18:915–9.
115. Patton V, Chen CM, Lubowski D. Long-term results of the cutting seton for high anal fistula. ANZ J Surg. 2015;85:720–7.
116. Rosen DR, Kaiser AM. Definitive seton management for transsphincteric fistula-in-ano: harm or charm? Color Dis. 2016;18:488–95.
117. Tan KK, Alsuwaigh R, Tan AM, et al. To LIFT or to flap? Which surgery to perform following seton insertion for high anal fistula? Dis Colon Rectum. 2012;55:1273–7.
118. Jarrar A, Church J. Advancement flap repair: a good option for complex anorectal fistulas. Dis Colon Rectum. 2011;54:1537–41.
119. Mitalas LE, Dwarkasing RS, Verhaaren R, Zimmerman DD, Schouten WR. Is the outcome of transanal advancement flap repair affected by the complexity of high transsphincteric fistulas? Dis Colon Rectum. 2011;54:857–62.
120. Schouten WR, Zimmerman DD, Briel JW. Transanal advancement flap repair of transsphincteric fistulas. Dis Colon Rectum. 1999;42:1419–22. discussion 22–3.
121. Madbouly KM, El Shazly W, Abbas KS, Hussein AM. Ligation of intersphincteric fistula tract versus mucosal advancement flap in patients with high transsphincteric fistula-in-ano: a prospective randomized trial. Dis Colon Rectum. 2014;57:1202–8.
122. Sonoda T, Hull T, Piedmonte MR, Fazio VW. Outcomes of primary repair of anorectal and rectovaginal fistulas using the endorectal advancement flap. Dis Colon Rectum. 2002;45:1622–8.
123. Soltani A, Kaiser AM. Endorectal advancement flap for cryptoglandular or Crohn's fistula-in-ano. Dis Colon Rectum. 2010;53:486–95.
124. Goos M, Manegold P, Gruneberger M, Thomusch O, Ruf G. Long-term results after endoanal advancement flap repair for fistulas-in-ano. How important is the aetiology? Int J Color Dis. 2015;30:413–9.
125. Jones IT, Fazio VW, Jagelman DG. The use of transanal rectal advancement flaps in the management of fistulas involving the anorectum. Dis Colon Rectum. 1987;30:919–23.

126. Schwandner O. Obesity is a negative predictor of success after surgery for complex anal fistula. BMC Gastroenterol. 2011;11:61.
127. Zimmerman DD, Briel JW, Gosselink MP, Schouten WR. Anocutaneous advancement flap repair of transsphincteric fistulas. Dis Colon Rectum. 2001;44:1474–80.
128. van der Hagen SJ, Baeten CG, Soeters PB, van Gemert WG. Staged mucosal advancement flap versus staged fibrin sealant in the treatment of complex perianal fistulas. Gastroenterol Res Pract. 2011;2011:186350.
129. Rojanasakul A, Pattanaarun J, Sahakitrungruang C, Tantiphlachiva K. Total anal sphincter saving technique for fistula-in-ano; the ligation of intersphincteric fistula tract. J Med Assoc Thail. 2007;90:581–6.
130. Hong KD, Kang S, Kalaskar S, Wexner SD. Ligation of intersphincteric fistula tract (LIFT) to treat anal fistula: systematic review and meta-analysis. Tech Coloproctol. 2014;18:685–91.
131. Rojanasakul A. LIFT procedure: a simplified technique for fistula-in-ano. Tech Coloproctol. 2009;13:237–40.
132. Liu WY, Aboulian A, Kaji AH, Kumar RR. Long-term results of ligation of intersphincteric fistula tract (LIFT) for fistula-in-ano. Dis Colon Rectum. 2013;56:343–7.
133. Shanwani A, Nor AM, Amri N. Ligation of the intersphincteric fistula tract (LIFT): a sphincter-saving technique for fistula-in-ano. Dis Colon Rectum. 2010;53:39–42.
134. Sirany AM, Nygaard RM, Morken JJ. The ligation of the intersphincteric fistula tract procedure for anal fistula: a mixed bag of results. Dis Colon Rectum. 2015;58:604–12.
135. Alasari S, Kim NK. Overview of anal fistula and systematic review of ligation of the intersphincteric fistula tract (LIFT). Tech Coloproctol. 2014;18:13–22.
136. Vergara-Fernandez O, Espino-Urbina LA. Ligation of intersphincteric fistula tract: what is the evidence in a review? World J Gastroenterol. 2013;19:6805–13.
137. Zirak-Schmidt S, Perdawood SK. Management of anal fistula by ligation of the intersphincteric fistula tract—a systematic review. Dan Med J. 2014;61:A4977.
138. Han JG, Wang ZJ, Zheng Y, et al. Ligation of intersphincteric fistula tract vs ligation of the intersphincteric fistula tract plus a bioprosthetic anal fistula plug procedure in patients with transsphincteric anal fistula: early results of a multicenter prospective randomized trial. Ann Surg. 2016;264:917–22.
139. Champagne BJ, O'Connor LM, Ferguson M, Orangio GR, Schertzer ME, Armstrong DN. Efficacy of anal fistula plug in closure of cryptoglandular fistulas: long-term follow-up. Dis Colon Rectum. 2006;49:1817–21.
140. Ellis CN. Bioprosthetic plugs for complex anal fistulas: an early experience. J Surg Educ. 2007;64:36–40.
141. Adamina M, Hoch JS, Burnstein MJ. To plug or not to plug: a cost-effectiveness analysis for complex anal fistula. Surgery. 2010;147:72–8.
142. Christoforidis D, Pieh MC, Madoff RD, Mellgren AF. Treatment of transsphincteric anal fistulas by endorectal advancement flap or collagen fistula plug: a comparative study. Dis Colon Rectum. 2009;52:18–22.
143. El-Gazzaz G, Zutshi M, Hull T. A retrospective review of chronic anal fistulae treated by anal fistulae plug. Color Dis. 2010;12:442–7.
144. Kleif J, Hagen K, Wille-Jorgensen P. Acceptable results using plug for the treatment of complex anal fistulas. Dan Med Bull. 2011;58:A4254.
145. Safar B, Jobanputra S, Sands D, Weiss EG, Nogueras JJ, Wexner SD. Anal fistula plug: initial experience and outcomes. Dis Colon Rectum. 2009;52:248–52.
146. Christoforidis D, Etzioni DA, Goldberg SM, Madoff RD, Mellgren A. Treatment of complex anal fistulas with the collagen fistula plug. Dis Colon Rectum. 2008;51:1482–7.
147. Schwandner T, Roblick MH, Kierer W, Brom A, Padberg W, Hirschburger M. Surgical treatment of complex anal fistulas with the anal fistula plug: a prospective, multicenter study. Dis Colon Rectum. 2009;52:1578–83.
148. Stamos MJ, Snyder M, Robb BW, et al. Prospective multicenter study of a synthetic bioabsorbable anal fistula plug to treat cryptoglandular transsphincteric anal fistulas. Dis Colon Rectum. 2015;58:344–51.
149. Loungnarath R, Dietz DW, Mutch MG, Birnbaum EH, Kodner IJ, Fleshman JW. Fibrin glue treatment of complex anal fistulas has low success rate. Dis Colon Rectum. 2004;47:432–6.
150. Adams T, Yang J, Kondylis LA, Kondylis PD. Long-term outlook after successful fibrin glue ablation of cryptoglandular transsphincteric fistula-in-ano. Dis Colon Rectum. 2008;51:1488–90.
151. Haim N, Neufeld D, Ziv Y, et al. Long-term results of fibrin glue treatment for cryptogenic perianal fistulas: a multicenter study. Dis Colon Rectum. 2011;54:1279–83.
152. Sentovich SM. Fibrin glue for anal fistulas: long-term results. Dis Colon Rectum. 2003;46:498–502.
153. Swinscoe MT, Ventakasubramaniam AK, Jayne DG. Fibrin glue for fistula-in-ano: the evidence reviewed. Tech Coloproctol. 2005;9:89–94.
154. Yeung JM, Simpson JA, Tang SW, Armitage NC, Maxwell-Armstrong C. Fibrin glue for the treatment of fistulae in ano—a method worth sticking to? Color Dis. 2010;12:363–6.
155. Buchanan GN, Bartram CI, Phillips RK, et al. Efficacy of fibrin sealant in the management of complex anal fistula: a prospective trial. Dis Colon Rectum. 2003;46:1167–74.
156. Lindsey I, Smilgin-Humphreys MM, Cunningham C, Mortensen NJ, George BD. A randomized, controlled trial of fibrin glue vs. conventional treatment for anal fistula. Dis Colon Rectum. 2002;45:1608–15.

157. Cintron JR, Park JJ, Orsay CP, et al. Repair of fistulas-in-ano using fibrin adhesive: long-term follow-up. Dis Colon Rectum. 2000;43:944–9. discussion 9–50.
158. Altomare DF, Greco VJ, Tricomi N, et al. Seton or glue for trans-sphincteric anal fistulae: a prospective randomized crossover clinical trial. Color Dis. 2011;13:82–6.
159. Zmora O, Mizrahi N, Rotholtz N, Pikarsky AJ, Weiss EG, Nogueras JJ, Wexner SD. Fibrin glue sealing in the treatment of perineal fistulas. Dis Colon Rectum. 2003;46(5):584–9.
160. Cadeddu F, Salis F, Lisi G, Ciangola I, Milito G. Complex anal fistula remains a challenge for colorectal surgeon. Int J Color Dis. 2015;30:595–603.
161. Panés J, et al. Expanded allogeneic adipose-derived mesenchymal stem cells (Cx601) for complex perianal fistulas in Crohn's disease: a phase 3 randomised, double-blind controlled trial. Lancet. 2016;388(10051):1281–90.
162. Panes J, et al. Long-term efficacy and safety of stem cell therapy (Cx601) for complex perianal fistulas in patients with Crohn's disease. Gastroenterology. 2018;154(5):1334–42.e4.
163. Molendijk I, et al. Allogeneic bone marrow-derived mesenchymal stromal cells promote healing of refractory perianal fistulas in patients with Crohn's disease. Gastroenterology. 2015;149(4):918–27.e6.
164. Garcia-Olmo D, et al. Expanded adipose-derived stem cells for the treatment of complex perianal fistula: a phase II clinical trial. Dis Colon Rectum. 2009;52(1):79–86.
165. Lightner A, et al. A systematic review and meta-analysis of mesenchymal stem cell injections for the treatment of perianal Crohn's disease: progress made and future directions. Dis Colon Rectum. 2018;61(5):629–40.

Rectovaginal Fistula

11

Elizabeth R. Raskin

Introduction

Rectovaginal fistula (RVF) is an abnormal communication between the rectum and vagina that results in the passage of gas and/or feces through an epithelialized tract.

A distressing condition associated with physical and psychosocial sequelae for the female patient, RVF represents a difficult challenge from the surgeon's perspective. Etiology and classification of RVF are important for developing medical and surgical treatment strategies. While many surgical options have been described, success rates are variable. Crohn's disease-related RVF can add complexity to the condition, as wound healing and tissue integrity may be suboptimal.

Etiology

Worldwide, an estimated two million women suffer from rectovaginal fistula (RVF), with an increased incidence in the developing countries of sub-Saharan Africa and South Asia [1, 2]. The leading cause of RVF is obstetric trauma. Acute perineal laceration, assisted vaginal delivery, and prolonged ischemia with necrosis of the RV septum following obstructed labor are the primary insults that precipitate the formation of RVF [3].

Despite repair of third-degree and fourth-degree perineal lacerations in close to 5% of all vaginal births, RVF develops in approximately 1–2% of these patients due to wound dehiscence [4]. While an increase in cesarean section rate in the US has lessened the rates of episiotomy and operative vaginal delivery, it is estimated that RVF still develops after 0.1–0.5% of all births [5, 6].

Nonobstetric operative trauma contributes to RVF formation, especially following low anterior resection (LAR) (3–10%), hemorrhoidectomy, hysterectomy and synthetic mesh repair for pelvic organ prolapse [5, 7–9]. Risk factors for RVF development following LAR include preoperative chemoradiation, serum albumin <4.0 g/dL, tumor size >5 cm, anastomosis <5 cm from the anal verge, intraoperative bleeding >200 mL, and lateral lymph node dissection [9, 10]. Inflammatory bowel disease is another major etiology of RVF, with development in 2–10% of all women with Crohn's disease [5, 11].

Ileoanal pouch-vaginal fistula after total proctocolectomy in patients with both ulcerative colitis and Crohn's disease has been significantly associated with pouch failure and the need for pouch excision [12–14].

Locally advanced gastrointestinal and gynecologic malignancy can result in RVF and may

E. R. Raskin (✉)
Division of Surgical Oncology, Department of Surgery, Loma Linda University Health, Loma Linda, CA, USA
e-mail: eraskin@llu.edu

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_11

Table 11.1 Etiology of rectovaginal fistulas

Congenital disorders
Acquired disorders
Trauma
Operative
Obstetric
Traumatic
Infection/Sepsis
Inflammatory bowel disease
Radiation
Carcinoma

complicate appropriate oncologic treatment. In addition, radiation therapy for pelvic malignancy has been associated with acute development of RVF, as well as, delayed presentation years later [15, 16]. Fecal diversion may be needed to allow for completion of radiation therapy when symptoms are intolerable. Diverticulitis, anorectal cryptoglandular disease, Bartholin gland abscess and other infectious entities, such as tuberculosis, lymphogranuloma venereum, and HIV have been reported to cause RVF [17].

Although sporadic, cases of RVF from forceful coitus, fecal impaction, and neglected vaginal pessaries are noted in the literature [18–20]. A summary of etiologies is listed in Table 11.1.

Classification

Rectovaginal fistulae are classified as either *simple* or *complex* based on location, tract width, and etiology. Typically, a *simple* RVF is one that is located in the low or mid-vaginal septum with a diameter ≤2.5 cm. Most *simple* RVFs are due to either traumatic or infectious causes. Alternatively, a *complex* fistula is usually found high in the rectovaginal septum or presents as a cloacal defect. With a diameter of >2.5 cm, the *complex* fistula tends to originate from neoplasia, radiation therapy, congenital malformations, or inflammatory bowel disease. Multiple organ involvement, as well as, complicated tract orientation can be seen in this variety. A fistula is also considered complex if it results after a prior repair (Table 11.2).

Table 11.2 Classification of rectovaginal fistulas

Simple
Through the low or mid vaginal septum
<2.5 cm in diameter
Trauma or infection
Complex
Through the high vaginal septum
>2.5 cm in diameter
Inflammatory bowel disease, radiation, or neoplasia
Multiple failed repairs

History

Patients tend to present with complaints of passage of flatus or stool through the vagina. Chronic vaginal infection, foul smelling vaginal discharge, and dyspareunia may also be reported. These symptoms tend to be magnified with loose stool or diarrhea. Fecal incontinence may be experienced, as anal sphincter injuries are uniquely associated with obstetric trauma and other causes of RVF formation. While recognized obstetric anal sphincter injuries have been reported in 4–6% of all vaginal deliveries, it is estimated that occult sphincter injury occurs in up to 28% of patients following a normal vaginal delivery [21, 22]. In a series by Yee and colleagues, anal sphincter injury was noted in 92% of patients undergoing surgical repair for RVF. A thorough history should be elicited, focusing on symptoms, bowel habits, quality of life, and possible etiologies for RVF formation. A detailed obstetric history is important, making note of complicated deliveries such as forceps or vacuum assisted delivery or the presence of shoulder dystocia. Prior anorectal surgery, as well as, a history of malignancy, radiation therapy, and IBD should be investigated.

Physical exam should include a digital rectal exam with anoscopy and a vaginal evaluation with speculum exam. A palpable defect or dimple in the wall of the rectum and/or vagina may be appreciated in a low to mid-RVF. A careful assessment of the anal sphincter complex should be performed to identify concomitant sphincter defects. Anoscopy and vaginal speculum exam may reveal stool in the vagina, evidence of vaginitis or inflammation of the mucosa of the RV septum. If tolerated by the patient, a fistula probe

can be inserted through the tract for confirmation. Conversely, the fistula tract may not be identified due to small size and patient discomfort, necessitating an exam under anesthesia for diagnosis.

Biopsies of indurated or inflamed tissue can be considered to exclude malignancy or IBD. Despite these efforts, not all fistulae will be visible on examination and a high index of suspicion should be had with the patient with concerning symptoms and history.

Orally administered activated charcoal or methylene blue enema tampon tests have been used to detect occult RVFs or fistulas located high in the RV septum.

Endorectal ultrasound (ERUS), computed tomography (CT), and magnetic resonance imaging (MRI) can be considered if the findings are unclear or if there is concern for accompanying pathology, such as neoplasm, diverticular disease, or IBD [23]. Multiple studies have demonstrated the usefulness of ERUS and MRI for collectively identifying RVF and mapping occult sphincter defects [22, 24, 25].

Stoker and colleagues found positive predictive values (PPV) of 100% and 92% for ERUS and MRI in detecting RVF, with similar PPV for associated anal sphincter defects [25]. Hydrogen peroxide-enhanced ERUS has been shown to improve visualization of difficult to image tracts [26].

Lastly, colonoscopy with biopsy should be performed to further elucidate the presence of colorectal malignancy or IBD, if history or symptoms warrant.

Medical Management

While spontaneous healing of RVFs has been noted in 7–10%, the vast majority of patients will require medical and/or surgical intervention [4, 27]. Conservative management is warranted immediately following the presentation of RVF due to traumatic etiologies. Prior to surgical repair, a minimum of 3–6 months following delivery should be considered in the setting of RVF after obstetric injury. Bulking therapy and antidiarrheal medications can be useful to minimize symptoms and to allow time for an appropriate evaluation. Drainage of sepsis and antibiotic therapy may be initially needed in the presence of cryptoglandular or Crohn's disease.

Crohn's-Related RVF

Medical management of Crohn's-related RVF had limited success. Aimed at treating underlying inflammatory disease, corticosteroids, antibiotics, salicylates, and immunomodulators have historically been the mainstay of medical therapy despite lackluster healing of RVFs in only 25–64% [28, 29]. High doses of intravenous cyclosporine have been reported to induce RVF closure in up to 80% of patients, however over a third of these relapsed after converting to oral therapy [30].

The advent of anti-tumor necrosis factor-α (TNF-α) therapy in the late 1990s revolutionized treatment for fistulizing Crohn's disease, with especially encouraging results for perianal disease. To investigate the effects of *infliximab* in patients with Crohn's-related enterocutaneous and perianal fistulae, Present and colleagues performed a randomized, multicenter, double-blind placebo-controlled trial [31]. In this study, rectovaginal fistulae were not specifically identified, as the fistulae were characterized as either "abdominal" or "perianal." Patients were randomized to either receive placebo, *infliximab* 5 mg/kg, or *infliximab* 10 mg/kg at 0, 2, and 6 weeks.

Results demonstrated a significant reduction in the number of draining fistulae in the groups treated with *infliximab* compared to placebo. The effect was not dose-related as the group receiving 5 mg/kg fared slightly better than the 10 mg/kg group, although not in a statistically significant manner. In patients who reached the primary end point (greater than 50% reduction or more from baseline in the number of draining fistulae), the benefits of *infliximab* were seen rapidly (about 2 weeks) and lasted for a median of 3 months. After 18 weeks, complete fistula closure was noted in 46% of patients treated with *infliximab* but only 13% in the placebo arm.

In a study by Parsi and colleagues, an association with the type of fistula and the effectiveness

of *infliximab* therapy was found in patients with Crohn's disease [32]. While patients with perianal and enterocutaneous fistulae had complete response rates of 78% and 38%, respectively, RVFs completely healed in only 14% of patients after 6 weeks.

To investigate the longer-term results of *infliximab* in patients responding to induction therapy, a post-hoc analysis of patients with RVFs participating in the ACCENT II trial (A Crohn's Disease Clinical Trial Evaluating *Infliximab* in a New Long-term Treatment Regimen in Patients with Fistulizing Crohn's Disease) was performed [33, 34]. Patients who were considered "responders" after 10–14 weeks of *infliximab* therapy were randomized to receive *infliximab* 5 mg/kg or placebo every 8 weeks through week 54. From weeks 14–46, fistula closure rates in patients receiving *infliximab* maintenance ranged from 54.5–90%, compared to 28.6–42.9% in the placebo maintenance arm. Median duration of response in the *infliximab* maintenance group was 46 weeks, in contrast to 33 weeks for the placebo maintenance group. However, at week 54, only 44.4 and 42.9% of fistulae remained closed in the two groups.

Surgical Management

Simple Fistula Repair

Surgical options for repair of a simple RVF can be predicated by the presence or absence of an associated sphincter injury. When no evidence of sphincter injury is noted, repair options range from endorectal advancement flap (ERAF) to biologic graft repair, depending on the etiology of the RVF. Unfortunately, simple suture repair seems to have relatively poor rates of healing, likely due to the significant pressure differential between the rectum and the vagina. This is especially true in the setting of a thin and poorly vascularized rectovaginal septum. Lay-open fistulotomy is only a valid surgical option in the very distal RVF where minimal sphincter muscle is involved.

In the presence of a sphincter injury, sphincteroplasty or perineoproctotomy can be considered to address both the RVF and the concomitant sphincter defect.

Endorectal Advancement Flap

Endorectal advancement flap (ERAF) is the most commonly performed repair for simple RVF. It entails the raising of a flap comprised of mucosa, submucosa, and a portion of internal sphincter muscle and advancing the tissue down the anal canal to cover the RVF opening (Fig. 11.1). To maintain appropriate vascular supply and prevent necrosis, the ERAF should begin above the fistula opening by 4 cm and have a base that measures twice the width of the apex. The flap should overlap the internal opening by 2 cm and be tacked in place with absorbable suture. Alternatively an elliptical flap can be employed such that only one single distal suture line rather than a distal and two lateral suture lines are needed. As noted in Chap. 10, it is the preference of one of the editors (SDW) to utilize an elliptical flap as illustrated in Fig. 10.15a–g.

Case series of ERAF repair report success rates ranging from 59.6–88% following initial repair [35–38]. Risk factors for poor healing and failure of the ERAF include Crohn's disease, history of pelvic radiation, and prior RVF repair.

Lowry et al. retrospectively evaluated 81 patients who underwent ERAF repair for simple RVF [38]. Successful repair was noted in 83% of patients with a strong correlation of success with the number of prior attempted repairs. The patients with no prior repair history demonstrated complete RVF healing rates of 88%, while patients with a history of a single previous repair showed healing rates of 85%. In contrast, patients with two prior attempted repairs healed only 55% of the time.

Biologic Repairs

Fibrin glue tract instillation has been associated with notoriously poor healing rates (14–33%) in both anorectal and RVF, and has largely been abandoned as a first-line treatment option [39, 40]. Porcine collagen plugs have also been used for repair of complex fistulae, including RVF. Only small series evaluating plug repair for RVF and ileoanal pouch vaginal fistulae exist, demonstrating relatively unfavorable results (healing rates 0–60%) [41–43]. Failure of plug repair has been associated with dislodgement of the plug, occurring more frequently in the setting of a thinned perineum. While success rates are unimpressive, the morbidity of the procedure is low, suggesting that there is a role for this repair in a subset of patients.

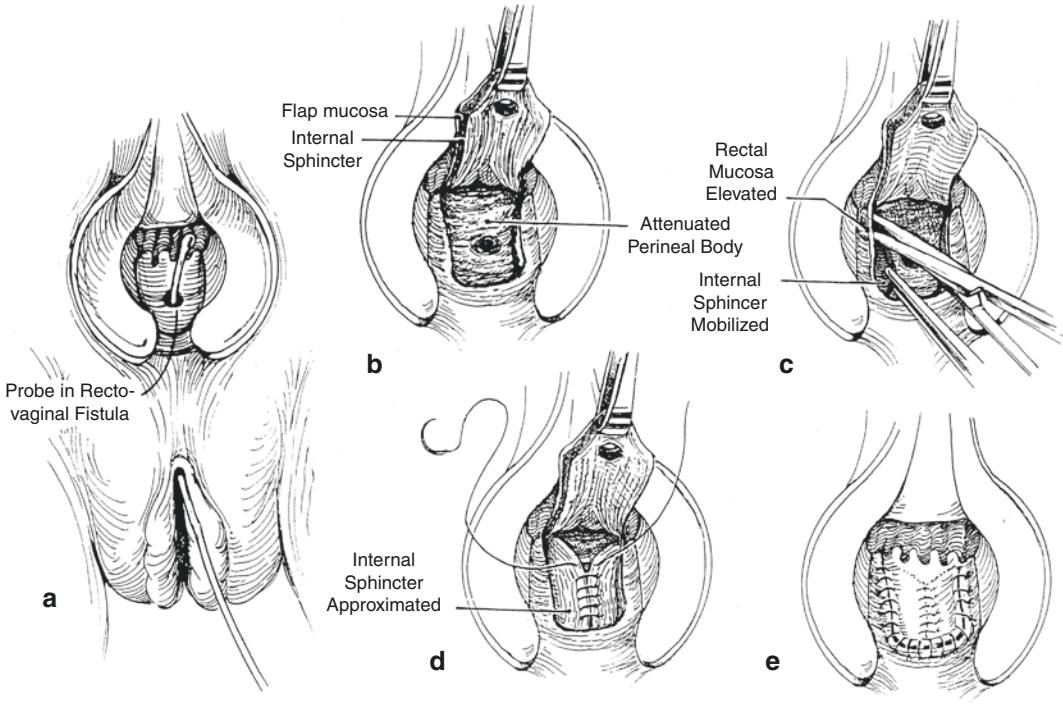


Fig. 11.1 Endorectal advancement flap. (**a**) Probe is placed through fistula. (**b**) Endorectral flap containing internal sphincter muscle is elevated. (**c**) rectal mucosa and internal sphincter muscle is mobilized. (**d**) internal sphincter muscle approximated. (**e**) distal end of flap is excised, advanced, and sutured in place

Overlapping Sphincteroplasty (OS)

First described by Parks and McPartlin in 1971, the technique for overlapping sphincteroplasty has changed only subtly over the past 45 years. The goals of the procedure are to reconstruct the entire length of the anal canal by reapproximating the severed ends of the sphincter muscle and to reestablish a functional sphincter mechanism. In the setting of RVF, the fistula is eradicated as the sphincter muscles are isolated and then overlapped.

The procedure should be done in the prone jackknife position with the buttocks taped apart for optimal exposure. A urinary catheter is placed for bladder decompression. Typically, a mechanical bowel preparation is recommended with preoperative broad-spectrum antibiotics.

A curvilinear incision is made in the perineum between the anus and vagina, taking care to respect the path of the external sphincter. The dissection is carried through the incision, freeing scar and muscle from both the vagina and the rectum. The proximal extent of dissection is the anorectal ring, while the lateral extent is the perirectal fat. Digital palpation and retraction through the vagina can help prevent "buttonholing" the posterior wall of the vagina.

Longitudinally, the scar-muscle complex is transected, creating two separate ends consisting of fused scar with both internal and external sphincter muscle. At this junction, the RVF is also divided. The sphincter complex is then recreated by overlapping the muscle ends, tacking them together with two to three 2-0 absorbable monofilament mattress sutures. Alternatively the intersphincteric plane can be entered to allow separate imbrication of the internal and overlap of the external anal sphincters. In the setting of a thinned perineal body, a concomitant levatorplasty can be performed to provide additional bulking to the perineum. Finally, the incision is closed in a longitudinal fashion using absorbable sutures, leaving a ¼-inch Penrose catheter within the wound to facilitate drainage. Another option is to leave the central portion of the wound open for drainage and subsequent healing by secondary intent.

Success of OS in the setting of RVF is measured by closure of the fistula tract and postoperative continence. In a small series by Chew

et al., RVF closure rate of 86% with improved continence scores following OS was reported after 24 months [44]. Multiple studies have looked at functional outcomes of OS following obstetrical injury, reporting "excellent/good" results in 23–88% of patients after a mean follow up of 24–120 months [45–48]. In a study by Barisic and colleagues, outcomes following OS were postoperatively evaluated at 3 months and a mean of 80 months using the Cleveland Clinic Florida-Fecal Incontinence Score (CCF-FIS) for measurement of continence [47]. While preoperative scores significantly dropped following OS, subsequent deterioration of continence was noted over time. Three months following surgery, greater than 66% of patients reported satisfactory results; only 50% of patients reported satisfactory results after a mean of 80 months. It is unclear what contributes to poor functional results and decreased continence over time, although patient age, preoperative pudendal nerve injury, and early postoperative incontinence have been postulated as contributing factors [48–50].

Perineoproctotomy (PP)

Also referred to as an episioproctotomy, PP is most commonly utilized for RVF repair in the setting of a significant anterior sphincter muscle defect. First, the fistula is identified with a probe and the residual perineal tissue is divided, essentially resulting in an iatrogenic cloaca. Next, the sphincter muscles are dissected free from the edges of the rectovaginal septum. The rectal mucosa is reapproximated prior to performing an OS. Lastly, the vaginal mucosa is closed, as well as, the perineal skin (Fig. 11.2).

Historically, surgeons have been reluctant to perform PP due to concerns of dividing perineal tissue and, occasionally, anterior sphincter muscle. In a series of 50 patients undergoing PP, Hull and colleagues demonstrated promising results with healing rates of 78%, comparable

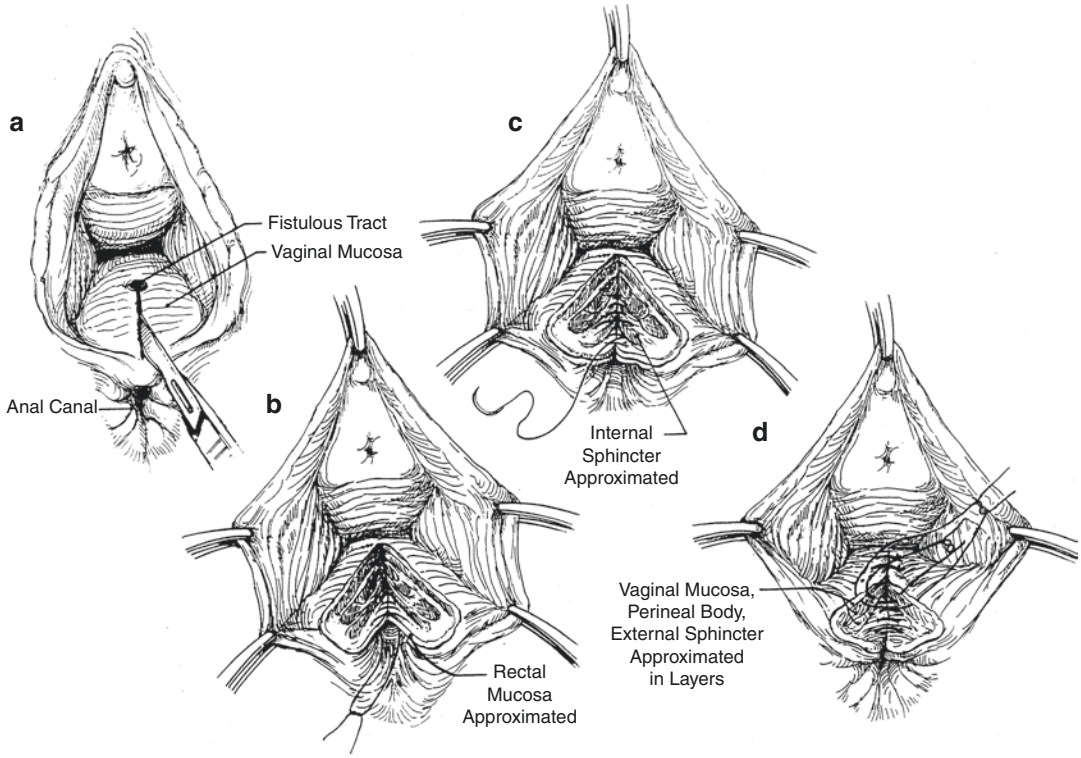


Fig. 11.2 Perineoproctotomy. (**a**) Fistula tract is opened from vagina to anus. (**b**) Rectal mucosa is approximated. (**c**) Internal sphincter muscle is approximated. (**d**) External sphincter, perineal body, and vagina mucosa are approximated in layers

to prior studies [51–53]. Improved fecal continence scores and sexual function have also been reported following PP repair [51].

Complex Fistula Repair

Tissue interposition flaps or reoperative resections can be warranted for complex RVF that may be large in size, surrounded by fibrotic tissue, recurrent in nature or associated with Crohn's disease.

Bulbocavernosus Muscle Flap

First described by Heinrich Martius in 1928, the Martius flap is a pedicled flap that consists of bulbocavernosus muscle and fibroadipose tissue from the labia majorus. It has been used for repair of urogynecologic defects and RVF. Drawing its blood supply from the internal and external pudendal arteries, it is a well-vascularized, accessible, and mobile flap that is well-suited for repairing complex and recurrent RVF, typically located in the lower to middle-third of the vagina.

After dissecting out the fistula in the rectovaginal septum through a perineal approach, both the rectal and vaginal fistula openings are sutured closed. The flap is harvested through a longitudinal incision in the labia majorus, taking care to preserve the integrity of the posterolateral internal pudendal artery. Sufficient flap length should be achieved to allow for tunneling of the flap underneath the bulbospongiosus muscle and tacking of the apex of the flap 2 cm proximal to the fistula tract (Figs. 11.3, and 11.4).

Although only reported in small series, success rates of 65–100% have been noted, with acceptable quality of life, sexual satisfaction, and continence scores [54–56].

Gracilis Muscle Transposition Flap (GMTF)

Typically reserved for recurrent RVF, the gracilis muscle transposition flap has also been utilized for primary repair in patients with high risk for repair failure such as a history of prior pelvic irradiation, Crohn's disease, large fistulae, or poor vascular supply to perineum. The rectovaginal septum is opened (Fig. 11.5) until the fistula is identified (Fig. 11.6).

Harvested through longitudinal incisions in the medial thigh, the GMTF is obtained by releasing the gracilis muscle tendon from its tibial insertion, ligating collateral vessels, and rotating the muscle over its neurovascular pedicle (Fig. 11.7). The GMTF is brought through a subcutaneous tunnel to the perineum and then positioned between the rectum and vagina, overlapping the fistula tract by at least 2 cm (Fig. 11.8). A diagram of the procedure is presented in Fig. 11.9a, b. Alternatively the gracilis muscle can be harvested through 2 3-4cm long incisions, one overlying the proximal neurovascular pedicle and one overlying the distal tendon (Figs. 11.10, 11.11, and 11.12).

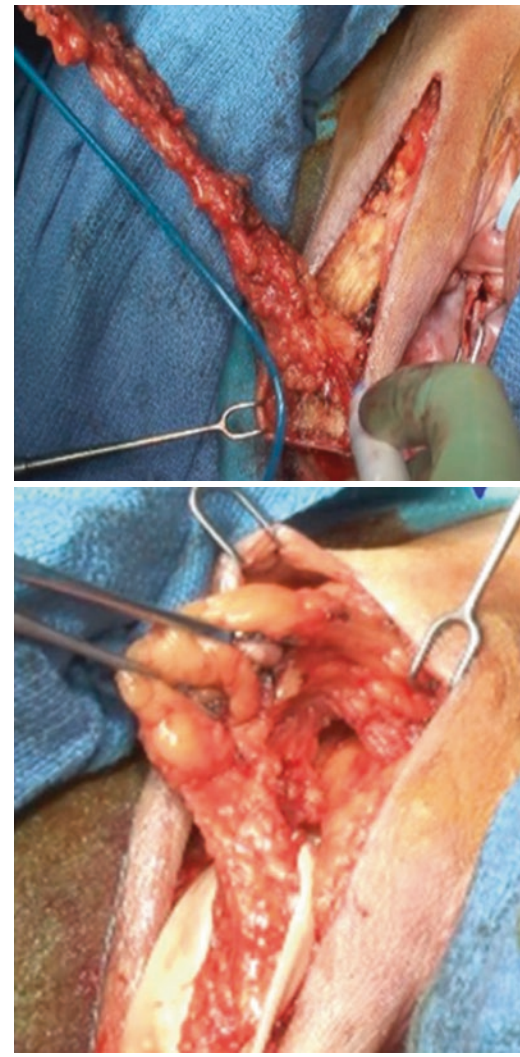


Fig. 11.3 Martius flap. Courtesy of Dr. Sam Siddighi

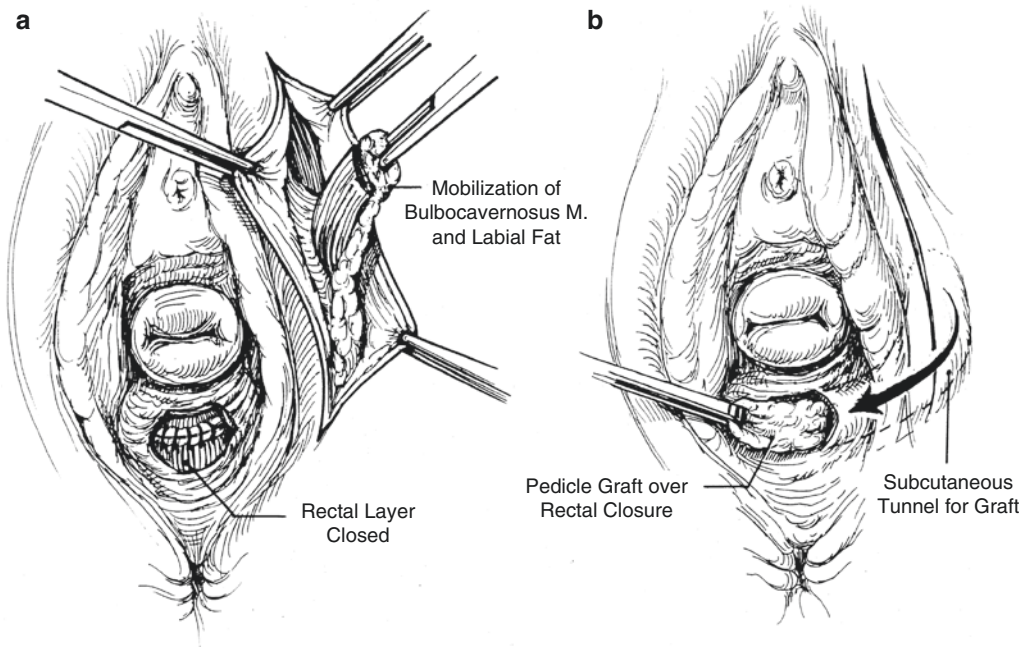


Fig. 11.4 Martius Flap. (**a**) Bubocavernous muscle and fat pad are mobilized through incison lateral to labia. Inferior blood supply is maintained. A pocket is created between vaginal mucosa and fistula. Rectal muscle at fistula site is approximated through vaginal mucosa incision. (**b**) A subcutaneous tunnel is created from labial incision to vaginal pocket. Pedicle of graft is positioned over rectal muscle and sutured in place. Incisions are closed

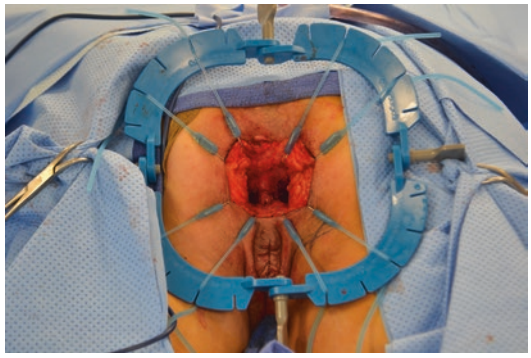


Fig. 11.5 Operative photograph demonstrating open rectovaginal fistula

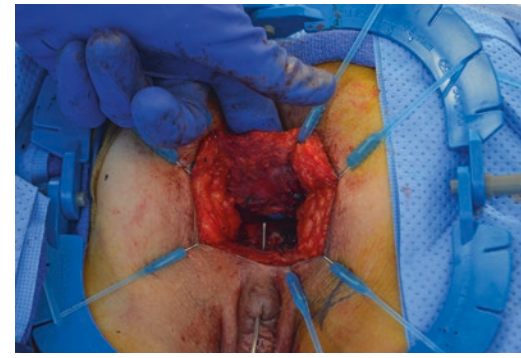


Fig. 11.6 Identification of fistula

The gracilis muscle may be harvested with the patient in the modified lithotomy position but secured in place after delineation of the fistula and dissection of the rectovaginal septum to the level of the anterior peritoneal reflection in the prone jackknife position. The patient should be mainted in an adduction splint for 3 days after surgery. Closed suction drains are left in both the thigh and perineal wounds until hospital discharge [57–59].

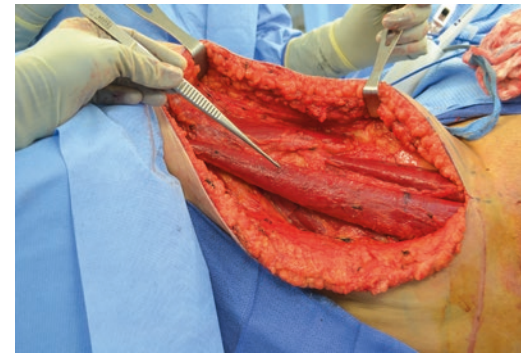


Fig. 11.7 Gracilis muscle is harvested. Courtesy of Dr. Izabela Galdyn

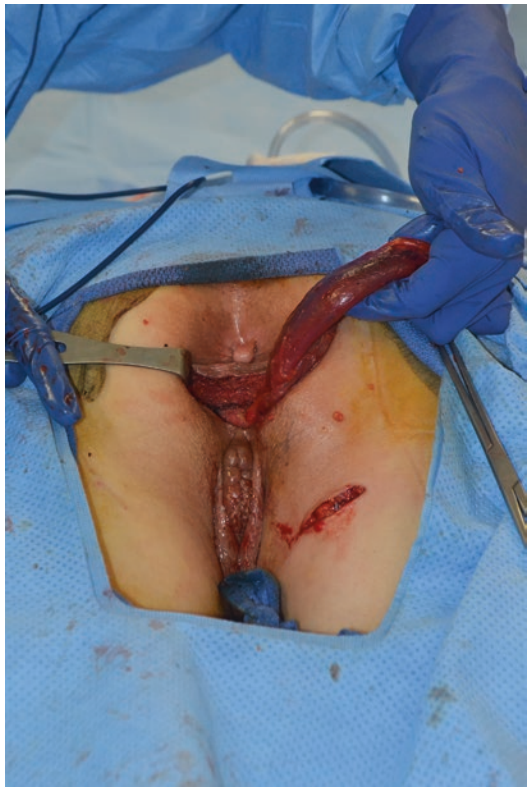


Fig. 11.8 Gracilis muscle has been brought through a subcutaneous tunnel to the perineal wound. Courtesy of Dr. Izabela Galdyn

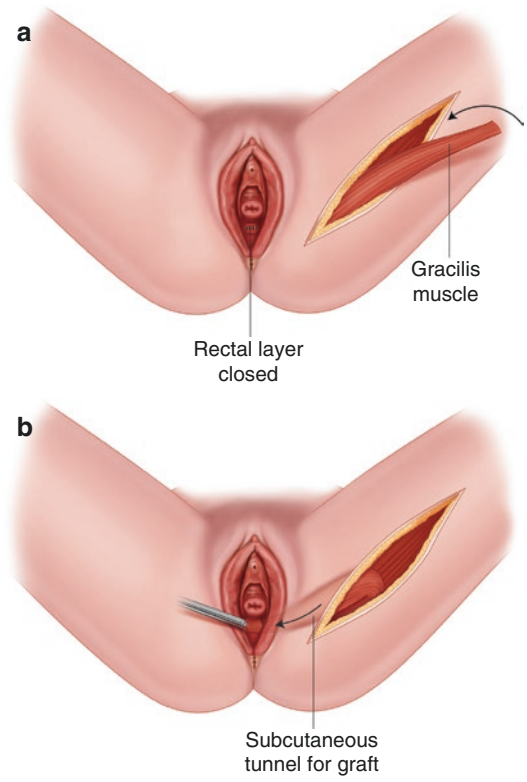


Fig. 11.9 (**a**, **b**) Gracilis muscle transposition flap

Healing rates of 53–92% have been noted in small series, with reports of minor complications such as wound infection, vaginal bleeding, and dyspareunia [60–62]. Fecal diversion is recommended due to the complexity of the fistulae and the degree of dissection. Successful stoma closure has been reported in up to 80% of patients.

Transperineal Omental Flap (TPOF)

Transperineal omental flap has also been employed for RVF repair by mobilizing the omentum from the hepatic flexure to the greater curvature of the stomach and, then buttressing the rectovaginal septal space with the well-vascularized omentum [63]. In addition, a perineal incision is used to further dissect out the RVF and to help anchor the omentum below the tract. Schloericke et al. reported a 100% healing rate in a series of nine patients within a 22-month follow up period. Studies by van der Hagen et al. and Mukwege et al. demonstrated successful techniques paring laparoscopic fistula excision and omentoplasty for high RVF [64, 65]. Created laparoscopically, the TPOF has the advantages of minimizing operative trauma

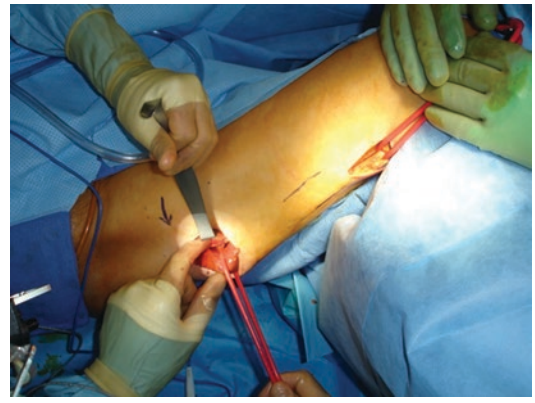


Fig. 11.10 One of the editors (SDW) prefers 2 smaller leg incisions instead of 1 long leg incision. The arrow shows the expected position of the neurovascular pedicle

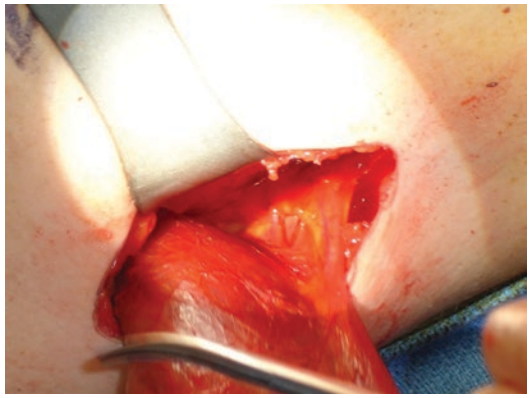


Fig. 11.11 Proximal muscle and neurovascular pedicle

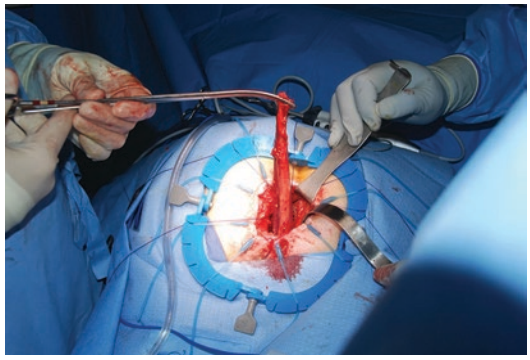


Fig. 11.12 With the patient in the prone-jackknife position, the muscle has been delivered through the perineal incision and will be secured in place between the anterior (vaginal) and posterior (rectal) fistula openings. Both the vaginal and rectal openings have been repaired by excision and primary flap closure and the sutures with which the gracilis muscle will be parachuted into place have been placed and tagged

and avoiding the physiologic impact of muscle transposition.

Resection Repair

In the setting of persistent RVF after proctectomy or previous repair, colorectal resection may be warranted. Reoperative surgery with a new colorectal or coloanal anastomosis may be an option, typically employing a proximal diverting stoma.

Originally described in the setting of Hirschsprung's disease, Chagasic megacolon, and rectal cancer, the Turnbull-Cutait delayed coloanal anastomosis has also been utilized in the setting of RVF to preserve sphincter function and salvage intestinal continuity (Fig. 11.13). This procedure involves a colonic pull-through with exteriorization of the proximal colon, followed by delayed coloanal anastomosis several days later.

Fig. 11.13 Turnbull-Cutait coloanal anastomosis

Although results from this approach have been promising with stoma-free RVF closure rates around 80%, the procedure is associated with high postoperative morbidity (19–55%) [66, 67]. Based on the difficulty of reoperative pelvic surgery and elevated surgical risks, reoperative surgery with or without delayed coloanal anastomosis is only recommended after all conservative repair options have been exhausted.

Bricker Patch Repair

In the setting of a radiation-induced fistula associated with stricture of the rectum, a Bricker patch or onlay colonic patch technique can be utilized (Fig. 11.14). The procedure involves dissecting out the RVF with fistulectomy. The vaginal fistula opening is closed, while the rectal defect is patched with a portion of proximal colon. This allows for a widening of the affected stretch of rectum and restoration of function [68].

Stent Repair

Lamazza and colleagues have described the use of endoscopically placed, self-expanding metallic stents in the setting of RVF after colorectal cancer resection [69]. In a small series of ten patients, an 80% healed rate without significant fecal incontinence was noted after a mean follow

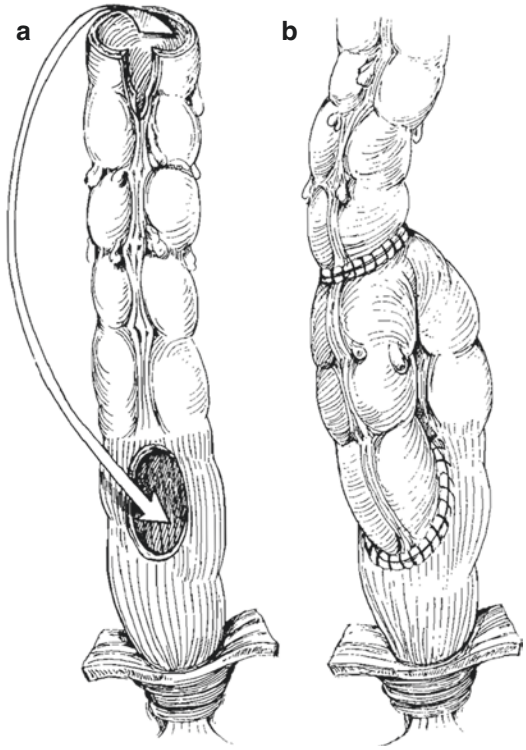


Fig. 11.14 Bricker patch repair. (**a**) Sigmoid colon is divided and distal end spatulated. (**b**) sigmoid is anastomosed to fistula and proximal sigmoid is attached to top of bowel loop

up of 24 months. The two patients who did not completely heal after stenting had reduction in fistula diameter, allowing for successful closure with an advancement flap.

Crohn's-Related RVF Repair

RVF in the setting of Crohn's disease is notoriously difficult to treat both medically and surgically. As evidenced by the ACCENT II trial, *infliximab* responders with RVF only remained healed at 54 weeks in 44% of cases. Multiple surgical approaches (ranging from ERAF to coloanal pull-through to proctectomy) have been taken to eradicate RVF, as there is no consensus regarding the appropriate strategy for this heterogeneous subset of patients.

El-Gazzaz and colleagues used ERAF, PP, coloanal pull-through, and biologic grafts and found no significant difference in the type of repair between healed and unhealed patients [70]. Successful healing was noted in 46.2% of patients and was adversely affected by steroid use and smoking.

Multiple authors have demonstrated similar long-term results ranging from 50–56% healing rates [37, 71–73]. An average of 2.1 procedures per patient was noted by Loffler to achieve healing, with 20% of patients ultimately undergoing proctectomy.

Disease activity, integrity of the perineal body, and quality of the sphincter complex should be taken into consideration prior to repair. As the presence of RVF is a negative prognostic indicator for successful anti-TNF-α therapy, active proctitis is negative prognostic indicator for surgical repair.

Ileoanal Pouch–Vaginal Fistula (IPVF) Repair

IPVF can occur following pouch creation as a result of poor healing or the development of Crohn's disease. In the setting of non-Crohn's related RVF, ileal advancement flap, re-do pouch surgery, and pouch excision have been advocated [74]. With Crohn's-related RVF, biologic therapy is typically initiated with hopes of minimizing active disease and salvaging the pouch. Poor response to biologic therapy is associated with increase pouch failure rate.

Diversion

Controversy remains regarding whether a patient undergoing RVF repair requires fecal diversion. While stomas tend to be created in the setting of more complex fistulae and in patients with multiple comorbidities, studies have suggested that diversion has no influence on recurrence, complication rates, wound infections, or number of operative revisions [75]. Most of the data regarding diversion in this setting emanate from retrospective studies where surgeons have elected to divert for various reasons. No randomized trials have been conducted to address this question.

Conclusion

A distressing condition afflicting millions of women worldwide, RVF is a complex condition that has traumatic, neoplastic, infectious, and inflammatory origins. A careful eye and

high index of suspicion must be utilized for accurate evaluation of the female patient who presents with the symptoms of the passage of gas and/or stool through the vagina. No clear consensus exists for management of RVF, as great heterogeneity exists amongst women seeking treatment. From the simple lay-open fistulotomy to more complex tissue interposition grafts, multiple surgical procedures have been utilized with varied results. ERAF are utilized with the greatest frequency for simple RVF with success rates in the 60–88% range. Complex fistulae tend to require more aggressive surgical intervention, commonly warranting more than one attempt at repair. In the setting of Crohn's disease, the presence of active disease can eliminate particular surgical options and inhibit appropriate wound healing. A careful evaluation of each patient with RVF is necessary to tailor treatment for appropriate medical and surgical intervention.

Acknowledgements Proctor and lecturer for Intuitive Surgical, Inc.

References

1. Champagne B, McGee M. Rectovaginal fistula. Surg Clin N Am. 2010;90:69–82.
2. Browning A, Whiteside S. Characteristics, management, and outcomes of repair of rectovaginal fistula among 1100 consecutive cases of female genital tract fistula in Ethiopia. Int J Gynecol Obstet. 2015;131:70–3.
3. Brown H, Wang L, Bunker C, Lowder J. Lower reproductive tract fistula repairs in inpatient US women, 1979-2006. Int Urogynecol J. 2012;23:403–10.
4. Reisenauer C. Presentation and management of rectovaginal fistulas after delivery. Int Urogynecol J. 2016;27:859–64.
5. Ommer A, Herold A, Berg E, Furst A, Schiedeck T, Sailer M. German S3-Guideline: rectovaginal fistula. Ger Med Sci. 2012;10:Doc15.
6. Goldaber K, Wendel P, McIntire D, Wendel G. Postpartum morbidity after fourth-degree perineal repair. Am J Obstet Gynecol. 1993;168:489–93.
7. Miller D, Lucente V, Babin E, Beach P, Jones P, Robinson D. Prospective clinical assessment of the transvaginal mesh technique for treatment of pelvic organ prolapse: 5-year results. Female Pelvic Med Reconstr Surg. 2011;17:139–43.
8. Caquant F, et al. Safety of transvaginal mesh procedure: retrospective study of 684 patients. J Obstet Gynaecol Res. 2008;34:449–56.
9. Watanabe J, et al. Incidence and risk factors for rectovaginal fistula after low anterior resection for rectal cancer. Int J Color Dis. 2015;30:1659–66.
10. Matthiessen P, Hansson L, Sjodahl R, Rutegard J. Anastomotic-vaginal fistula after anterior resection of the rectum for cancer—occurrence and risk factors. Color Dis. 2010;12:351–7.
11. Radcliffe A, Ritchie J, Hawley P, Lennard-Jones J, Northover J. Anovaginal and rectovaginal fistulas in Crohn's disease. Dis Colon Rectum. 1988;31:94–9.
12. Richard C, Cohen Z, Stern H, McLeod R. Outcome of the pelvic pouch procedure in patients with prior perianal disease. Dis Colon Rectum. 1997;40:647–52.
13. Belliveau P, Trudel J, Vasilevsky C, Stein B, Gordon P. Ileoanal anastomosis with reservoirs: complications and long-term results. Can J Surg. 1999;42:345–52.
14. Seidel S, Peach S, Newman M, Sharp K. Ileoanal pouch procedures: clinical outcomes and quality of life assessment. Am Surg. 1999;65:40–6.
15. Corte H, Maggiori L, Treton X, Lefevre J, Ferron M, Panis Y. Rectovaginal fistula: what is the optimal strategy? Ann Surg. 2015;262:855–61.
16. Jakubowicz J, Blecharz P, Skotnicki P, Reinfuss M, Walasek T, Luczynska E. Toxicity of concurrent chemoradiotherapy for locally advanced cervical cancer. Eur J Gynaecol Oncol. 2014;35:393–9.
17. De Beche-Adams T, Bohl J. Rectovaginal fistulas. Clin Colon Rectal Surg. 2010;23:99–103.
18. Ugurel V, Ozer D, Varol F. A rare case of rectovaginal fistula after consensual vaginal intercourse. J Sex Med. 2014;11:1345–8.
19. Schwartz J, Rabinowitz H, Rozenfeld V, Leibovitz A, Stelian J, Habot B. Rectovaginal fistulas associated with fecal impaction. J Am Geriatr Soc. 1992;40:641.
20. Ozuner G, Elagili F, Aytac E. Rectovaginal fistula secondary to an erosive pessary. Tech Coloproctol. 2015;19:491–2.
21. Ampt A, Patterson J, Roberts C, Ford J. Obstetric anal sphincter injury rates among primiparous women with different modes of vaginal delivery. Int J Gynaecol Obstet. 2015;131:260–4.
22. Yee L, Birnbaum E, Read T, Kodner I, Fleshman J. Use of endoanal ultrasound in patients with rectovaginal fistulas. Dis Colon Rectum. 1999;42:1057–64.
23. Stoker J, Rociu E, Wiersma T, Lameris J. Imaging of anorectal disease. Br J Surg. 2000;87:10–27.
24. Tsang C, et al. Anal sphincter integrity and function influences outcome in rectovaginal fistula repair. Dis Colon Rectum. 1998;41:1141–6.
25. Stoker J, Rociu E, Schouten W, Lameris J. Anorectal and rectovaginal fistulas: endoluminal sonography versus endoluminal MR imaging. AJR Am J Roentgenol. 2002;178:737–41.
26. Denson L, Shobeiri S. Peroxide-enhanced 3-dimensional endovaginal ultrasound imaging for diagnosis

of rectovaginal fistula. Female Pelvic Med Reconstr Surg. 2014;20:240–2.
27. Rahman M, Al-Suleiman S, El-Yahia A, Rahman J. Surgical treatment of rectovaginal fistula of obstetric origin: a review of 15 years' experience in a teaching hospital. J Obstet Gynaecol. 2003;23:607–10.
28. Hannaway C, Hull T. Current considerations in the management of rectovaginal fistula from Crohn's disease. Color Dis. 2008;10:747–56.
29. Zhu Y, Tao G, Zhou N, Xiang C. Current treatment of rectovaginal fistula in Crohn's disease. World J Gastroenterol. 2011;28:963–7.
30. Present D, Lichtinger S. Efficacy of cyclosporine in the treatment of fistula of Crohn's disease. Dig Dis Sci. 1994;39:374–80.
31. Present D, et al. Infliximab for the treatment of fistulas in patients with Crohn's disease. N Engl J Med. 1999;340:1398–405.
32. Parsi M, Lashner B, Achkar J, Connor J, Brzezinski A. Type of fistula determines response to infliximab in patients with Crohn's disease. Am J Gastroenterol. 2004;99:445–9.
33. Sands B, Blank M, Patel K, van Deventer S. Long-term treatment of rectovaginal fistulas in Crohn's disease: response to infliximab in the ACCENT II study. Clin Gastroenterol Hepatol. 2004;10:912–20.
34. Lichtenstein G, et al. Clinical trial: benefits and risks of immunomodulators and maintenance infliximab for IBD-subgroup analyses across 4 random trials. Aliment Pharmacol Ther. 2009;30:210–26.
35. Kodner I, Mazor A, Shemesh E, Fry R, Fleshman J, Birnbaum E. Endorectal advancement flap repair of rectovaginal and other complicated anorectal fistulas. Surgery. 1993;114:682–90.
36. Ozuner G, Hullt T, Cartmill J, Fazio V. Long-term analysis of the use of transanal rectal advancement flaps for complicated anorectal/vaginal fistulas. Dis Colon Rectum. 1996;39:10–4.
37. Sonoda T, Hull T, Piedmonte M, Fazio V. Outcomes of primary repair of anorectal and rectovaginal fistulas using the endorectal advancement flap. Dis Colon Rectum. 2002;45:1622–8.
38. Lowry A, Thorson A, Rothenberger D, Goldberg S. Repair of simple rectovaginal fistulas: influence of previous repairs. Dis Colon Rectum. 1988;31:676–8.
39. Buchanan G, et al. Efficacy of fibrin sealant in the management of complex anal fistulas: a prospective trial. Dis Colon Rectum. 2003;46:1167–74.
40. Loungnarath R, Dietz D, Mutch M, Birnbaum E, Kodner I, Fleshman J. Fibrin glue treatment of complex anal fistulas has low success rates. Dis Colon Rectum. 2004;47:432–6.
41. Gonsalves S, Sagar P, Lengyel J, Morrison C, Dunham R. Assessment of the efficacy of the rectovaginal button fistula plug for the treatment of ileal pouch-vaginal and rectovaginal fistulas. Dis Colon Rectum. 2009;52:1877–81.
42. Thekkinkattil D, Botterill I, Ambrose N, Lundby L, Sagar P, Buntzen S, Finan P. Efficacy of the anal fistula plug in complex anorectal fistulae. Color Dis. 2009;11:584–7.
43. Gajsek U, McArthur D, Sagar P. Long-term efficacy of the button fistula plug in the treatment of ileal pouch-vaginal and Crohn's-related rectovaginal fistulas. Dis Colon Rectum. 2011;54:999–1002.
44. Chew S, Rieger N. Transperineal repair of obstetric-related anovaginal fistula. Aust N Z J Obstet Gynaecol. 2004;44:68–71.
45. El-Gazzaz G, Zutshi M, Hannaway C, Gurland B, Hull T. Overlapping sphincter repair: does age matter? Dis Colon Rectum. 2012;55:256–61.
46. Maslekar S, Gardiner A, Duthie G. Anterior anal sphincter repair for fecal incontinence: good long-term results are possible. J Am Coll Surg. 2007;204:40–6.
47. Barisic G, Krivokapic Z, Markovic V, Saranovic D, Kalezic V, Sekulic A. Endorectal ultrasound (ERUS) in pelvic disorders. Acta Chir Iugosl. 2006;53:117–20.
48. Goetz L, Lowry A. Overlapping sphincteroplasty: is it the standard of care? Clin Colon Rectal Surg. 2005;18:22–30.
49. Bravo-Gutierrez A, Madoff R, Lowry A, Parker S, Buie W, Baxter N. Long-term results of anterior sphincteroplasty. Dis Colon Rectum. 2004;47:727–31.
50. Malouf A, et al. A prospective audit of fistula-in-ano at St. Mark's Hospital. Color Dis. 2002;4:13–9.
51. Hull T, El-Gazzaz G, Gurland B, Church J, Zutshi M. Surgeons should not hesitate to perform episioproctotomy for rectovaginal fistula secondary to cryptoglandular or obstetrical origin. Dis Colon Rectum. 2011;54:54–9.
52. Mazier W, Senagore A, Schiesel E. Operative repair of anovaginal and rectovaginal fistulas. Dis Colon Rectum. 1995;38:148–52.
53. Tancer M, Lasser D, Rosenblum N. Rectovaginal fistula or perineal and anal sphincter disruption, or both, after vaginal delivery. Surg Gynecol Obstet. 1990;171:43–6.
54. Reichert M, Schwandner T, Hecker A, Behnk A, Baumgart-Vogt E, Wagenlehner F, Padberg W. Surgical approach for repair of rectovaginal fistula by modified Martius flap. Geburtshilfe Frauenheilkd. 2014;74:923–7.
55. Kniery K, Johnson E, Steele S. How I do it: Martius flap for rectovaginal fistulas. J Gastrointest Surg. 2015;19:570–4.
56. Pitel S, Lefevre J, Parc Y, Chafai N, Shields C, Tiret E. Martius advancement flap for low rectovaginal fistula: short and long-term results. Color Dis. 2011;13:112–5.
57. Takano S, Boutros M, Wexner SD. Gracilis muscle transposition for complex perineal fistulas and sinuses: a systematic literature review of surgical outcomes. J Am Coll Surg. 2014;219(2):313–23. https://doi.org/10.1016/j.jamcollsurg.2014.04.006.
58. Abu Gazala M, Wexner SD. Management of rectovaginal fistulas and patient outcome. Expert Rev Gastroenterol Hepatol. 2017;11(5):461–71. https://doi.org/10.1080/17474124.2017.1296355.

59. Takano S, Boutros M, Wexner SD. Gracilis transposition for complex perineal fistulas: rectovaginal fistula and rectourethral fistula. Dis Colon Rectum. 2014;57(4):538. https://doi.org/10.1097/DCR.0000000000000093.
60. Lefevre J, Bretagnol F, Maggiori L, Alves A, Ferron M, Panis Y. Operative results and quality of life after gracilis muscle transposition for recurrent rectovaginal fistula. Dis Colon Rectum. 2009;52:1290–5.
61. Wexner S, Ruiz D, Genua J, Nogueras J, Weiss E, Zmora O. Gracilis muscle interposition for the treatment of rectourethral, rectovaginal, and pouch-vaginal fistulas: results in 53 patients. Ann Surg. 2008;248:39–43.
62. Fürst A, Schmidbauer C, Swol-Ben J, Iesalnieks I, Schwander O, Agha A. Gracilis transposition for repair of recurrent anovaginal and rectovaginal fistulas in Crohn's disease. Int J Color Dis. 2008;23:349–53.
63. Schloericke E, Hoffmann M, Zimmermann M, Kraus M, Bouchard R, Roblick U, Hildebrand P, Nolde J, Bruch H, Limmer S. Transperineal omentum flap for the anastomotic reconstruction of the rectovaginal space in the therapy of rectovaginal fistulas. Color Dis. 2011;14:604–10.
64. van der Hagen S, Soeters P, Baeten C, van Gemert W. Laparoscopic fistula excision and omenoplasty for high rectovaginal fistulas: a prospective study of 40 patients. Int J Colorectal Dis. 2011;26:1463–7.
65. Mukwege D, Mukanire N, Himpens J, Cadiere G. Minimally invasive treatment of traumatic high rectovaginal fistulas. Surg Endosc. 2016;30:379–87.
66. Maggiori L, Blanche J, Harnoy Y, Ferron M, Panis Y. Redo-surgery by transanal colonic pull-through for failed anastomosis associated with chronic pelvic sepsis or rectovaginal fistula. Int J Color Dis. 2015;30:543–8.
67. Hallet J, Bouchard A, Drolet S, Milot H, Desrosiers E, Lebrun A, Gregoire R. Anastomotic salvage after rectal cancer resection using Turnbull-Cutait delayed anastomosis. Can J Surg. 2014;57:405–11.
68. Rivadeneira D, Ruffo B, Amrani S, Salinas C. Rectovaginal fistulas: current surgical management. Clin Colon Rectal Surg. 2007;20:96–101.
69. Lamazza A, Fiori E, Schillaci A, Sterpetti A, Lezoche E. Treatment of rectovaginal fistula after colorectal resection with endoscopic stenting: long-term results. Color Dis. 2014;17:356–60.
70. El-Gazzaz G, Hull T, Mignanelli E, Hammel J, Gurland B, Zutshi M. Analysis of function and predictors of failure in women undergoing repair of Crohn's related rectovaginal fistula. J Gastrointest Surg. 2010;14:824–9.
71. Loffler T, Welsch T, Muhl S, Hinz U, Schmidt J, Kienle P. Long-term success rate after surgical treatment of anorectal and rectovaginal fistulas in Crohn's disease. Int J Color Dis. 2009;24:521–6.
72. Hull T, Fazio V. Surgical approaches to low anovaginal fistula in Crohn's disease. Am J Surg. 1997;173:95–8.
73. Ruffalo C, et al. Outcome of surgery for rectovaginal fistula due to Crohn's disease. Br J Surg. 2009;96:1190–5.
74. Shah N, Remzi F, Massmann A, Baixauli J, Fazio V. Management and treatment outcome of pouch-vaginal fistulas following restorative proctocolectomy. Dis Colon Rectum. 2003;46:911–7.
75. Lambertz A, Luken B, Ulmer T, Bohm G, Neumann U, Klink C. Influence of diversion stoma on surgical outcome and recurrence rates in patients with rectovaginal fistula—a retrospective cohort study. Int J Surg. 2016;25:114–7.

Pelvic Organ Prolapse and Perineal Hernias

12

Dana R. Sands, Daniel S. Lavy, and Eric A. Hurtado

Introduction

As defined by the Joint Report on the Terminology for Female Pelvic Organ Prolapse (POP) by the International Urogynecological Association (IUGA)/International Continence Society (ICS), pelvic organ prolapse is defined as an anatomical change (i.e. downward displacement) of the pelvic organs which includes the uterus and/or the different vaginal compartments involving such organs as the bladder, rectum, or bowel [1]. Along with POP, urinary incontinence and bladder and bowel dysfunction comprise the category of pelvic floor disorders. Although rarely life threatening, these disorders can have a great impact upon one's quality of life. Not long ago these disorders were rarely discussed, and many women suffered in silence. As medical knowledge has expanded, growth in understanding these disorders has followed. Once thought to be uncommon, it is now known that the prevalence of one or more pelvic floor disorders among US women was 25% among 8368 non-pregnant US women surveyed. Of those women, 2.9% reported prolapse by answering "yes" to the question, "Do you see or feel a bulge in the vaginal area?" [2]. In another study of 479 women presenting for their annual gynecologic exam, 48% of women were noted to have Stage 2 POP (1 cm within to 1 cm past the hymen), and 2.6% of women were noted to have Stage 3 POP (greater than 1 cm past the hymen) [3]. Once diagnosed, approximately 1 in 9 American women will undergo surgery for a vaginal prolapse or a related disorder in their lifetime [4].

POP is thought to begin by having an injury, such as childbirth that damages the levator ani muscles. With muscle damage and dropping of the pelvic floor, the intra-abdominal forces are placed upon the connective tissue attachments or "ligaments" that suspend the pelvic organs. Certain individuals with genetically-prone weakened connective tissue will then be more susceptible to POP. Promoting factors such as further vaginal deliveries, advancing age, and obesity, may also place individuals at risk for POP. Heavy lifting, straining from constipation, and previous hysterectomy may be other risk factors [5, 6]. POP may be graded by the Baden-Walker halfway system where grades are made in reference to halfway to the hymen or halfway past the hymen [7]. POP may also be graded by the POP quantification system or POP-Q. It is a system where different points along the anterior vaginal wall, pos-

D. R. Sands (✉) · D. S. Lavy
Department of Colorectal Surgery, Cleveland Clinic Florida, Weston, FL, USA
e-mail: sandsd@ccf.org

E. A. Hurtado
Department of Gynecology, Section of Urogynecology and Reconstructive Pelvic Surgery, Cleveland Clinic Florida, Weston, FL, USA

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_12

terior wall, and apex are measured in reference to the hymen and categorized into 4 stages [8]. Currently, the POP-Q is the most commonly used in research since it can measure specific changes in pelvic support.

Rectocele

The rectovaginal fascia, sometimes named the rectovaginal septum is a thin structure separating the vagina from the rectum. A rectocele is defined as a weakness in this rectovaginal fascia with resulting herniation of the rectal wall into the vaginal lumen [9]. Age, obesity, and stress of vaginal delivery can be contributory factors. Additionally, some rectoceles may be caused by a paradoxical sphincter response, leading to an outlet obstruction. Straining to defecate in the setting of paradoxical contraction of the levator muscle can result in increased pressure anteriorly in the rectum, contributing to a rectocele [10].

The normal vagina is supported on three levels, thus the etiology of rectoceles forms at these same anatomic levels: high, mid and low (Fig. 12.1a–c). High level rectoceles are due to weakness at the upper third of the vaginal wall and cardinal or uterosacral ligaments. These can be associated with enteroceles, cystoceles and uterine prolapse, which may need to be addressed at the same time. Mid level rectoceles are most common, and are usually secondary to loss of pelvic floor support due to childbirth. Low level rectoceles are a result of perineal body defects secondary to trauma from vaginal childbirth. Obstetrical injury during childbirth commonly leads to perineal lacerations and weakening of bulbocavernous and transverse perineal muscles [11].

Patients often present with a variety of complaints including obstructive defecation, dyspareunia and most commonly, perineal pressure [11]. Women may report a need to digitally reduce the vaginal bulge in order to evacuate their bowels.

Without digital assistance in evacuation, women complain of increasing degrees of perineal pressure, which can then translate into a

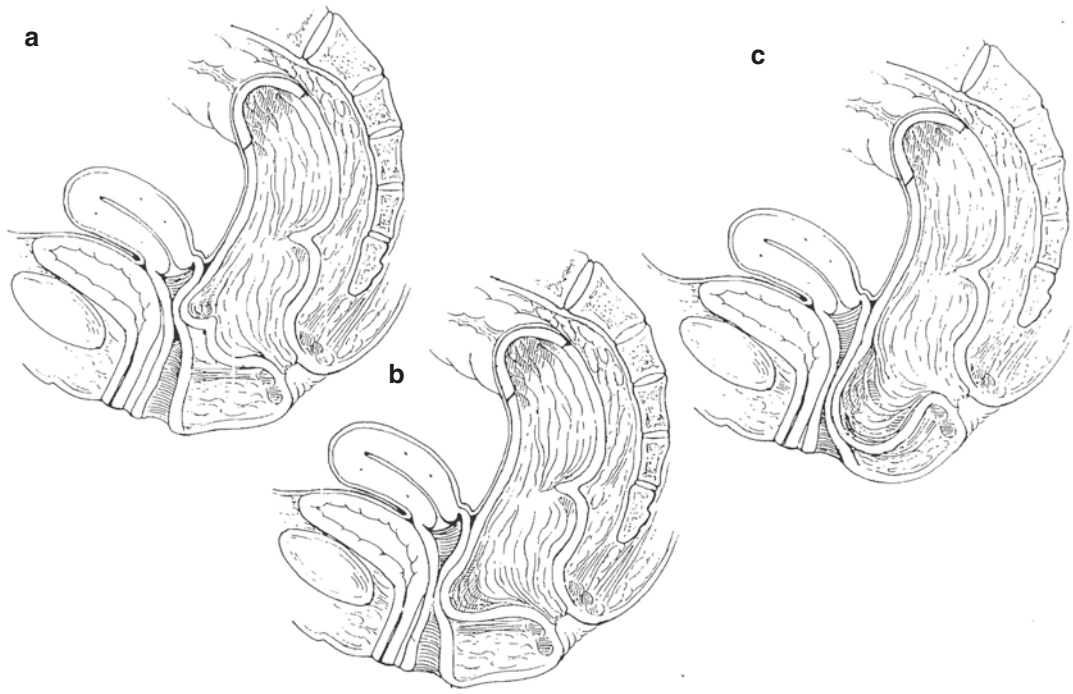


Fig. 12.1 Anatomic levels of rectoceles. (**a**) High rectocele. (**b**) Mid rectocele. (**c**) Low rectocele

cycle of increasing pelvic pressure, stronger valsalva efforts, increase in size of rectocele bulge, and a further increasing perineal pressure [9].

Patients may also complain of vaginal looseness and decreased sensation during intercourse secondary to the progressive enlargement of genital hiatus. If the rectocele extends beyond the hymenal ring the patient may present with vaginal ulceration or erosion.

Diagnosis

Physical Examination

Physical examination should be performed in a prone or supine position. A digital rectal examination and a vaginal examination should be performed. Typical findings in a female with a symptomatic rectocele include a bulge in the lower posterior vaginal wall.

Various classification tools have been devised in order to calculate severity of rectocele. The Baden-Walker system was originally created and uses the mid-vaginal plane to calculate degree of prolapse. Anatomic defects are graded from 0–4. Grade 0 is normal while grade 3 extends beyond the hymen. The pelvic organ prolapse quantification (POP-Q) system is a clinical tool used to quantify the degree of prolapse. It provides for a reproducible method to determine the relative position of cervix and posterior vaginal fornix in order to calculate the total vaginal length during straining maneuvers. POP-Q system uses defined points to measure degree of prolapse instead of the underlying organ, which decreases clinician variability [12, 13].

Imaging/Anorectal Physiologic Tests

Defecography can be a useful tool to adequately detect the presence of a rectocele, and to further evaluate rectocele size, degree of emptying, and signs of obstructed defecation.

The study is performed by injecting 100–200 cc of radiopaque paste directly into the rectum, with the patient lying on the left lateral position. The subject is then seated upright on a radiolucent commode on a fluoroscopic x-ray table. The fluoroscopic monitor is connected to a video recorder, to allow for continuous recording and review of the entire process. Images are taken at rest (R), squeeze (S), and throughout push (P); some advocate for a post-evacuatory film to evaluate for complete emptying. Anorectal angle (ARA), perineal descent (PD), and rectocele diameter can be measured (Fig. 12.2). Rectocele diameter is the distance between anorectal axis and the anterior most portion of rectocele (Fig. 12.3) [14].

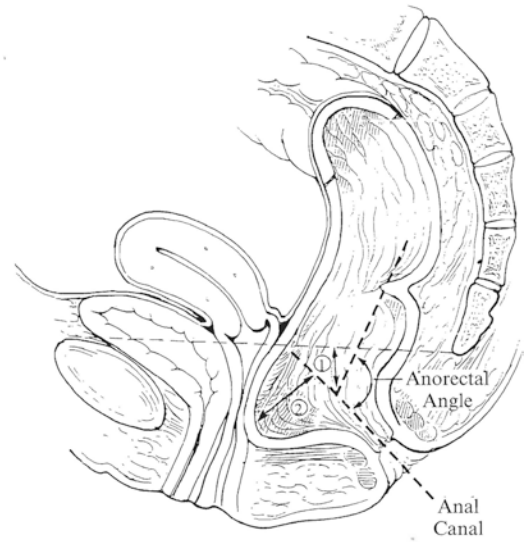


Fig. 12.2 Measurements of anorectal angle (ARA), perineal descent (1) and rectocele diameter (2) can be obtained from defecography

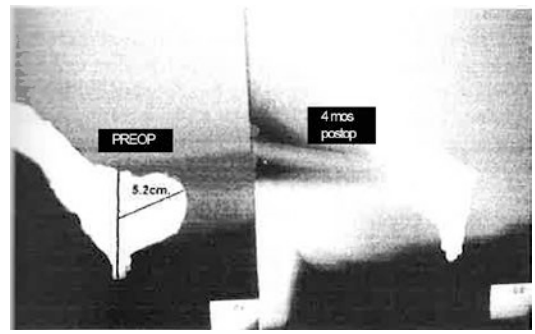


Fig. 12.3 Defecogram (lateral view) rectocele diameter is the distance between the interpolated anterior anorectal axis and the anyerior most portion of the rectocele

Treatment

Nonoperative

The most frequent complaint in patients with rectocele is difficulty with defecation. Therefore, even after the diagnosis is confirmed, an attempt should be made for conservative treatment prior to surgical intervention. 25–35 g fiber/day in addition to adequate fluid intake (2–3 L of non-caffeinated nonalcoholic liquid) is recommended. If the patient is still experiencing symptoms after 8–16 weeks, surgical therapy should be considered. Paradoxical sphincter reaction (PSR), also termed anismus or paradoxical puborectalis contraction is a frequent finding in patients with rectoceles. These patients have incomplete rectal emptying as a result of lack of relaxation of anal sphincters and the puborectalis during straining and rectal evacuation. The relationship between PSR and rectocele is controversial. Some advocate that PSR may lead to poor outcomes after rectocele repair [12]. Biofeedback is a viable option where patients learn to evacuate the rectum with a normal physiologic response. Success with this technique is highly variable and depends on aptitude of the therapist and diligence of patient. Mimura et al. showed that biofeedback therapy can lead to major symptom relief in a minority and partial symptom relief in majority of patients with a rectocele and a feeling of impaired defecation, thus the initiation of biofeedback therapy may be a viable first line option in patients with both PSR and a large rectocele [15]. Surgical repair is reserved for those patients with rectocele larger than 4 cm, which do not empty on defecography and have failed medical therapy symptoms that are attributable to the defect. Relief of evacuatory symptoms with perineal or vaginal support maneuvers is a common finding as well.

Operative

Transvaginal (Posterior Colporrhaphy)

Transvaginal approach is typically the procedure of choice used by most gynecologists. This technique can involve plication of the levator muscles and the vaginal muscularis in the midline and resection of redundant vaginal wall [12]. General anesthesia is used and patient is placed in lithotomy position. Retractors are placed in the vagina to expose the rectocele and a finger is used to determine the extent of the defect. Using electrocautery or scalpel, a transverse or anchor-shaped mucosal incision is created at the mucocutaneous border. After submucosal flaps have been raised, lateral mobilization of the rectovaginal septum is undertaken. Allis clamps are then placed at the edges of the defect of the rectovaginal fascia(muscularis). The rectocele defect is then closed in either a vertical or horizontal fashion with absorbable interrupted sutures while simultaneously depressing the anterior rectal wall. Excess vaginal epithelium is trimmed and then re-approximated with absorbable sutures (Fig. 12.4).

This technique has historically provided good functional results. However, many studies have reported high rates of sexual dysfunction. One of the most common forms of sexual dysfunction includes dyspareunia, which has been reported between 20–50% [9, 16, 17]. This may be attributed to too tight of a levator plication, causing vaginal narrowing and dyspareunia [9, 17]. This led to the evolution of a modified rectocele repair, where instead of plicating the levator muscles in the midline, discrete fascial defects in the rectovaginal septum are closed. Several studies noted improvement in sexual dysfunction ranging from 66–92% of patients [12, 17–19].

Transperineal

The transperineal approach is another approach that has been shown to have good functional results [20]. This approach necessitates a prone jackknife patient position. A U shaped incision is made in the perineum, and dissection occurs in the plane between the eternal anal sphincter (EAS) and vaginal epithelium. An L shaped strip of posterior redundant vaginal wall is retracted and resected. The resected vaginal wall is sutured closed with 3–0 absorbable sutures and the space between rectal and vaginal walls is closed. Levator plication is completed to further strengthen the

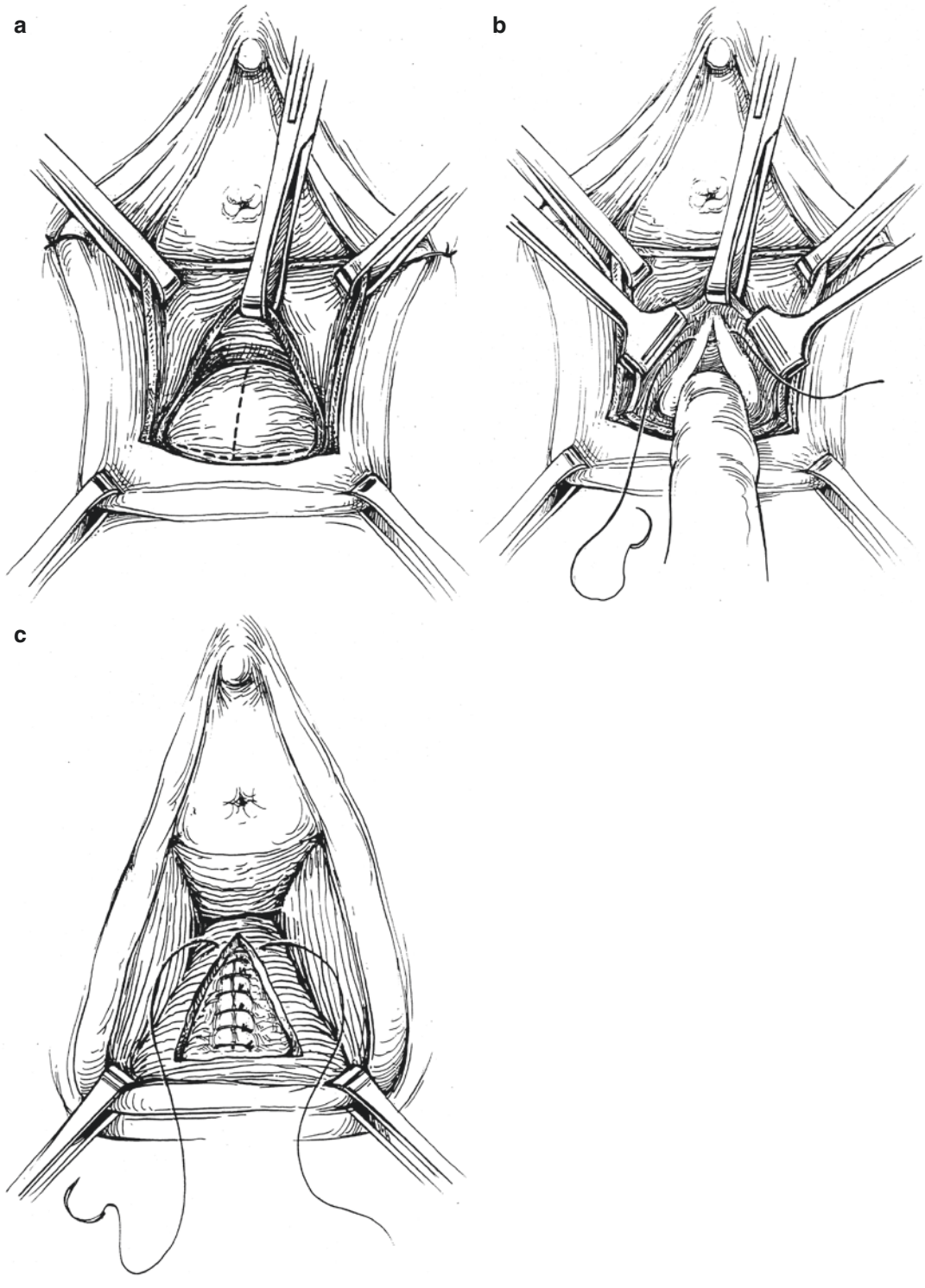


Fig. 12.4 Transvaginal rectocele repair (posterior colporrhaphy). (**a**) Incision is made in vaginal mucosa, (**b**) Rectocele is rediced and lateral rectocaginal fascia is plicated in the midline with interrupted sutires, (**c**) Excess mucosa is excised and closed

rectovaginal septum with or without the use of mesh. The skin is then completely closed. A randomized controlled trial of 62 patients in 2010 showed statistically significant improvement in defecatory symptoms in comparison to the transanal approach. Additionally, patients receiving transperineal repair with levatorplasty had significantly greater functional scores than patients receiving transperineal repair alone or transanal repair (Fig. 12.5) [20].

Transanal

The transanal approach is preferred by colorectal surgeons since they are familiar with this area. In addition, many of their patients have other concomitant anorectal pathology such as hemorrhoids, fissure, and anterior mucosal prolapse. Additionally, postoperative pain may be less than a transvaginal approach [9, 11, 12, 14]. However, the access to high rectoceles may be limited in this approach due to the high rates of anal incontinence as a result of excessive dilation for proper exposure [11]. The patient first receives a mechanical and antibiotic bowel preparation. The patient is then placed in a prone jackknife position with buttocks taped apart. The rectum is cleaned with povidine-iodine and exposure is obtained with a retractor (e.g. Pratt bivalve). Digital pal-

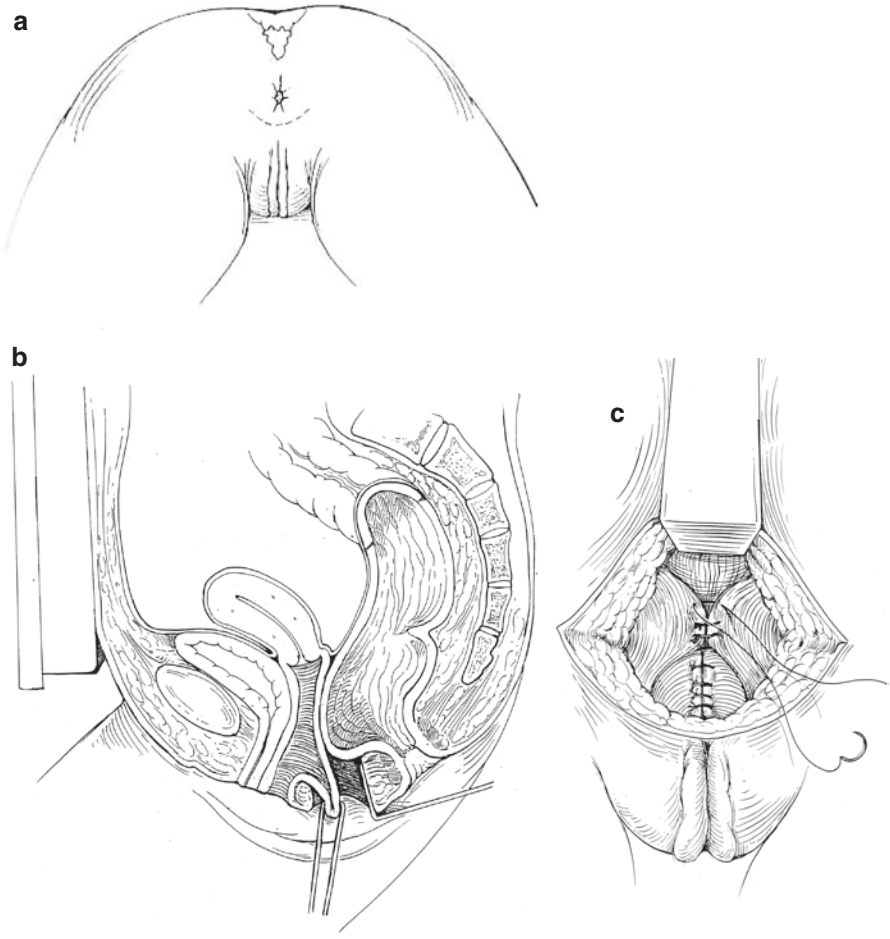


Fig. 12.5 Transperineal rectocele repair. (**a**) Surgical repair is performed through a U-shaped perineal incision. (**b**) Redundant vaginal mucosa is retracted and resected. (**c**) Resected vaginal wall is sutured closed (inferiorly) and 'levator' plicated with sutures. The skin is completely closed without drainage

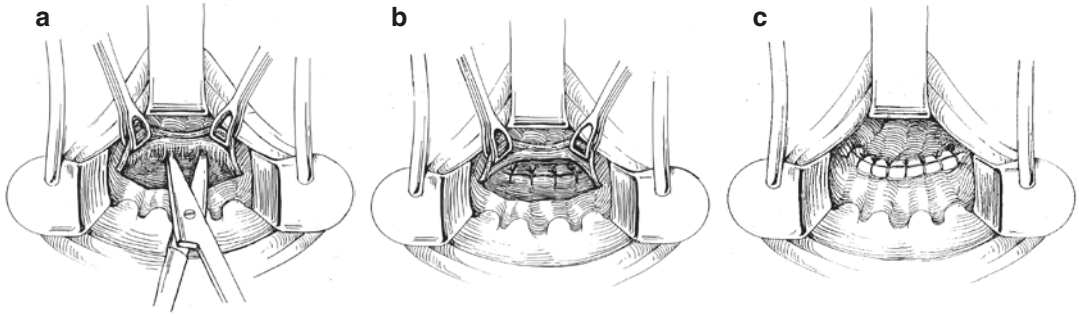


Fig. 12.6 Transanal rectocele repair. (**a**) Mucosal flap is created, (**b**) Rectal wall is plicated, (**c**) Excess mucosal is excised and closed

pation is used to confirm the size of the rectovaginal defect. Local anesthesia is injected into the submucosal plane, and a vertical, horizontal or elliptical incision is created in the anorectal mucosa depending on the repair. Mucosal flaps are then created, and the rectovaginal fascia is then plicated with absorbable sutures. Redundant mucosa is excised and closed with absorbable sutures (Fig. 12.6). Most studies support high rates of symptomatic improvement after transanal repair [21]. Despite this, a Cochrane review found lower recurrence rates when a transvaginal approach was used compared to transanal repairs, however the vaginal approach was associated with significantly higher blood loss and narcotic use. The review noted no significant differences in rates of post-operative incontinence or dyspareunia [22].

Laparoscopic Rectocele Repair Technique

Laparoscopic approach is another method specifically designed to address the fascial defects seen from above the pelvic floor. Thornton et al. described a technique of laparoscopic repair. After general anesthesia is induced and entry into the abdomen is obtained, dissection of the posterior compartment begin with uterine or vaginal vault elevation to display the uterosacral ligaments. An incision is then made in the peritoneum medial to the ureters. The superior fascia of the levator ani is exposed by dissecting medial to the uterosacral ligaments into the pararectal space. The rectovaginal space is then dissected in order to properly expose the posterior vaginal wall down to the perineal body. The rectocele is repaired by suturing the superior fascia of the levator ani from the perineal body to the uterosacral ligament. The uterosacral-cardinal ligaments are then plicated using 2–0 absorbable sutures to the vaginal fornix or the pubocervical fascia to reconstruct the vaginal vault. This retrospective matched cohort study comparing laparoscopic and transanal repair of rectoceles showed that patients treated with the transanal repair showed significantly higher degree of bowel symptom alleviation sustained over a longer period of time than patients treated laparoscopically. However, those treated laparoscopically had a lower rate of post-operative dyspareunia [23].

Cystocele/Anterior Vaginal Wall Prolapse

A cystocele (Fig. 12.7) is defined as a hernia of the urinary bladder, especially one protruding into the vagina [24]. This is also commonly referred to as anterior vaginal wall prolapse as per the IUGA/ICS Joint Terminology. Specifically, it has been defined as observation of descent of the anterior vaginal wall, which is most commonly thought to represent bladder prolapse [1]. Often anterior vaginal wall prolapse will include an apical component such as the uterus or vaginal vault and is thought to contribute to the size of the prolapse [25, 26]. Further treatment of the vaginal apex will be discussed later.

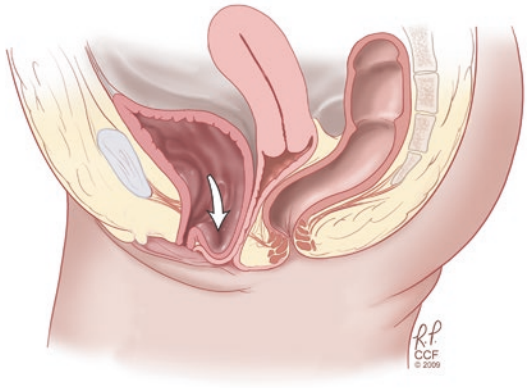


Fig. 12.7 Cystocele. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2017. All Rights Reserved

Diagnosis

Anterior vaginal wall prolapse is thought to occur from compromise of the support structures which include the vaginal muscularis (pubocervical fascia), tendinous arch, endopelvic fascia, and levator ani muscle [27]. The vaginal wall itself is composed of non-keritatinized epithelium, submucosa consisting of lamina propria, and a peripheral muscle layer also known as the muscularis. The muscularis is composed of collagen and smooth muscle, which lies under the bladder base and neck to the cervical ring [28]. Weakness of the connective tissue is thought to allow for stretching and is thought to contribute to POP. Additionally, lack of support to a vaginal compartment can lead to POP. DeLancey described three levels of vaginal support according to the "hammock theory". According to this theory, level 2 support comprised of the arcus tendineus fascia pelvis (ATFP) gives lateral support to the vaginal wall [29]. Petros et al. instead describe a system of connective tissue and ligamentous-fascial structures extending from the posterior pubis to the S3 and S4 sacrum known as the integral theory. Pelvic symptoms are proposed to come from laxity of these structures [30].

When referring to cytoceles, they may be divided into different sub-categories though some controversy exists as to whether these different defects exist or are created surgically during dissection. Apical cystoceles refer to anatomic defects in the superior third of the vagina. This is thought to be from detachment of the anterior vaginal wall muscularis from the cervical ring allowing the anterior wall to swing down like a trap door. In contrast, a medial or midline cystocele is felt to be from a weakness or thinning of the muscularis in the center of the vaginal wall. Often, this is said to be associated with lack of vaginal ruggation. The lateral cystocele may result from ligamentous or muscularis defects from the ATFP. This is also known as a paravaginal defect [27].

Treatment

Medical

When discussing treatments, non-surgical options should be offered to all patients. There is some controversy as to whether pelvic floor muscle exercises can improve mild prolapse but no evidence supports its use with prolapse at higher stages. With moderate to advanced prolapse, a pessary can be offered. They are often made of silicone in numerous sizes and several different shapes that are either supportive or space occupying. Observation may also be offered to patients without significant voiding dysfunction.

Surgical

Often, patients opt for surgical management as many do not wish to use a device that must be removed and cleaned periodically. Surgical repair of the anterior vaginal wall can be broken into reconstructive and obliterative surgery. Obliterative surgery will be discussed with apical repairs. Within the reconstructive approach, surgery may involve native tissue repair, biological grafts, or synthetic mesh. Traditionally, anterior repair (colporrhaphy) has been used to address anterior vaginal wall prolapse. This technique involves making a midline incision from the bladder neck to the apex through the vaginal epithelium. A split thickness dissection of the

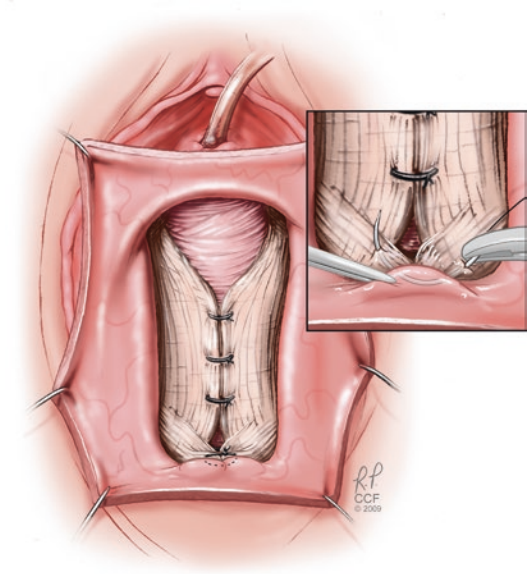


Fig. 12.8 The muscularis layer is plicated in the midline with either interrupted or a running suture. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2017. All Rights Reserved

anterior vaginal wall is then performed out laterally favoring more muscularis on the side of the bladder rather than the vaginal epithelium. Once completed, the muscularis layer is then plicated in the midline with either interrupted or a running suture (Fig. 12.8). Permanent suture may also be used but is often used as the first layer in a 2-layer technique to decrease the risk of suture exposure in the future. The plicated tissue is also often attached to the apex to address any possible apical cystoceles. Site-specific repairs are performed in a similar fashion. However, the muscularis is then attached to the separated structure such as a paravaginal repair where the muscularis is reattached to the ATFP. Native tissue repairs have been criticized due to their low success rate, which has been reported to be as low as 30–57% [31, 32]. However, many of these early studies that are often quoted do not address apical defects and used strict anatomic criteria that may not have reflected patients' symptoms.

In an effort to improve outcomes, it was felt that biological grafts would be more successful by reinforcing the weakened muscularis layer and attaching laterally and apically to address potential site-specific defects. Multiple products have been used including cadaveric skin, cadaveric fascia lata, porcine skin, porcine small intestine submucosa, porcine bladder, and bovine pericardium among others. Different processing techniques have also been used from freeze-drying to cross-linking to other special patented techniques. Success rates have been difficult to discern due to the paucity of randomized trials and the multitude of products. For example, success rates with cadaveric dermis have varied from 42 to 84% at 2 years [33]. Currently, further studies are underway to determine if biological graft augmentation leads to superior outcomes.

Mesh suspension of the vaginal apex, also known as sacrocolpopexy, has been performed for decades. Due to the good success obtained with this technique and the low success rates with anterior repairs, surgeons began using synthetic mesh in the anterior compartment to mimic these results. Many early reports demonstrated improved success rates. However, new complications arose with the most common being mesh exposure where mesh passes through the vaginal epithelium. Although rare, severe complications such as mesh erosion into the bladder and rectum have also been reported [34, 35]. Many of the original studies were hand-sewn with attachment similar to biological graft augmentation. In one of the few randomized controlled trials, 202 women were randomly assigned to traditional anterior repair or anterior repair augmented with a self-tailored low-weight monofilament polypropylene mesh. Recurrence of anterior wall prolapse occurred in 38.5% of the traditional anterior repair group versus 6.7% in the group with mesh at 1 year. Though mainly asymptomatic, mesh exposure was found to be 17.3% [36].

As early success rates with mesh augmentation appeared to be superior to native tissue repair, several companies started producing transvaginal mesh kits with standardized placement via the use of trocars passing through the transobturator space and/or sacrospinous ligament. The first kit to market in 2005 was the Prolift™, which could be placed for anterior

vaginal wall support, posterior vaginal wall support, or both. In the first multicenter case series of 110 patients, recurrence occurred in 4.7% of patients and mesh exposure in 4.7% at 3 months [37]. Rapid adoption of the use of these kits occurred. As the number of patients undergoing these procedures increased dramatically, reports of complications such as chronic pain, dyspareunia, and vaginal bleeding increased [38]. In 2008, the FDA issued a Public Health Notification due to an increase in the number of adverse events reported. As the rates of reported complications reported with transvaginal mesh continued to increase substantially, the FDA issued an Updated Safety Notification stating that serious adverse events are "not rare" and "transvaginal POP repair with mesh may not be more effective than traditional non-mesh repair" [39]. The FDA notification was supported by a large randomized trial by the Nordic Transvaginal Mesh Group, which involved 389 patients undergoing a transvaginal mesh kit or traditional anterior colporrhaphy. At 1 year 60.8% of women were considered a success by a composite score in comparison with 34.5% in the traditional group. The group concluded that the trocar-guided mesh kit for cystocele repair resulted in a higher short-term success but also had higher rates of surgical complications and postoperative adverse events [40]. These results have led both the Society of Gynecological Surgeons and the International Urogynecolgical Society to publish papers weighing the risks and benefits of mesh augmentation. Unfortunately, both societies concluded that there was insufficient evidence to guide surgeons in deciding whether the use of graft augmentation was beneficial in the anterior vaginal wall [41, 42]. Since the FDA advisory, numerous companies halted the production of their first generation transvaginal mesh kits. New kits have come to market from the same process as before while some companies have halted all production of transvaginal mesh for prolpase. In 2016, the FDA again has made changes and now requires post-market surveillance and has reclassified these devices from class II to class III based upon these devices providing a "potential unreasonable risk of illness or injury" [43]. The optimal approach for surgical repair of the anterior vaginal wall has yet to be determined.

Apical Prolapse

Apical prolapse can occur with the uterus in situ or after hysterectomy. Per the ICS/IUGA Joint Terminology, a uterine prolapse is defined as observation of descent of the uterus or cervix. A vaginal vault prolapse (cuff scar) is defined as observation of descent of the vaginal vault or cuff scar after hysterectomy [1]. As described earlier, the levator muscles contribute to POP. Additionally, the uterosacral ligament (USL) plays an integral role in providing apical support. DeLancey labeled this as Level 1 support [29]. The USLs are composed of smooth muscle cells and collagenous connective tissue with higher rates of collagen type 3 expression in patients with POP [44]. Compared to both the round and cardinal ligaments, the USL is the most rigid pelvic ligament at both low and high deformation [45]. Distally, the USL attaches to the cervix posteriorly and laterally at the level of the internal os. Proximally, the USL attaches to the presacral fascia between S2 to S4 [46].

Similarly to anterior vaginal wall prolapse, non-surgical management should be offered to all patients which includes observation, pelvic floor muscle exercises, and pessary placement. When surgical management is preferred, surgery may be performed vaginally, open, laparoscopically, or robotically. For elderly women who no longer desire to be sexually active, an obliterative procedure may be offered. This can be done with uterine preservation known as a LeFort colpocleisis. A rectangle of tissue is removed from both the anterior and posterior vaginal wall and sewn together creating 2 channels for drainage while elevating the uterus. When a vaginal vault prolapse is present, the entire mid and proximal vaginal tissue can be removed known as a colpectomy. Often the

anterior wall is again sewn to the posterior wall whereas others may use pursestring sutures. An aggressive perineorrhaphy is often performed. Both procedures will leave a normal appearance externally while creating a very narrow and short vagina. Rates of success have been reported to be as high as 98% ([47], This is the largest retrospective study to date, which reported high anatomical success and patient satisfaction with LeFort colpocleisis with minimal complication rates.).

Often reconstructive surgery is performed vaginally. The 2 most common native tissue repairs are the uterosacral ligament suspension (USLS) and the sacrospinous ligament fixation (SSLF). The USLS is performed by suturing the USL at the level of the ischial spine or higher. One to three permanent or delayed absorbable sutures are used to attach the USL to the vaginal cuff on each side, therefore suspending the vaginal apex (Fig. 12.9a). If sutures are brought across from USL to USL posteriorly, the technique is referred to as a McCall's culdoplasty. Success rates range from 66.8 to 92.4% [48]. Complications related to this procedure include ureteral occlusion, which has been reported to vary from 1 to 11% [49, 50].

The SSLF is performed unilaterally or bilaterally with either permanent or absorbable sutures. With this approach, the sacrospinous ligament (SSL) is dissected out via an anterior or posterior vaginal approach. One or more sutures are then passed under direct visualization or with a suture-capturing device. In a large study comparing SSLF to USLS, there was no statistically significant difference with success rates of 63.1% and 64.5% respectively at 2 years as defined by the apex within the upper 1/3 of the vaginal length, anterior or posterior wall to the hymen or within, no bulge symptoms, and no re-operation for prolapse [51]. Complications of this procedure include buttock pain, hemorrhage,

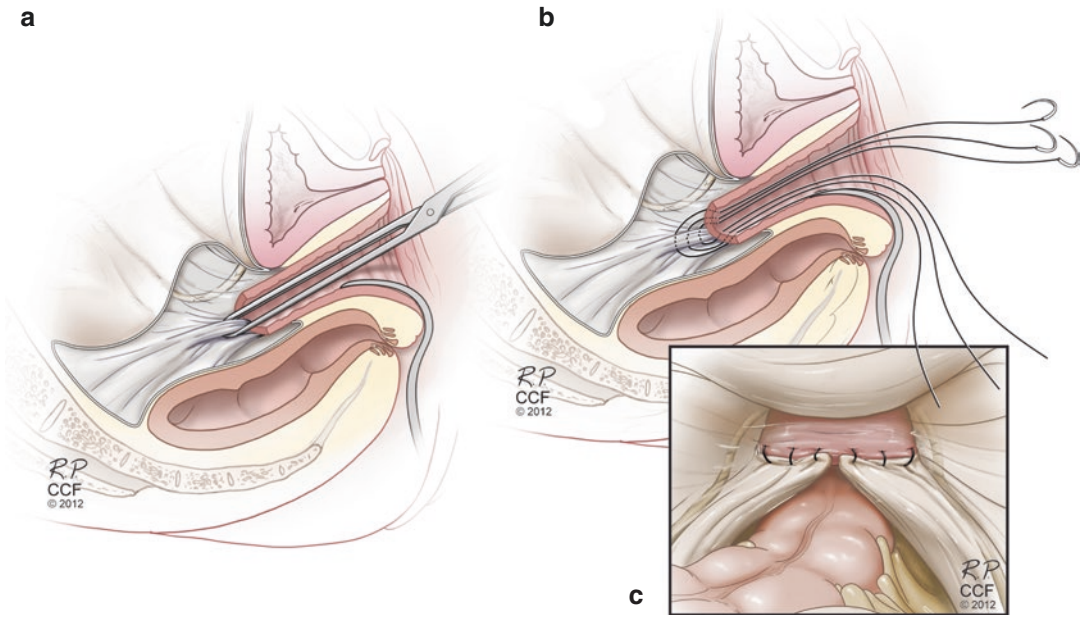


Fig. 12.9 Uterosacral ligament suspension (USLS). (**a**) One to three permanent or delayed absorbable sutures are used to attach the USL to the vaginal cuff on each side, therefore suspending the vaginal apex; (**b**) A synthetic Y-shaped mesh or two separate strips of monofilament polypropylene mesh is commonly used; (**c**) The mesh is then secured to the vaginal wall with either permanent or delayed absorbable sutures and then secured to the anterior longitudinal ligament at the sacral promontory or below. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2017. All Rights Reserved

and recurrent anterior vaginal wall prolapse [52]. Vaginal mesh may also be used to anchor to the SSL to suspend the vaginal apex while supporting the anterior vaginal wall. However as described previously, there is controversy as to whether the current reported success rates justify the rate of complications.

Apical vaginal suspension may also be performed via an abdominal approach. This was begun in 1962 where a graft was used to suspend the vaginal apex to the anterior longitudinal ligament via a laparotomy [53]. This technique is now often performed in a minimally invasive fashion either by laparoscopy or robotic assistance. A synthetic Y-shaped mesh or 2 separate strips of monofilament polypropylene mesh is commonly used (Fig. 12.9b). Deep dissection into the vesicovaginal and rectovaginal space is often performed. The mesh is then secured to the vaginal wall with either permanent or delayed absorbable sutures and then secured to the anterior longitudinal ligament at the sacral promontory or below (Fig. 12.9c). Early studies have shown superior success rates when compared to vaginal approaches [54]. Although there is a lack of randomized-controlled trials comparing the minimally invasive sacrocolpopexy to vaginal approaches, several studies have shown comparable success rates between open and minimally invasive approaches [55]. Mesh exposure rates in larger case series have varied. In a comprehensive review it was 3.4% [56].

Enteroceles

Enteroceles are defined as a hernia of peritoneum and possibly abdominal contents often occurring after reconstructive surgery. Often this occurs with widening of the rectovaginal septum. Enteroceles are associated with other defects in pelvic organ support. Symptoms of enteroceles often include pelvic pain, heaviness, or pressure. Many patients also complain of incomplete emptying of their bowels [57]. Some patients will complain of a vaginal bulge whereas others may not.

On physical examination, an enterocele may be palpated in the rectovaginal septum as the patient bears down noting widening of the rectovaginal septum. It may also be distinguished from a rectocele by rectal exam during straining. Compression of the anterior vaginal wall may also be appreciated. This may be more noticeable with the patient in a standing position. Physical examination may not always detect the presence of an enterocele. Imaging such as dynamic evacuation proctography (DEP) has been considered the gold standard for functional imaging especially to assess the posterior pelvic floor compartment. However, dynamic pelvic floor MRI and dynamic ultrasound are 2 other imaging modalities that are also proving to be useful in understanding functional disorders and diagnosing enteroceles [58].

Treatment often involves performing a culdoplasty where the posterior cul-de-sac is closed often with permanent sutures. Vaginally, a McCall's culdoplasty can be performed by including the vaginal cuff and USL. One or more sutures are then reefed across the posterior peritoneum through the contralateral USL and other side of the vaginal cuff. When tied, the cul-de-sac is obliterated. A Moschowitz culdolplasty involves a purse-string closure of the peritoneum. This can be performed abdominally or vaginally though the original technique is done abdominally as it incorporates the posterior vaginal wall, peritoneum and taenia of the rectum. Care must be taken to avoid the ureters. In contrast, a Halban culdoplasty uses several vertical rows of sutures starting at the each uterosacral ligament laterally and traveling distally to the cul-de-sac incorporating the peritoneum then travelling back up caudally including the posterior vaginal wall. Several more medial rows of sutures are placed in a similar fashion including peritoneum or the taenia of the rectum. Figure 12.10 depicts a 41 year-old patient with an obstructive enterocele causing fecal staining and rectal pressure. No vaginal prolapse was noted on exam. A laparoscopic culdoplasty was performed to obliterate the cul-de-sac. The patient experienced

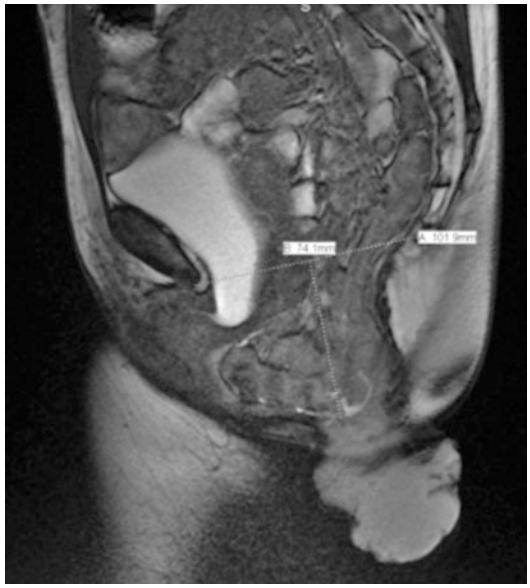


Fig. 12.10 A 41-year-old patient with an obstructive enterocele causing fecal staining and rectal pressure

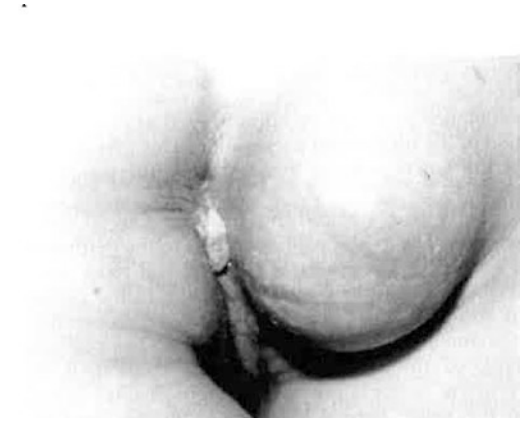


Fig. 12.11 Perineal hernia post abdominoperineal resection. Copyright © 2009 by JSLS, Journal of the Society of Laparoendoscopic Surgeons [60]

good functional improvement with at least 1 year of follow-up. Unfortunately, data is lacking in regards to long-term functional improvement and anatomic success.

Perineal Hernia

Definition

A perineal hernia is a protrusion of an intraabdominal organ or intraperitoneal tissue through a defect in the pelvic floor. Perineal hernias can be congenital, acquired (primary) or postoperative (secondary) [14, 59].

Primary Perineal Hernia

Primary perineal hernias bulge through congenital weaknesses in the pelvic floor. Their location can be described as either anterior or posterior based upon the relation to paired superficial transverse perineal muscles (Figs. 12.11 and 12.12). Anterior primary perineal hernias occur only in females and most commonly present as a mass in the labium majorus. Their contents may contain small bowel, bladder and colon. Posterior primary perineal hernias protrude through weakness in the levator plane or between the levator and coccygeus muscles. Their contents often contain a portion of sigmoid colon, small bowel or omentum. Obstruction is a rare occurrence and occurs as a result of the elasticity of surrounding tissues and a wide hernia neck. The patient will present with symptoms such as pain, perineal pressure and difficulty with urination or bowel movements. On physical examination, there may be a lump below the lower margin of the gluteus maximus or a swelling between the anus and ischial tuberosity [14, 59].

Computer tomography (CT) is especially important in diagnosis to distinguish between obturator, sciatic and perineal hernias, in addition to identifying hernia contents. In a perineal hernia, a CT shows protrusion through the ishiorectal fossa or the labia majora [62].

Secondary Perineal Hernia

Secondary perineal hernia is a weakness in the endopelvic fascia due to surgically manipulated

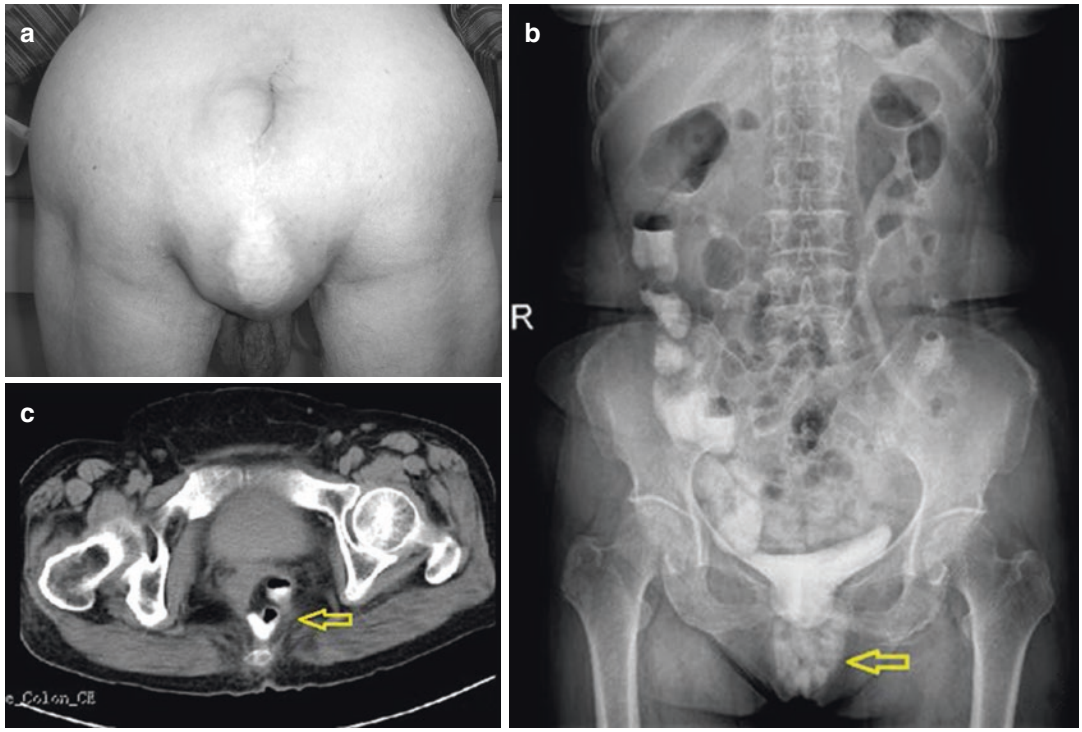


Fig. 12.12 (**a**) Preoperative picture showing the perineal hernia defect; (**b**) X-ray of the abdominal orthostatic showing hernia; (**c**) Computed tomography (CT) scan showing the small bowel sliding through the pelvic floor into the perineal area. CT image showing perineal hernia [61]. Copyright © 2015 by authors and Scientific Research Publishing Inc.

pelvic floor musculature. Herniation of intraabdominal and pelvic organs such as small bowel, colon and bladder can migrate through this defect (Fig. 12.12) [60, 63].

Contributing factors include multiple pelvic floor surgeries, therapy or excessive length of small bowel mesentery. Peri-operative pelvic radiation is one of the most commonly cited contributory factors [64]. The reported incidence of postoperative perineal hernia requiring surgical repair is less than 1% after APR and 3% after pelvic exenteration [63]. However, prevalence in the literature is variable and ranges from 0.6–7% [64].

Symptoms include perineal pressure, fullness, discomfort, bowel obstruction, skin breakdown or evisceration. The most commonly reported symptom of secondary perineal hernia is discomfort during sitting.

Physical examination should demonstrate a perineal bulge with bowel sounds. If the examination is not as straightforward, CT imaging can be helpful to establish a diagnosis and differentiate a perineal hernia from a locally recurrent tumor (Fig. 12.12). There are many operative techniques for repair of perineal hernias including perineal, open and combined abdominoperineal approach, and lapaoroscopic transabdominal repair. The repair is challenging, as the recurrence rate has been reported to be as high as 37% [64].

Types of Repair (Table 12.1) [73]

Transabdominal Repair

This approach is best for those with recurrent hernias, or in those that merit a laparotomy for

Table 12.1 Overview of the literature on perineal hernia repair

Author	No patients	Perineal	Abdominal	Combined	Mesh	Recurrence (%)	Preference
So et al. 1997 [65]	21	13	3	3	5	14	Perineal
Ego-Aguirre et al. 1964 [66]	9	8	1	0	4	44	Perineal
Aboian et al. 2006 [67]	8	4	4	0	4	0	No
Beck et al. 1987 [68]	8	2	6	0	6	37	Abd
Dulucq et al. 2006 [69]	4	0	4 (lap)	0	4	25	Abd (lap)
De Campos et al. 2005 [70]	3	1	2	0	0	0	No
Villar et al. 2003 [71]	3	0	3	0	3	33	No
Veenhof et al. 2007 [72]	2	0	2	0	2	0	Abd
Rayhanabad et al. 2009 [60]	2	0	2 (lap)	0	1	0	Abd (lap)
Abbas et al. 2014 [64]	7	1	6 (lap 5)	0	4	0	Abdominal (Lap)

Abd abdominal, *lap* laparoscopic

some other reason. In this approach, the patient is placed in Lloyd-Davies position and a midline laparotomy is performed. Herniated organs, including small bowel or bladder are dissected and freed from their adhesions. The ureters, bladder and prostate (or vagina) are identified and protected.

A large nonabsorbable propylene mesh is placed across the defect and fixed to the lateral sacrotuberal ligaments with interrupted sutures. Care is taken to avoid the large pelvic vessels. During this process, an obturator may be placed into the vagina through the perineum to help identify the vaginal cuff. Any remaining omentum is placed over the mesh. This reduces the chance of bowel adhering to or eroding into the mesh. *Many* different sources describe where anatomically to anchor sutures. There is currently no consensus agreement. Beck & Wexner describe the attachment of posterior mesh to Waldeyer's fascia and sacral periosteum at or below level of S3; anteriorly, the mesh is sutured to the vagina or prostatic capsule, and laterally fascia of the pelvic sidewall and ligamentous structures are used to anchor the mesh (Fig. 12.13) [14, 67, 73].

The laparoscopic transabdominal approach can offer some advantages over the open transabdominal approach, however there are few reports describing this technique. The anatomic structures can be seen more clearly, and with this better visualization, tumor recurrence is easier to identify. Dulucq et al. describe a prospective study of four patients undergoing a laparoscopic transabdominal approach, where patients were able to be fed orally and were completely mobile the day following the procedure. Technique described includes pneumoperitoneum established through a hasson trocar. The first trocar placed at the right mammarian line. The camera port should be placed 3 cm below the umbilicus, and three additional 5 mm trocars placed suprapubic, umbilicus and right lower abdomen. After the abdomen was surveyed for tumor recurrence, the defect was repaired using a mesh arranged in the shape of the pelvic outlet by suturing the edges. The mesh is fixed laterally to the border of the levator muscle, anteriorly to the posterior face of the vagina with nonabsorbable sutures, and posteriorly with tacks to the sacral periosteum [69]. Abbas et al. reviewed 7 perineal hernias after abdominoperineal resection over 6 year time period, 6 treated with transabdominal approach and one perineal approach. They concluded that the laparoscopic mesh repair was the preferred approach with no recurrences noted [64].

Laparoscopic Repair

The use of laparoscopic transabdominal technique offers several advantages in comparison to the two alternative techniques (Table 12.2). This approach facilitates a clear view of anatomic structures, helps to exclude tumor recurrence, and

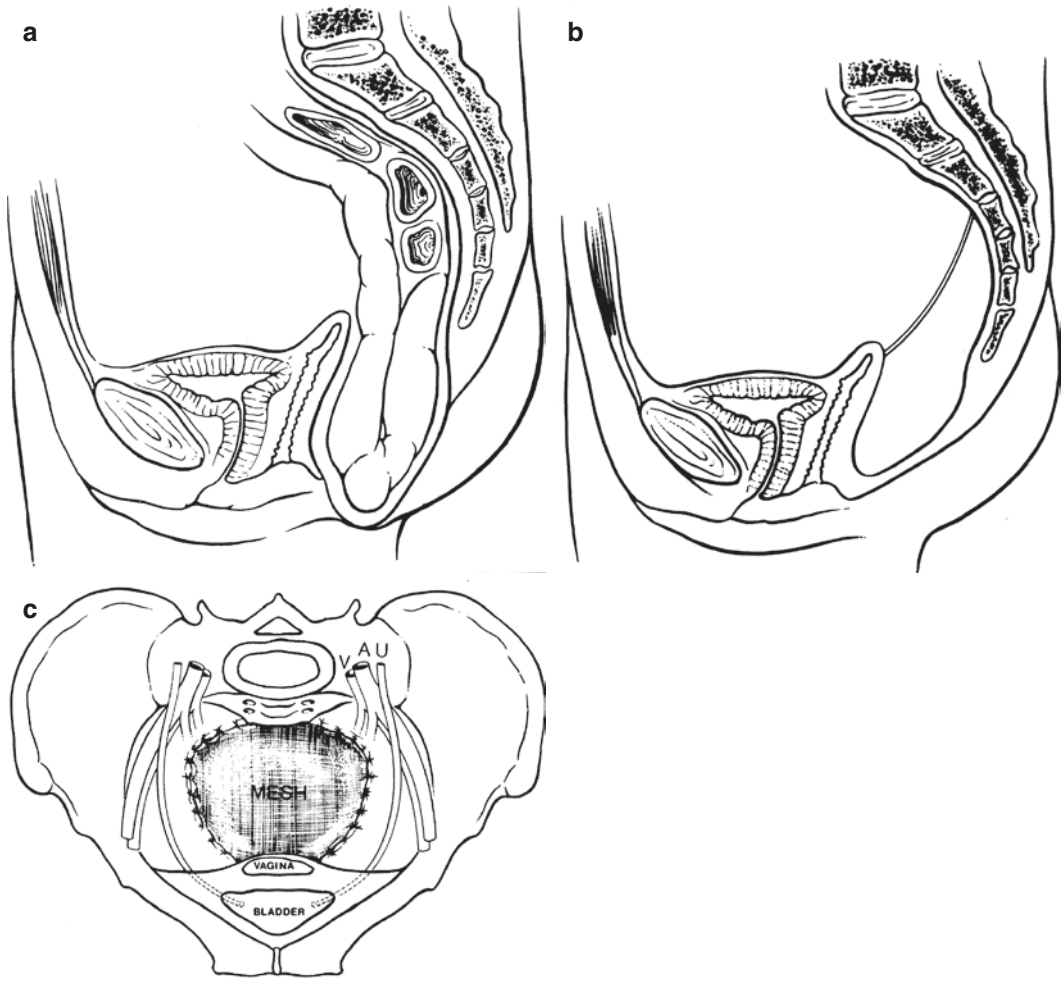


Fig. 12.13 Perineal hernia. (**a**) Sagital section of the pelvis demonstrating a perineal hernia with incarcerated small bowel. (**b**) Sagital section of the pelvis with mesh in place. (**c**) View of the pelvis from above with mesh in place (A, common iliac artery; V, common iliac vein; U, ureter)

Table 12.2 Review of Laparoscopic Repairs

Author/year	No of patients	Type of mesh	Recurrence (%)
Dulucq et al. 2006 [69]	4	Composite polypropylene	25
Rayhanabad et al. 2009 [60]	2	Composite ½	0
Casasanta et al. 2012 [74]	1	Marlex	0
Svabe et al. 2012 [75]	1	Permacol biological	0
Abbas et al. 2014 [64]	5	Composite mesh	0

patients enjoyed a hasty recovery. In a case series of 4 patients undergoing laparoscopic repair of postoperative perineal hernia from 2003–2004. Their approach involved a 12 mm trocar at the right mammarian line, 3 cm below the umbilicus, which served as the camera port. In addition, 3 additional 5 mm trocars were placed; one suprapubic and the other trocars in the right lower quadrant. The defect was repaired with a composite mesh shaped into a concave form by sutur-

ing the edges to the fit the shape of the pelvic outlet. The mesh was sutured laterally to the levator muscle, anteriorly to the posterior surface of the vagina with nonabsorbable sutures, and posteriorly with tacks (Protack Norwalk, CT) to the sacral periostium. Patients in their case series did well with minimal blood loss, average length of hospital satay was 4 days and at 6 months, their results showed no hernia recurrence [69].

Perineal Repair

Other techniques of perineal hernia repair include the perineal approach.

The patient is placed in lithotomy or trendelenburg position and a skin incision is created over the perineal bulge. Once the sac is entered, its contents are reduced and the sac is excised. The hernia defect is then closed using nonabsorbable sutures [59]. Many critics of this approach argue that exposure is limited. Not only is there the risk of missing a tumor recurrence, but if bleeding or bowel injury is encountered, it becomes much more challenging to fix [14, 59, 64].

Many other techniques have been described to repair the pelvic defect and further strengthen the weakened pelvic floor. So et al. advocated for a simple closure of the pelvic defect by approximating the levators with a nonabsorbable suture [65, 69]. One of the editors (SDW) prefers a perineal repair with mesh as shown in (Fig. 12.14). Gluteal flaps are mobilized to cover the mesh [76].

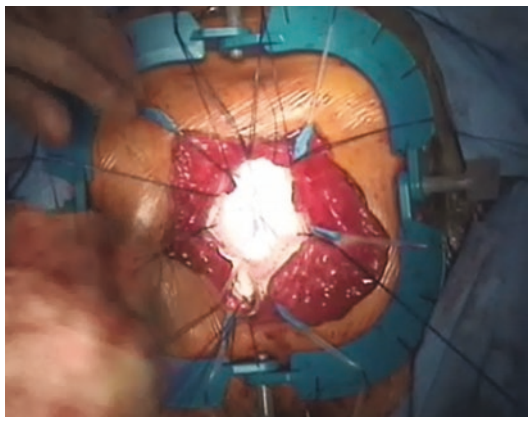


Fig. 12.14 Perineal view

Hansen et al. describes reinforcement with a gracilis myocutaneous flap [77]. Other flap options include vertical rectus abdominis myocutaneous (VRAM) flap (Figs. 12.15, 12.16, and 12.17) [78, 79] or gluteal flap (Fig. 12.18) [80].

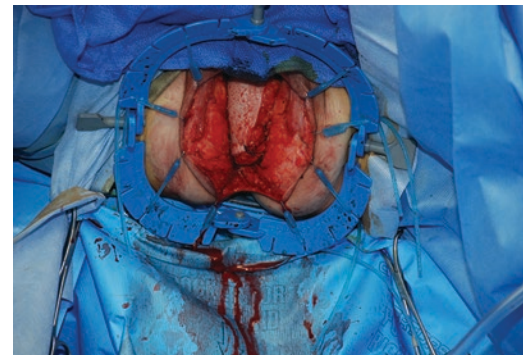


Fig. 12.15 VRAM myocutaneous flap being delivered

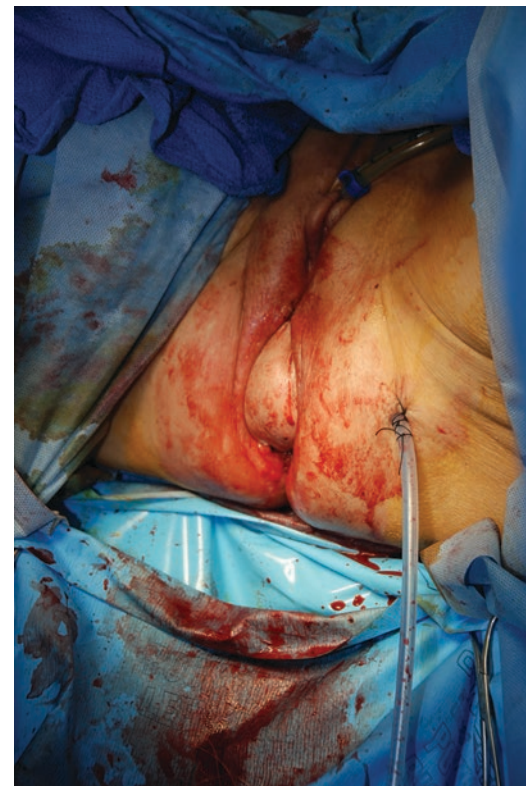


Fig. 12.16 VRAM myocutaneous flap in place

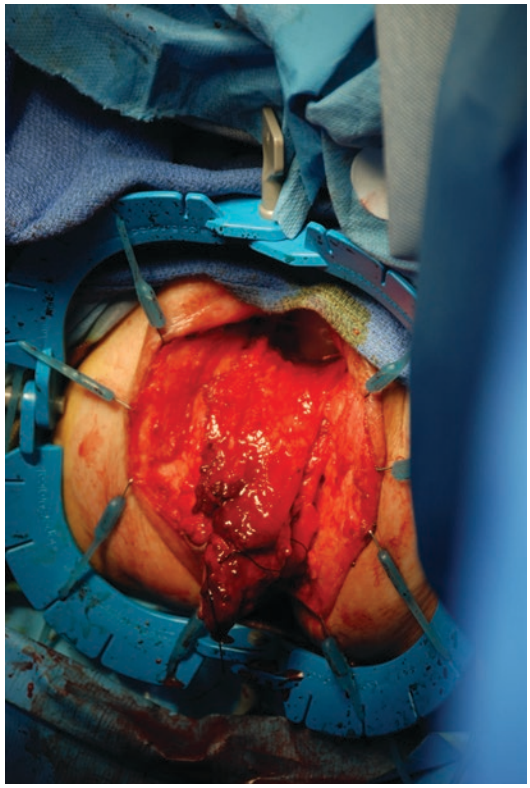


Fig. 12.17 VRAM flap without a cutaneous component being placed

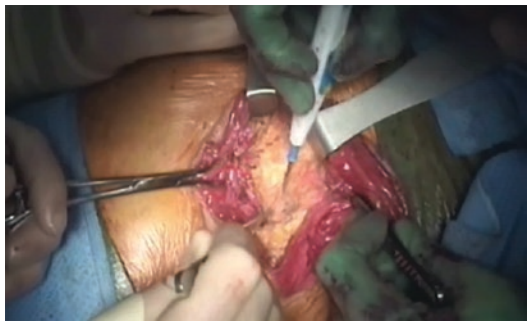


Fig. 12.18 Medical portions of the gluteal muscles being harvested with the patient in the prone-jackknife position

Summary

The pelvic floor represents a complex anatomic region, which is prone to laxity, herniation and prolapse. Often, treatment will require a multidisciplinary approach with input from colorectal surgeons, urogynecologists and urologists. A thorough understanding of the anatomic deficit combined with its functional significance is imperative when contemplating invasive interventions. Excellent functional results are incumbent on the surgeon correlating the patients symptoms with the anatomic findings. Numerous approaches are available to correct pelvic floor deficits and should be tailored to the individual patient taking into account the need for a team approach and also their comorbidities.

References

1. Haylen BT, Maher CF, Barber MD, Camargo S, Dandolu V, Digesu A, Goldman HB, Huser M, Milani AL, Moran PA, Schaer GN, Withagen MI. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic organ prolapse (POP). Int Urogynecol J. 2016;27(2):165–94.
2. Wu JM, Vaughan CP, Goode PS, Redden DT, Burgio KL, Richter HE, Markland AD. Prevalence and trends of symptomatic pelvic floor disorders in U.S. women. Obstet Gynecol. 2014;123:141–8.
3. Swift SE. The distribution of pelvic organ support in a population of female subjects seen for routine gynecologic health care. Am J Obstet Gynecol. 2000;183:277–85.
4. Olsen AL, Smith VJ, Bergstrom JO, Colling JC, Clark AL. Epidemiology of surgically managed pelvic organ prolapse and urinary incontinence. Obstet Gynecol. 1997;89:501–6.
5. Dietz HP. The aetiology of prolapse. Int Urogynecol J Pelvic Floor Dysfunct. 2008;19:1323–9.
6. Jelovsek JE, Maher C, Barber MD. Pelvic organ prolapse. Lancet. 2007;369:1027–38.
7. Baden W. Surgical repair of vaginal defects. In: Book surgical repair of vaginal defects. Philadelphia: Lippincott; 1992.
8. Bump RC, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. Am J Obstet Gynecol. 1996;175:10–7.
9. Beck D, Allen N. Rectocele. Clin Colon Rectal Surg. 2010;23:90–8.
10. Evetts B, Billingham R. Current Therapy in colon and rectal surgery. 2nd ed. St. Louis: Mosby; 2005. p. 148–51.
11. Lefevre R, Davila GW. Functional disorders: rectocele. Clin Colon Rectal Surg. 2008;21:129–37.
12. Mellgren A, et al. Recocele. In: Wexner SD, Zbar AP, Pescatori M, editors. Complex anorectal disorders:

investigation and management. London: Springer; 2005. p. 446–60.
13. Persu C, et al. Pelvic Organ Prolapse Quantification System (POP-Q)—a new era in pelvic prolapse staging. J Med Life. 2001;4(1):75–81.
14. Beck DE, Wexner SD, editors. Fundamentals of anorectal surgery. New York: McGraw-Hill; 1992.
15. Mimura T, et al. Treatment of impaired defecation associated with rectocele by behavioral training. Dis Colon Rectum. 2000;43(9):1267–72.
16. Paraiso MF, Barber MD, Muir TW, Walters MD. Rectocele repair: a randomized trial of 3 surgical techniques including graft augmentation. Am J Obstet Gynecol. 2006;195(6):1962–771.
17. Kahn MA, Stanton SL. Posterior colporrhaphy: its effects on bowel and sexual dysfunction. Br J Obstet Gynaecol. 1997;104(1):82–6.
18. Glavind K, Madsen H. A prospective study of the discrete fascial defect rectocele repair. Acta Obstet Gynecol Scan. 2000;79:145–7.
19. Singh K, Cortes E, Reid WM. Evaluation of the fascial technique for surgical repair of isolated posterior vaginal wall prolapse. Obstet Gynecol. 2003;101:320–4.
20. Farid M, et al. Randomized controlled trial between perineal and anal repairs in obstructed defecation. World J Surg. 2010;34:822–9.
21. Hammond K, Ellis N. Outcome after transanal repair of rectoceles. Dis Colon Rectum. 2010;53:1.
22. Maher C, Feiner B, Baessler K, Schmid C. Surgical management of pelvic organ prolapse in women. Cochrane Database Syst Rev. 2013;4:CD004014.
23. Thornton M, Lam A, King D. Laparoscopic or transanal repair of rectocele? A retrospective matched cohort study. Dis Colon Rectum. 2005;48:792–8.
24. Cystocele. Collins English Dictionary—complete & unabridged, 10th ed. n.d. Dictionary.com. Retrieved 5 Mar 2016.
25. Chen L, et al. Interaction among apical support, levator ani impairment, and anterior vaginal wall prolapse. Obstet Gynecol. 2006;108(2):324–32.
26. Lowder JL, et al. The role of apical vaginal support in the appearance of anterior and posterior vaginal prolapse. Obstet Gynecol. 2008;111(1):152–7.
27. Lamblin G, et al. Cystocele and functional anatomy of the pelvic floor: review and update of the various theories. Int Urogynecol J. 2016;27:1297–305.
28. De Landsheere L, Munaut C, Nusgens B, Maillard C, Rubod C, Nisolle M, et al. Histology of the vaginal wall in women with pelvic organ prolapse: a literature review. Int Urogynecol J. 2013;24:2011–20.
29. DeLancey JO. Anatomic aspects of vaginal eversion after hysterectomy. Am J Obstet Gynecol. 1992;166:1717–24.
30. Petros P, Ulmsten U. An integral theory of female urinary incontinence. Experimental and clinical considerations. Acta Obstet Gynecol Scand. 1990;153:7–31.
31. Weber AM, Walters MD, Piedmonte MR, Ballard LA. Anterior colporrhaphy: a randomized trial of three surgical techniques. Am J Obstet Gynecol. 2001;185(6):1299–304. discussion 1304–6.
32. Sand PK, Koduri S, Lobel RW, Winkler HA, Tomezsko J, Culligan PJ, Goldberg R. Prospective randomized trial of polyglactin 910 mesh to prevent recurrence of cystoceles and rectoceles. Am J Obstet Gynecol. 2001;184(7):1357–62. discussion 1362–4.
33. Maher C. Anterior vaginal compartment surgery. Int Urogynecol J. 2013;24(11):1791–802. https://doi.org/10.1007/s00192-013-2170-3.
34. Hurtado EA, Bailey HR, Reeves KO. Rectal erosion of synthetic mesh used in posterior colporrhaphy requiring surgical removal. Int Urogynecol J Pelvic Floor Dysfunct. 2007;18(12):1499–501.
35. Yamada BS, Govier FE, Stefanovic KB, Kobashi KC. Vesicovaginal fistula and mesh erosion after Perigee (transobturator polypropylene mesh anterior repair). Urology. 2006;68(5):1121. e5–7.
36. Hiltunen R, Nieminen K, Takala T, Heiskanen E, Merikari M, Niemi K, Heinonen PK. Low-weight polypropylene mesh for anterior vaginal wall prolapse: a randomized controlled trial. Obstet Gynecol. 2007;110(2 Pt 2):455–62.
37. Fatton B, Amblard J, Debodinance P, Cosson M, Jacquetin B. Transvaginal repair of genital prolapse: preliminary results of a new tension-free vaginal mesh (Prolift technique)—a case series multicentric study. Int Urogynecol J Pelvic Floor Dysfunct. 2007;18(7):743–52.
38. Hurtado EA, Appell RA. Management of complications arising from transvaginal mesh kit procedures: a tertiary referral center's experience. Int Urogynecol J Pelvic Floor Dysfunct. 2009;20(1):11–7.
39. Jacoby VL, Subak L, Waetjen LE. The FDA and the vaginal mesh controversy-further impetus to change the 510(k) pathway for medical device approval. JAMA Intern Med. 2016;176(2):277–8.
40. Väyrynen T, Engh ME, Axelsen S, Falconer C, Nordic Transvaginal Mesh Group. Anterior colporrhaphy versus transvaginal mesh for pelvic-organ prolapse. N Engl J Med. 2011;364(19):1826–36.
41. Sung VW, Rogers RG, Schaffer JI, Balk EM, Uhlig K, Lau J, Abed H, Wheeler TL 2nd, Morrill MY, Clemons JL, Rahn DD, Lukban JC, Lowenstein L, Kenton K, Young SB, Society of Gynecologic Surgeons Systematic Review Group. Graft use in transvaginal pelvic organ prolapse repair: a systematic review. Obstet Gynecol. 2008;112(5):1131–42.
42. Davila GW, Baessler K, Cosson M, Cardozo L. Selection of patients in whom vaginal graft use may be appropriate. Consensus of the 2nd IUGA grafts roundtable: optimizing safety and appropriateness of graft use in transvaginal pelvic reconstructive surgery. Int Urogynecol J. 2012;23(Suppl 1):S7–14.
43. Food and Drug Administration, HHS. Obstetrical and gynecological devices; reclassification of surgical mesh for transvaginal pelvic organ prolapse repair; final order. Fed Regist. 2016;81(2):353–61.

44. Gabriel B, Denschlag D, Göbel H, Fittkow C, Werner M, Gitsch G, Watermann D. Uterosacral ligament in postmenopausal women with or without pelvic organ prolapse. Int Urogynecol J Pelvic Floor Dysfunct. 2005;16(6):475–9.
45. Rivaux G, Rubod C, Dedet B, Brieu M, Gabriel B, Cosson M. Comparative analysis of pelvic ligaments: a biomechanics study. Int Urogynecol J. 2013;24(1):135–9.
46. Campbell RM. The anatomy and histology of the sacrouterine ligaments. Am J Obstet Gynecol. 1950;59:1–12.
47. Zebede S, Smith AL, Plowright LN, Hegde A, Aguilar VC, Davila GW. Obliterative LeFort colpocleisis in a large group of elderly women. Obstet Gynecol. 2013;121(2 Pt 1):279–84.
48. Margulies RU, Rogers MA, Morgan DM. Outcomes of transvaginal uterosacral ligament suspension: systematic review and metaanalysis. Am J Obstet Gynecol. 2010;202(2):124–34.
49. Shull BL, Bachofen C, Coates KW, Kuehl TJ. A transvaginal approach to repair of apical and other associated sites of pelvic organ prolapse with uterosacral ligaments. Am J Obstet Gynecol. 2000;183(6):1365–73.
50. Barber MD, Visco AG, Weidner AC, Amundsen CL, Bump RC. Bilateral uterosacral ligament vaginal vault suspension with site-specific endopelvic fascia defect repair for treatment of pelvic organ prolapse. Am J Obstet Gynecol. 2000;183(6):1402–10.
51. Barber MD, Brubaker L, Burgio KL, Eunice Kennedy Shriver National Institute of Child Health and Human Development Pelvic Floor Disorders Network, et al. Comparison of 2 transvaginal surgical approaches and perioperative behavioral therapy for apical vaginal prolapse: the optimal randomized trial. JAMA. 2014;311(10):1023–34.
52. Lantzsch T, Goepel C, Wolters M, Koelbl H, Methfessel HD. Sacrospinous ligament fixation for vaginal vault prolapse. Arch Gynecol Obstet. 2001;265(1):21–5.
53. Lane FE. Repair of posthysterectomy vaginal-vault prolapse. Obstet Gynecol. 1962;20:72–7.
54. Benson JT, Lucente V, McClellan E. Vaginal versus abdominal reconstructive surgery for the treatment of pelvic support defects: a prospective randomized study with long-term outcome evaluation. Am J Obstet Gynecol. 1996;175(6):1418–21. discussion 21–2.
55. Costantini E, Mearini L, Lazzeri M, Bini V, Nunzi E, di Biase M, Porena M. Laparoscopic versus abdominal sacrocolpopexy: a randomized controlled trial. J Urol. 2016. https://doi.org/10.1016/j.juro.2015.12.089.
56. Nygaard IE, McCreery R, Brubaker L, Connolly A, Cundiff G, Weber AM, Zyczynski H, Pelvic Floor Disorders Network. Abdominal sacrocolpopexy: a comprehensive review. Obstet Gynecol. 2004;104(4):805–23.
57. Takahashi T, Yamana T, Sahara R, et al. Enterocele: what is the clinical implication? Dis Colon Rectum. 2006;49:S75–81.
58. Ribas Y, Hotouras A, Chan CL, Clavé P. Imaging of pelvic floor disorders: are we underestimating gravity. Dis Colon Rectum. 2014;57(10):1242–4.
59. Stamatiou D, et al. Perineal hernia: surgical anatomy, embryology, and technique of repair. Am Surg. 2010;76(5):474.
60. Rayhanabad J, et al. Laparoscopic repair of perineal hernia. JSLS. 2009;13:237–41.
61. He ZH, Zhu GY, Zhang S. Perineal hernia after laparoscopic abdominoperineal re-section for rectal cancer: a case report and review of the literature. J Cancer Ther. 2015;6:222–6.
62. Gonzalez S, et al. Perineal hernia. Emerg Radiol. 2009;16:395–8.
63. Casanta M, Moore LJ. Laparoscopic repair of pernieal hernia. Hernia. 2012;16:363–7.
64. Abbas Y, Garner J. Laparoscopic and perineal approaches to perineal hernia repair. Tech Coloproctol. 2014;18:361–4.
65. So J-y, et al. Postoperative perineal hernia. Dis Colon Rectum. 1997;40:954–7.
66. Ego-Aguirre E, Spratt JA Jr, Butcher HR Jr, Bricker EM. Repair of perineal hernia developing subsequent to pelvic exenteration. Ann Surg. 1964;159:66–71.
67. Aboian E, et al. Perineal hernia after proctectomy: prevalance, risks and management. Dis Colon Rectum. 2006;49:1564–8.
68. Beck DE, Fazio VW, Jagelman DG, Lavery IC, McGonagle BA. Postoperative perineal hernia. Dis Colon Rectum. 1987;30(1):21–4.
69. Dulucq JL, et al. Laparoscopic repair of postoperative perineal hernia. Surg Endosc. 2006;20:414–8.
70. de Campos FG, Habr-Gama A, Araújo SE, et al. Incidence and management of perineal hernia after laparoscopic proctectomy. Surg Laparosc Endosc Percutan Tech. 2005;15(6):366–70.
71. Villar F, Frampas E, Mirallié E, Potiron L, Villet R, Lehur PA. Perineal incisional hernia following rectal resection. Diagnostic and management. Ann Chir. 2003;128(4):246–50.
72. Veenhof AA, van der Peet DL, Cuesta MA. Perineal hernia after laparoscopic abdominoperineal resection for rectal cancer: report of two cases. Dis Colon Rectum. 2007;50(8):1271–4.
73. Martijnse IS, et al. Perineal hernia repair after abdominoperineal rectal excision. Dis Colon Rectum. 2012;55:90–5.
74. Casasanta M, Moore LJ. Laparoscopic repair of a perineal hernia. Hernia. 2012;16(3):363–7.
75. Svane M, Bulut O. Perineal hernia after laparoscopic abdominoperineal resection—reconstruction of the

pelvic floor with a biological mesh (Permacol™). Int J Color Dis. 2012;27(4):543–4.
76. Takano S, Newman M, Gill K, Wexner SD. Vertical rectus muscle flap repair for perineal defect: abdominoperineal resection and perineal hernia. J Am Coll Surg. 2015;220(6):e89. https://doi.org/10.1016/j.jamcollsurg.2015.02.034. Epub 2015 Mar 14. No abstract available.
77. Hansen MT, et al. Perineal hernia repair using gracilis myocutaneous flap. South Med J. 1997;90:75–7.
78. Horch RE, Hohenberger W, Eweida A, Kneser U, Weber K, Arkudas A, Merkel S, Göhl J, Beier JP. A hundred patients with vertical rectus abdominis myocutaneous (VRAM) flap for pelvic reconstruction after total pelvic exenteration. Int J Colorectal Dis. 2014;29(7):813–23. https://doi.org/10.1007/s00384-014-1868-0.
79. Touny A, Othman H, Maamoon S, Ramzy S, Elmarakby H. Perineal reconstruction using pedicled vertical rectus abdominis myocutaneous flap (VRAM). J Surg Oncol. 2014;110(6):752–7. https://doi.org/10.1002/jso.23692.
80. Papadakis M, Hübner G, Bednarek M, Arafkas M. Composite mesh and gluteal fasciocutaneous rotation flap for perineal hernia repair after abdominoperineal resection: a novel technique. Updates Surg. 2017;69(1):109–11. https://doi.org/10.1007/s13304-017-0427-y.

Pruritus Ani

13

Bradley R. Davis

Introduction

Pruritus ani is a cutaneous sensation characterized by unpleasant itching and burning of the perianal skin. Acutely it may be protective but chronically it causes distress and is maladaptive. Patients often delay seeking medical attention, and their unsupervised attempts at treatment, including aggressive repetitive cleaning and the use of over-the-counter creams or ointments, typically only worsens the symptoms and can make it more difficult to manage [1]. This condition affects up to 5% of the general population on a daily basis, with a male predominance of 4:1 [2, 3]. Pruritus ani may be localized or diffuse in the perianal region. The onset of symptoms is typically gradual and is often worse at night or in warm, moist climates. It can be subdivided into two categories based on etiology—idiopathic (primary) pruritus ani and secondary pruritus ani. Idiopathic pruritus ani is a diagnosis of exclusion, while secondary pruritus ani is attributed to a specific cause [4]. It is difficult to assign a value as to the percent of patients with secondary versus idiopathic pruritus ani as the literature assigns ranges between 20 and 75% and is largely dated and of variable quality. If a patient presents with the sole complaint of anal itching particularly if it wakens him or her at night and there is no cutaneous evidence of a dermatologic condition then initial management should focus on idiopathic pruritus ani. In those patients in whom therapy is not effective after 4–6 weeks, attention should be given to excluding the multiple potential causes of secondary pruritus ani, which can be divided into several broad categories: infectious, dermatologic, systemic, local irritants, and colorectal or anal causes. Potential causes of irritation include moisture from sweat, stool and mucus; fecal factors such as bile salts and stool pH; inadequate hygiene, as well as overzealous hygiene with introduction of irritating soaps, lotions, and scents; certain food products; as well as topical compounds used by the patient to obtain relief have all been implicated. Diagnosis, patient education, and treatment often simultaneously proceed.

Etiology

Itch is an unpleasant sensation that leads to the desire to scratch and is mediated by C nerve fibers in the dermis that is referred to as pruritoceptive itching. These nerve endings may become chronically active with the repetitive trauma of scratching over months to years. Itching can also be neuropathic, due to disorders of the afferent pathways (e.g. post herpetic neuralgia) neurogenic as

B. R. Davis (✉)
Section of Colon and Rectal Surgery, Carolinas Medical Center, Charlotte, NC, USA
e-mail: bradley.r.davis@carolinas.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_13

a result of centrally mediated stimuli (e.g. morphine induced itching) and psychogenic [5, 6].

The sensation of itch can be caused by various stimuli with histamine release as a potential neuronal mechanism of itch; however, it is not the only substance that produces itching. Kallikrein, bradykinin, papain, and trypsin are all itch-mediating substances that are not responsive to blockades with classic histamine antagonists, such as diphenhydramine. As a consequence, antihistamines have proven ineffective in treating pruritus in many instances.

Scratching the affected skin provides inadequate feedback to inhibit itching and prolonged itching can cause damaging excoriations and infections, which provides additional itching stimuli. Thus, scratching results in a vicious cycle of itching and scratching that is difficult to break. The major contributors to secondary pruritus ani are listed in Table 13.1.

Table 13.1 Selected causes of secondary pruritis ani

Infectious	Bacterial infection (Staphylococcus, Streptococcus, erythrasma) Sexually-transmitted infection (Gonococcus, Chlamydia) Fungal infection (Candida, dermatophytes) Parasites (pinworms, scabies) Viral infection (herpes virus, condylomata, Molluscum)
Anorectal	Hemorrhoids (external, prolapsing internal) Fistula-in-ano Anal fissures Hidradenitis suppurativa Fecal incontinence Perianal Crohn's disease Skin tags Chronic diarrhea Pilonidal disease
Dermatologic	Contact dermatitis Atopic dermatitis Perianal psoriasis Lichen sclerosus Seborrheic dermatitis
Malignant	Anal canal cancer Anal margin cancer Rectal cancer Bowen's disease Extramammary Paget's disease
Systemic disease	Diabetes mellitus Leukemia Lymphoma Chronic renal failure Iron-deficiency anemia Hyperthyroidism Hyperbilirubinemia

Idiopathic Pruritus Ani

The symptom of pruritus is common to many anorectal conditions second only to bleeding as a presenting complaint [7, 8]. While the pathogenesis of idiopathic pruritus is not entirely understood the unifying theory is the presence of an irritative secretion usually feces emanating from the anal canal causing itching [9]. Anorectal physiology studies also support this theory. They demonstrated that patients with pruritus have a more pronounced relaxation of the internal anal sphincter with rectal distention compared with control subjects and leak sooner on a saline infusion test [10, 11]. Studies have also shown that patients with pruritus ani are more likely to have loose stools, drink more water, and have weekly fecal soiling compared to patients without this condition [12].

Several factors have been implicated in idiopathic pruritus ani, including local irritants, excess moisture and repeated trauma from wiping. Fecal contamination is particularly noxious to the perianal skin and leads to local irritation. Fecal matter contains allergens, bacteria, and bacterial enzymes capable of activating C-type nerve fibers within the dermis. Caplan reported that 44% of 27 subjects who were patch tested with autogenous fresh feces, developed pruritus. Of these 12 symptomatic patients, only 4 had a previous history of anal pruritus. The authors concluded that the quickly developing symptoms were compatible with an irritant rather than an allergic effect [9]. Marks confirmed that, in pruritic patients, the perianal skin pH paralleled the stool pH. The authors attributed the excessive alkalinity of the perianal skin in pruritus patients to lysozyme, a component of intestinal mucosecretions [13]. The anoderm, in particular, has been shown to be more sensitive to fecal matter when compared with other areas of the body [9].

In pruritoceptive itching, the repetitive trauma of scratching over time stimulates release of local

pro-inflammatory cytokines, leading to chronic activation of C-type nerve fibers. This is also referred to as the *itch-scratch cycle*, and is well described in dermatology literature [6].

Poor anal hygiene is a common factor among patients presenting with perianal pruritus, but overzealous hygiene has also been implicated in its pathogenesis. Patient's often attribute the symptom to being dirty and use excessive amounts of toilet paper and often feel moist following bowel movements a symptom of incomplete evacuation. As a result they often shower, bath or perform elaborate cleansing routines after every bowel movement or when symptoms occur. This, in addition to the use of topical steroids, can destroy the natural barriers and traumatize the anoderm and anal margin skin and exacerbate the problem.

Dietary Factors

In addition, dietary factors have been associated with the development of perianal pruritus [14]. Diet may incite symptoms through three major pathways. First, it will affect the consistency of the stool, which in turn can lead to fecal soiling. Second, the components of the diet may lead to direct irritation secondary to their chemical composition. Third, if an excessive volume of liquid is consumed, it could directly lead to more watery stools and pruritus as a result of frequent contact irritation. These so-called pruritogenic foods include coffee, colas, citrus fruits, chocolate, tea, energy drinks, and spicy foods. Proposed mechanisms by which pruritogenic foods trigger symptoms include local irritation, alteration of stool pH, histamine release, and inappropriate relaxation of the internal sphincter. Coffee can elicit pruritus when it is ingested in any form (fresh, instant, decaffeinated, or when used as a flavor additive to other foods, such as sodas). An apparent threshold for coffee drinkers usually varies between 2 and 4 cups per day. In an observational study evaluating the influence of diet on pruritus Smith et al. noted an average drop in anal sphincter pressures of 11 mmHg in 8 of 11 patients who drank 3 cups of coffee [12]. A similar threshold, noted in milk-drinking patients, arises at ingestion of between 6 and 10 oz. daily. Pruritus caused by chocolate, tea and cola is believed to be related to the xanthine content of these substances. Although beer has been implicated in eliciting pruritus ani, Smith and associates [12] found no correlation between alcohol ingestion and pruritus in their group of 75 patients. Patients with vitamin A and vitamin D deficiencies are also believed to be predisposed to pruritus ani.

Secondary Pruritus Ani

Secondary pruritus ani, which is pruritus induced by an underlying cause, can be divided into the following categories: inflammatory, nonsexual infectious, systemic, premalignant and malignant, and anorectal causes (Table 13.1). As is the case with idiopathic pruritus ani, secondary causes of perianal pruritus are also exacerbated by pruritoceptive itching and the itch-scratch cycle.

Infectious Agents

Infectious agents must be considered in the differential diagnosis of secondary pruritus ani. The etiologic agents may be viral, bacterial, mycotic, or parasitic. Primary bacterial infections are an unusual occurrence, and when documented are usually superimposed on preexisting perianal skin trauma.

Bacterial offenders include Staphylococcus aureus, beta-hemolytic Streptococcus pyogenes, and Corynebacterium minutissimum (erythrasma) [15]. Baral successfully cultured Staphylococcus aureus from a small patient population with pruritis ani and reported that 100% of patients had resolution of symptoms after appropriate antibiotic therapy was instituted [16]. Streptococcus infection can result in perianal eczema and while it is more often seen in children it can affect adults. Culture swabs of the perianal skin can be obtained in patients who have failed more conservative measures to evaluate for streptococcus particularly in those patients with an eczemoid

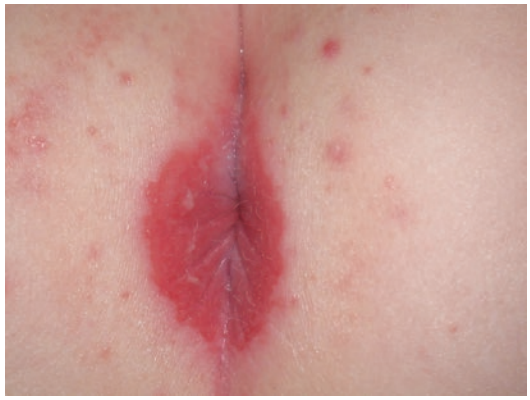


Fig. 13.1 Perianal streptococcus

skin reaction (Fig. 13.1). Treatment is initiated when cultures are positive, usually consisting of amoxicillin 1 g three times daily for 14 days [15]. Hidradenitis suppurativa may also cause pruritus (Fig. 13.2). Erythrasma is an uncommon bacterial infection caused by Corynebacterium minutissimum [17], lesions which initially present as a reddish scaly area that is well demarcated, eventually change to a tan color during the course of the disease. The diagnosis can be confirmed by using a Woods ultraviolet lamp, which allows the examiner to observe the characteristic red fluorescence of these lesions. Bowyer and McColl diagnosed erythrasma in 15 of their 81 patients with pruritus ani but were only able to culture the organism in 3 patients. A 10-day course of erythromycin usually relieves the symptoms, but the condition sometimes recurs.

Sexually transmitted infections have also been implicated, including Neisseria gonorrhoeae (gonorrhea), Chlamydia trachomatis, and Treponema pallidum (syphilis); though these are rarely responsible for chronic symptoms. Syphilitic lesions in their primary or secondary stages may have an associated exudate. Continued local irritation secondary to moisture may lead to maceration and pruritic complaints. In the secondary stage of syphilis, a maculopapular rash is seen to convert to a red, indurated lesion that may or may not lead to pruritus. When syphilis is suspected, appropriate laboratory tests should be performed to confirm the diagnosis, and one should be especially suspicious of sexu-

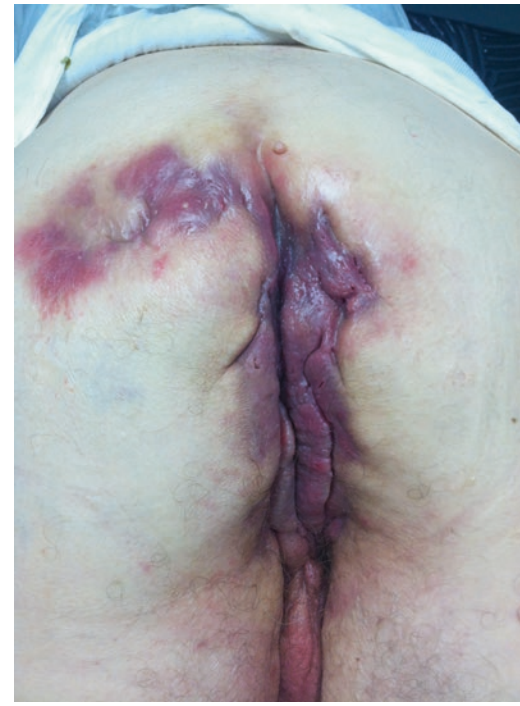


Fig. 13.2 Hidradenitis suppurativa

ally transmitted diseases in patients practicing anal intercourse. The drug of choice for the treatment of syphilis remains penicillin, or tetracycline in penicillin-allergic patients [18].

Viruses

Pruritis ani may be associated with three major sexually transmitted viruses: herpes simplex virus (anogenital herpes), papillomavirus (condyloma accuminatum) and cytomegalovirus (CMV). Patients with herpes simplex virus present with painful small vesicles surrounded by an erythematous areola (Fig. 13.3). The vesicles usually rupture at approximately 48 h, then progress over weeks to scaly eschars; the diagnosis can be confirmed by viral culture. Oral acyclovir is the current treatment of choice; recent studies have indicated the prophylactic use of this medication is successful in patients known to have frequent recurrences [19]. Condylomata accuminata are wart-like lesions found in the perianal region and the anal canal (Fig. 13.4). Patients often present with perineal moistness and irritation. Lesions on the anal margin skin should prompt the clini-

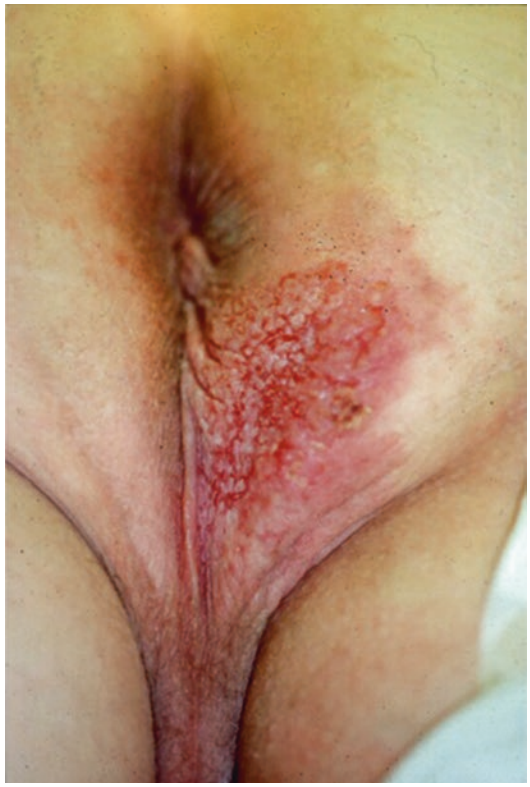


Fig. 13.3 Herpes simplex virus with painful small vesicles surrounded by an erythematous areola

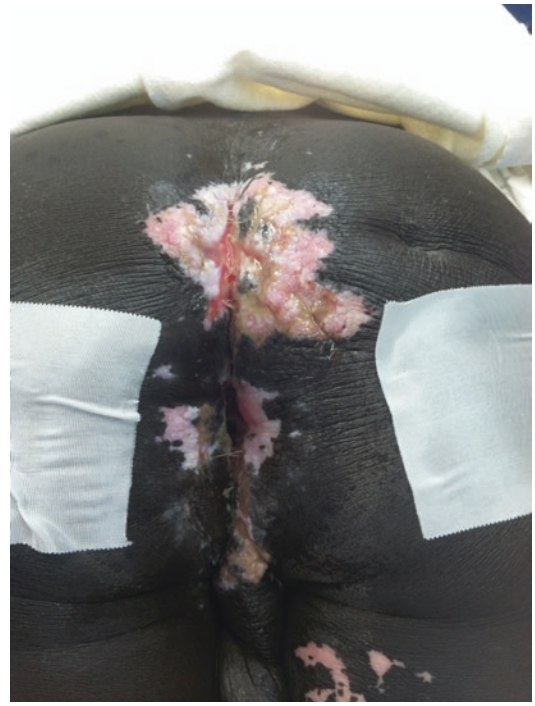


Fig. 13.4 Condylomata accuminata

cian to evaluate the anal canal especially in men that have sex with men. Biopsy of these lesions can confirm the diagnosis. Unfortunately, these organisms are notoriously resistant to antiviral therapy but a trial of imiquimod may be warranted for immunocompetent patients [20].

According to literature, Candida is responsible for up to 15% of secondary pruritus ani [21]. Fungal infections with Candida species and other dermatophytes often proliferate in diabetics, or after treatment with antibiotics or immunosuppressant medications, such as steroids. This fungal infection tends to occur in moist or sweaty environments, including in the deeper folds of obese or elderly patients. It can also be associated with tight-fitting clothing. Patients often present with diffuse, erythematous, and often macerated plaques erythematous plaques, often accompanied by satellite lesions. In the setting of pruritus ani, the presence of any dermatophytes should be considered pathologic and treated with either topical or systemic antifungal medications Antifungal powder or lotion can be used, depending on the moisture level of the perianal region. Oral antifungal agents such as fluconazole can also be used for severe infections [22]. Viral agents include herpes simplex virus (HSV) and human papillomavirus (HPV), the latter of which may manifest as condyloma acuminata. Herpes zoster, also referred to as singles, can also affect the perineal region in a dermatomal pattern. Herpes zoster can only occur in people who were previously infected with the virus and although the disease can occur at any age, it typically presents in patients older than the age of 50. The rash has a distinct appearance and can usually be diagnosed visually. Herpes zoster causes a deep red rash with blisters that do not cross the midline of the body. Treatment options include antiviral medications including valacyclovir hydrochloride [23].

Parasites

Nocturnal symptoms in the pediatric population should alert suspicion towards a parasitic infec-

tion with *Enterobius vermicularis* (pinworms) [24]. Other parasites that induce pruritic symptoms include *Sarcoptes scabei* (scabies) and *Pediculosis pubis* (crabs).

Pinworms (Enterobius vermicularis) are the most common cause of perianal itching in the pediatric age group. Jillson challenged the common belief that pinworms elicit pruritus and proposed that symptoms are an uneasy crawling sensation and not itching [25]. The diagnosis can be made by microscopically evaluating perianal skin samples collected on cellulose tape. It is imperative that other family members be evaluated so that they can be treated and recontamination does not occur. The symptoms usually occur in the evening, when these 6-mm long parasites migrate to the perianal skin. Pinworm infestation is generally treated with a single dose of mebendazole [26]. Scabies is a contagious skin infestation due to the mite Sarcoptes scabiei that can elicit severe pruritus. Although usually found on the finger webs or sides of the fingers, these lesions can often be identified in the perianal region. The diagnosis of scabies can be confirmed by demonstrating the mite or its products, such as ova or feces, from scrapings prepared on a slide with one drop of 10% potassium hydroxide [27]. Lesions appear initially as vesicles as the mite burrows its way into the stratum corneum. Treatment consists of the application of an appropriate scabeticide such as Kwell R lotion (Reed & Carnrick, Jersey City, NJ). The parasite Pediculosis pubis (crab or louse) can often be found grasping the base of a hair shaft and is noted to produce macular steel-gray spots, especially on the thighs and chest. With careful examination under magnification this parasite strikingly resembles a crab. Management requires the treatment of all infected family members, appropriate delousing of all fomites such as clothes, bedding and upholstery and showering with an appropriate pediculocide such as permethrin [28].

Organic Colorectal Conditions

A variety of anorectal diseases are associated with pruritus ani, including external hemorrhoids, prolapsing internal hemorrhoids, fistula-in-ano, anal fissures, hidradenitis suppurativa, perianal Crohn's disease, skin tags, pilonidal disease, and chronic diarrhea.

Anorectal conditions resulting in pruritus can be divided into two broad categories based on their pathophysiologic mechanism: fecal contamination and local inflammation.

In a study by Daniel et al. of 109 patients with pruritus ani whose sole complaint was itching, 52% had anorectal disease as the cause. Conditions found in this study included hemorrhoids, anal fissure, anal condyloma, ulcerative proctitis, fistula, and abscess [29]. In another study of 82 patients presenting with hemorrhoids Murie et al. found that pruritus was more common than in age- and gender-linked control subjects. They also reported that treatment of hemorrhoidal prolapse reduced the incidence of pruritus, and soiling [30]. In a study of 200 patients with pruritus ani by Bowyer et al., 43 were noted to have hemorrhoids that were contributory and in 16 cases were the sole cause. The study also revealed that fissure treatment in five patients, skin tag removal in five patients, and treatment of spasm in four patients led to complete relief of their pruritus. They postulated that skin tags trap fecal matter in the perianal region, which induces the irritant process [31]. Fistula-in-ano results in chronic drainage of fecal matter onto the perianal skin (Fig. 13.5). Other common factors resulting in fecal contamination include fecal incontinence due to impaired sphincter tone (Fig. 13.6), decreased stool bulk, and chronic diarrhea. Hidradenitis and perianal Crohn's disease, on the other hand, are examples of pruritus mediated by inflammatory mechanisms.

Dermatologic

The most common dermatologic conditions resulting in chronic pruritus ani include contact dermatitis, allergic dermatitis, atopic dermatitis, psoriasis, and lichen sclerosus. Contact dermatitis results from local irritants, commonly deodorants, perfumes, soaps, and certain foods. A detailed history focusing on post-defecation

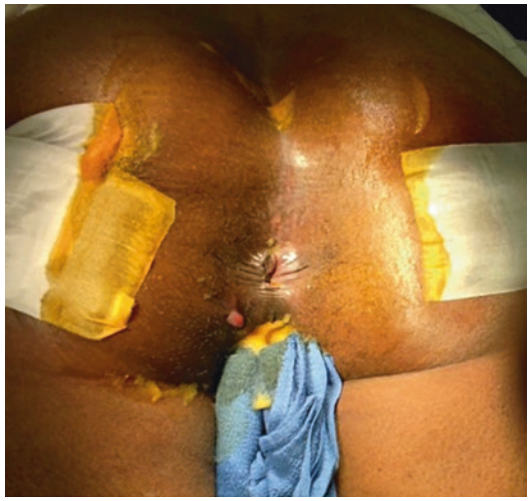


Fig. 13.5 Fistula-in-ano

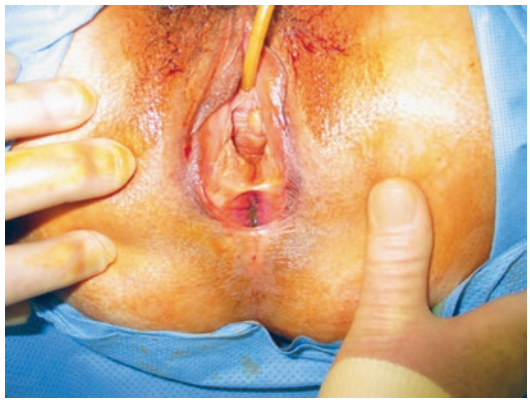


Fig. 13.6 Anal incontinence due to impaired sphincter tone

cleansing habits and anal hygiene can elucidate whether or not irritants may be involved [32]. Atopic dermatitis is a chronic, relapsing pruritic dermatitis, which usually occurs in adults and is localized to the flexural surfaces of the face, neck, cubital or popliteal fossa and hands. The dermatitis usually occurs in patients with a personal or family history of atopy or hay fever/asthma/urticaria; lesions may present as papular, scaly or chronic lichenified plaques. The etiology is unknown, but is believed to be IgE mediated. Some researchers support food allergies and proteinaceous aeroallergens as possible etiologies. Patients with atopic dermatitis are likely to acquire both bacterial and viral infections. Treatment is directed at skin hydration, corticosteroid administration, immunotherapy and antibiotics if secondary infections are present [33].

Lichen sclerosus is a poorly understood condition that commonly affects perimenopausal women. Most patients suffering from lichen sclerosus present with vulvovaginal pruritus, though perianal symptoms are also common [21]. Typical lesions are porcelain-white papules and plaques. These patients respond well to topical steroids. Chronic nonresponders, however, carry a 5% risk of malignant degeneration into squamous cell carcinoma, and should have biopsies performed should symptoms persist. Women with lichen sclerosis have a 300-fold increased risk of developing cancer compared with those without the disease [34]. Treatment of the condition does not reduce this risk. Short term (6–8 weeks) treatment with a potent topical steroid, such as clobetasol, is effective in reducing symptoms [35]. Retinoids, testosterone creams, and tacrolimus ointment have also been described [36].

Psoriasis frequently involves the scalp and flexor surfaces of the knees and elbows, but can less frequently involve the perianal skin. Psoriasis has been shown in numerous studies to be a prevalent underlying cause of pruritus ani. Psoriasis present in the anus, groin, genitals, and axillae is referred to as “inverse psoriasis” because it presents as the inverse of the normal distribution. Although the exact incidence is unknown, one study found that a significant portion of patients (54%) with inverse psoriasis had involvement of the anus [37]. Psoriasis is incurable but symptoms can be treated with short-term use of a low-to-mid potency steroid for up to 4 weeks. After the induction of remission the patient should switch to a nonsteroidal topical treatment, such as calcipotriene, for maintenance [38].

Radiation dermatitis can also involve the perineum, though it is less commonly seen since the development of high- and medium-energy accelerators. In addition, radiation proctitis leads to diarrhea, which further exacerbates local perianal skin irritation. Radiation proctitis can be managed with dietary measures and bulking agents or a trial of hydrocortisone retention ene-

mas. The standard of care for radiation-induced dermatitis involves topical steroids and routine skin care with mild, unscented soap.

Neoplastic Disease

Neoplastic diseases should be considered in the differential diagnosis of any patient with perianal pruritus. While these maladies could include anal canal cancer, anal margin cancer and rectal cancer it is far more likely that pruritus as a presenting symptoms would be found in anal intraepithelial neoplasia (Bowen's Disease) and extramammary Paget's disease (cutaneous adenocarcinoma in situ). The clinician must be cognizant of these potential etiologies and should exclude them by performing a careful physical examination and biopsy if necessary. In the setting of malignancy, pruritic symptoms will often be more severe and persistent in comparison to idiopathic pruritus ani. If malignancy is suspected, biopsies and endoscopic evaluation is crucial to the work-up. Polypoid tumors of the anorectum may lead to soiling which may be secondary to changes in the normal anatomy or mucous secretions, as seen in the case of villous lesions.

Extramammary Paget's disease is an intraepidermal neoplasm with a cellular composition similar to Paget's disease of the breast. Although the cell type of this lesion is still undefined, it is believed to be a pluripotential epithelial cell that borders on differentiation into sweat gland tissue. The lesions are usually red, indurated, scaling plaques often confused with eczema. Approximately 15% of such lesions are associated with an underlying cutaneous carcinoma or a breast or urogenital tumor [39]. A 60 year review of Paget's Disease at Memorial Sloan Kettering demonstrate that pain and pruritus were the most common presenting symptom [40]. The condition typically manifests itself as an erythematous, eczematoid plaque in the perianal region (Fig. 13.7). Paget disease is most common in the seventh decade of life. A wide excision is the treatment of this condition [41] (see Chapter 19).

Bowen's disease is a unique form of squamous cell carcinoma-in-situ. This squamous carcinoma usually resides solely in the epidermal region but has invasive potential, seen in up to 5% of cases [42, 43]. The disease can present as pruritus or may be found incidentally in an anorectal surgical specimen. The lesion is characteristically an erythematous, hyperkeratotic plaque sharply demarcated from the surrounding skin (Fig. 13.8). The size of the lesions ranges from a few millimeters to several centimeters. Small lesions may be treated successfully with topical 5-fluorouracil, while larger lesions have been managed with either surgery (wide local excision) or more recently photodynamic therapy [43] (see Chapter 19).

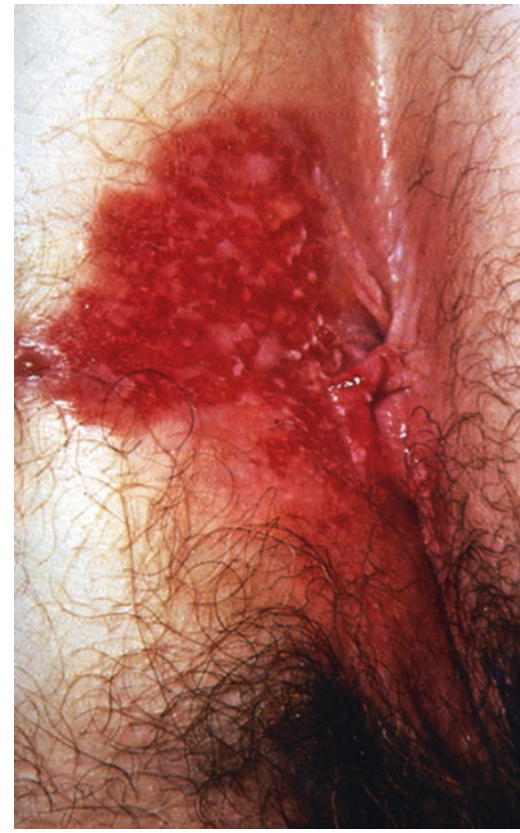


Fig. 13.7 Erythematous, eczematoid plaque in the perianal region caused by Paget's disease

Systemic Diseases

Systemic diseases associated with perianal pruritus include diabetes mellitus, leukemia, lymphoma,

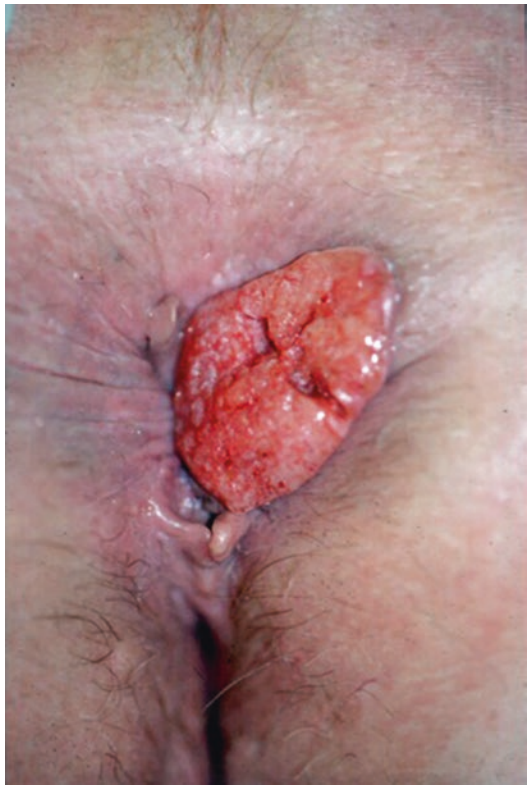


Fig. 13.8 Erythematous, hyperkeratotic plaque sharply demarcated from the surrounding skin caused by anal squamous cell carcinoma

chronic renal failure, iron-deficiency anemia, hyperthyroidism, and cholestatic disease. These conditions are more often associated with generalized pruritus rather than pruritus ani specifically. Uremic pruritus, or pruritus due to chronic renal failure, is a common symptom affecting up to 90% of dialysis patients. At present time, the only known cure is kidney transplantation [44]. Cholestatic pruritus is a common symptom among patients with hepatic dysfunction, which may be alleviated with medications such as cholestyramine. In these cases, pruritus is rarely the sole symptom, and definitive treatment should be directed towards the underlying disease process [45].

Psychological

The role of psychological factors in the etiology of pruritus ani has been poorly studied and overall lacking. Smith and colleagues [12] evaluated the psychological profiles of 25 patients with pruritus ani by administering the Minnesota Multiphasic Personality Inventory. The authors found no statistically significant deviations from the clinical scales provided for non-pruritic patients, but it was noted that the pruritus patients demonstrated some possible tendencies toward "a relatively high degree of inhibition of aggression and denial of feeling of social and emotional alienation". In another study 17 patients suffering from pruritus ani were compared to 23 patients who did not by administering a personality test [46]. The mean hypomania and depression scale scores were greater and smaller respectively in the idiopathic pruritus ani group. Nevertheless, the percentage of abnormal psychological profiles was not significantly different between the two groups.

Drugs

Several oral medications have been implicated in eliciting pruritus ani, by both contact irritation and increased leakage of fecal material from the anal opening. Quinidine, quinine, and colchicine can initiate the acute onset of pruritus, even though the patient may have been taking these medications in consistent dosages for years. Pruritus is usually controlled when the medication is temporarily stopped, which may be related to a threshold phenomenon. Mineral oil (taken orally) has also been detected as an offending agent; in this instance, pruritus is believed to be secondary to the pasty stool the patient develops and the associated perianal seepage. Ingestion of tetracycline also may cause pruritus by irritating the gut, which leads to a loose stool. In addition, tetracycline facilitates the occurrence of secondary perianal candidal infections. The intravenous administration of hydrocortisone phosphate has also been shown to produce pruritus ani. The application of certain topical ointments, creams or cleansing agents may also elicit pruritus. Preparations containing either ester or amide based local anesthetics ("caines") can produce an allergic reaction in susceptible patients. Many over-the-counter hygiene products, such as

scented soaps, deodorants, colored toilet tissues and laundry detergents contain chemicals that may cause increased skin sensitivity and irritation. These chemicals include formaldehyde, alcohol, perfumes and astringents, which elicit symptomatology by depriving the skin of its natural acidity. Patients must be assisted in their selection of appropriate nonirritating, atraumatic perianal cleansing products.

Patient Evaluation

History

A detailed history and physical examination are critical to the evaluation of any patient presenting with perianal pruritus. The history should focus on the following points: onset and duration of pruritus; toileting behaviors and post-defecation cleansing habits; anal hygiene; mucous leakage or perianal moisture; travel history; dietary history specific to pruritogenic foods and beverages; and any accompanying symptoms. All medications should be identified, as many can contribute to pruritus; special attention should be given to antibiotics, colchicine, quinidine and topical medicines containing corticosteroids, estrogens or "caine" drugs. The history should also elicit any symptoms of inflammatory bowel disease or acholic stools. Prior anorectal surgery may suggest deformed anorectal anatomy, which in turn can lead to poor continence. The physician should also document whether the patient has allergies or any generalized dermatoses such as psoriasis or seborrhea. A sexual history should include the patient's sexual orientation and specific practices, especially the practice of anal receptive intercourse. The immune status of the patient is also important, not only because of primary immunodeficient states or contracted states such as acquired immunodeficiency syndrome, but also in transplantation patients who are receiving immunosuppressive medications. A careful gynecologic and obstetric history should be obtained from female patients and should include contraceptive practices and any history of inflammatory or ulcerative lesions. A history of difficult vaginal deliveries and/or perineal trauma should increase the suspicion for anatomic and/or functional sphincter compromise; manometry and rectal ultrasound can be helpful in selected cases.

Physical Examination

The goal of the physical examination is to identify any secondary causes of pruritus. Physical examination should include close inspection of perianal skin and anoderm, genitalia, inguinal lymph nodes, and digital rectal examination. Anoscopy should also be performed to evaluate the anal canal for evidence of disease, and if malignancy is suspected, biopsies and further endoscopic evaluation should be pursued.

Developed at the Washington Hospital Center, the Washington criteria (Table 13.2) are often used to stage the appearance of perianal skin according to severity of disease [47]. Stage I disease consists of erythematous and inflamed skin; stage II disease consists of lichenified changes in addition to perianal erythema; and stage III disease reveals coarse ridges and ulcerations. In a small minority of patients, perianal skin may appear normal (Washington stage 0). Any suspicious lesions should be biopsied in the office with a simple (3–4 mm) punch biopsy, including both normal-appearing perianal skin and the lesion in question. If Bowen's disease (carcinoma in situ) or condyloma acuminata are suspected, application of 3–5% acetic acid can help guide the biopsy. Infectious causes of pruritus can be evaluated with aerobic, anaerobic, and fungal swabs. If there has been any exposure to children harboring pinworm (*Enterobius vermicularis*), a scotch tape test can easily be performed, ideally done in the early morning

Table 13.2 Washington hospital staging criteria

Stage 0	Normal-appearing perianal skin
Stage I	Erythematous and inflamed perianal skin
Stage II	White, lichenified perianal skin
Stage III	Lichenified skin with coarse ridges and ulceration

on consecutive days. All children suffering from pruritic symptoms should be evaluated with the cellophane "scotch tape" test.

Treatment

Once the diagnosis of pruritus ani has been reached, patient education and treatment modalities should proceed simultaneously. Treatment may include: Conservative dietary changes to identify offending agents or their symptomatic thresholds; Appropriate medical therapy for infections, dermatoses or systemic disorders; Surgical intervention for the few anatomic deformities which contribute to pruritus; Supportive therapy for the majority of patients with pruritus who have no identifiable etiology and subsequently fall into the category of idiopathic pruritus ani. Success in this group begins with proper perianal hygiene, bowel augmentation, and the discontinuation of any offending agents. Most patients achieve symptomatic relief and reversal of morphologic features with these conservative measures. Patient suffering from idiopathic pruritus ani frequently present with chronic symptoms and resultant social anxiety, thus patient reassurance and counseling are invaluable adjuncts to medical therapy.

The goal of perianal hygiene is to restore clean dry perianal skin. Optimal anal hygiene includes avoidance of over wiping, alcohol-based wipes, perfumes, dyes, and witch hazel products. The patient should also initially discontinue the use of any topical steroid agents because of their harmful thinning of the perianal skin. Trauma incurred by scratching must be stopped, and for patients with severe symptoms, wearing white cotton gloves at bedtime may be necessary. Patients should only use plain, white, unscented, toilet paper for wiping the anal area. In severe cases patients should be encouraged to take a bath after a bowel movement or take a shower. While uncommon in North American the use of a bidet following a bowel movements may be a more convenient option for some patients [48]. Otherwise, simple cleansing with disposable moist towels, such as baby wipes, is sufficient. Afterwards, the skin should be pat dried with unscented toilet paper or a soft towel, as vigorous wiping results in further trauma to the area. Clean and dry skin should be maintained throughout the day. Moist areas can be kept dry with cornstarch, talcum powder, or a simple cotton ball. The skin can also be protected with a zinc oxide–based barrier ointment, such as Calmoseptine (Calmoseptine, Inc., Huntington Beach, CA). For severe cases application of Berwick's dye and benzoin can create a barrier for up to a week so long as only water is used as a cleanser [49].

If chronic diarrhea or mucous leakage impedes proper perianal hygiene, bowel-augmenting medications such as fiber supplement may be prescribed. The psyllium regimens should be tailored to achieve soft, well-formed stools, while minimizing fecal soiling. Tap water enemas may also be a helpful adjunct if incomplete evacuation remains a problem.

As stated earlier there are at least six common foods believed to precipitate pruritus ani although the evidence is generally lacking and is mostly anecdotal. Patients should be counseled against excessive consumption of these so-called pruritogenic foods (coffee, colas, chocolate, tea, tomatoes and beer). Gradual reintroduction of the offending foods can then help the patient identify both the food group and the threshold for tolerance. Other factors that contribute to the disease process are listed in Table 13.3, and should also be eliminated once identified. These potential triggers include specific medications, pruritogenic foods, topical agents, and lifestyle changes.

Topical steroids may serve as an effective adjunct to the aforementioned measures. Evidence for the use of topical steroids is conflicting, but in the setting of refractory disease, a short course of betamethasone or 1% hydrocortisone cream may alleviate pruritic symptoms. A small randomized controlled trial comparing 1% hydrocortisone cream versus placebo noted a 68% reduction in symptoms and 75% improvement in quality of life after a 2-week course [50]. The use of topical steroids should be limited to several weeks, as chronic use may result in atrophic changes to the perianal skin.

Table 13.3 Factors contributing to pruritic symptoms

Medications	Tetracycline Colchicine Quinidine Erythromycin Stool softeners
Foods	Coffee Colas Citrus fruits Chocolate Tea Energy drinks Beer Spicy foods
Lifestyle	Poor hygiene Chronic diarrhea Excessive wiping Perianal sweat (obesity, athletic activity) Tight-fitting garments Moist environments Nocturnal scratching
Topical agents	Lotions Scented creams Perfumes Detergents

Recent Advances

The majority of patients suffering from idiopathic pruritus ani respond favorably to conservative measures. There exist a subset of patients, however, who remain refractory to treatment despite strict adherence to hygienic and dietary modifications. After 4 weeks of conservative therapy, and secondary causes are again excluded, one of several second-line interventions may be pursued. These include topical capsaicin, topical tacrolimus, and methylene blue injection. Several studies have been performed in recent years to support the use of these second-line agents.

Capsaicin is a product of *Capsicum* chili peppers, and is postulated to increase the resting threshold for depolarization in local C-type nerve fibers. Topical capsaicin (0.006%) can be applied in a thin layer over the perianal skin, up to three times daily for 4 weeks. This is diluted from the usual concentration of capsaicin at 0.025%, which reduces the local burning sensation. Patients undergoing topical capsaicin therapy should be advised against specific side-effects, including burning sensation and urticaria upon application.

A randomized, placebo-controlled trial comparing active capsaicin versus menthol ointment noted symptomatic relief in 70% in the capsaicin arm. After a mean follow-up period of 10.9 months, 94% of original responders remained symptom-free but continued to use topical capsaicin on a near-daily basis. The study also noted that capsaicin treatment was associated with higher burning sensation scores upon application [51]. A systematic review of six randomized controlled trials comparing topically applied capsaicin in treating pruritus in any medical condition concluded that there was no convincing evidence for the use of capsaicin in pruritus [52].

Tacrolimus, an immunosuppressive agent, is commonly utilized in the treatment of eczema. Ucak et al. aimed to compare topical tacrolimus with Vaseline placebo, in patients suffering from refractory pruritus ani. Notably, these patients also suffered from atopic dermatitis. Topical tacrolimus ointment (0.03%), applied twice daily, resulted in a significant decrease in symptoms after a 4-week period [53]. The study is not without its limitations, namely its small size and lack of long-term follow-up.

Several studies have investigated intradermal methylene blue as a treatment modality for refractory pruritus ani. Methylene blue is believed to be directly toxic to the sensory nerves supplying the perianal skin. A 15 mL solution of 1% methylene blue can be injected using a 22-gauge needle, mixed with local anesthetics if desired. The injection should be localized to the affected perianal area, up to the level of the dentate line. A repeat injection may be performed at 4 weeks for partial response. A prospective study by Mentes et al. noted complete relief of symptoms with methylene blue therapy in 24 of 30 patients after 1 month. Twenty-three of 30 patients remained symptom-free after a 12 months of follow-up [54]. A more recent prospective study demonstrated similar results: symptomatic improvement in 96% and complete resolution in 57% of patients after a single treatment [55]. The positive effect of methylene blue to control the symptoms of pruritus may only be short term with 8 out of 10 patients report-

ing recurrence of their symptoms at a median follow up of 47 months [56]. Patients should be informed about the side-effects of methylene blue prior to injection, including numbness and discoloration at the injection site. Skin necrosis and anaphylaxis are rare, but have been reported.

Summary

Pruritus ani is a common ailment, affecting up to 5% of the population on a daily basis. The diagnosis heavily relies on a focused history and physical examination. Any secondary causes of pruritus ani should be elucidated if present, and treatment should be guided towards any identified potential etiology. Simple procedures, such as punch biopsies or anal swabs, may be performed in the office setting to aid in unclear situations. The majority of cases can be managed with adequate perianal hygiene, topical agents, and the elimination of any offending agents. Patient education and reassurance are critical adjuncts to the healing process.

References

1. Oueidat D, Bou Assi T, Jurjus A. Pruritus ani: more than a decade of personal experience in Lebanon. J Med Liban. 2014;62(4):203–6.
2. Siddiqi S, Vijay V, Ward M, Mahendran R, Warren S. Pruritus ani. Ann R Coll Surg Engl. 2008;90(6):457–63.
3. Hanno R, Murphy P. Pruritus ani. Classification and management. Dermatol Clin. 1987;5(4):811–6.
4. Murrray DH. Pruritus ani the probable cause and outline of treatment. J Am Med Assoc. 1911;LVII(24):1913–4.
5. Ringkamp M, Schepers RJ, Shimada SG, Johanek LM, Hartke TV, Borzan J, et al. A role for nociceptive, myelinated nerve fibers in itch sensation. J Neurosci. 2011;31(42):14841–9.
6. Twycross R, Greaves MW, Handwerker H, Jones EA, Libretto SE, Szepietowski JC, et al. Itch: scratching more than the surface. QJM. 2003;96(1):7–26.
7. Kuehn HG, Gebbensleben O, Hilger Y, Rohde H. Relationship between anal symptoms and anal findings. Int J Med Sci. 2009;6(2):77–84.
8. Abramowitz L, Benabderrahmane M, Pospait D, Philip J, Laouenan C. The prevalence of proctological symptoms amongst patients who see general practitioners in France. Eur J Gen Pract. 2014;20(4):301–6.
9. Caplan RM. The irritant role of feces in the genesis of perianal itch. Gastroenterology. 1966;50(1):19–23.
10. Allan A, Ambrose NS, Silverman S, Keighley MR. Physiological study of pruritus ani. Br J Surg. 1987;74(7):576–9.
11. Farouk R, Duthie GS, Pryde A, Bartolo DC. Abnormal transient internal sphincter relaxation in idiopathic pruritus ani: physiological evidence from ambulatory monitoring. Br J Surg. 1994;81(4):603–6.
12. Smith LE, Henrichs D, McCullah RD. Prospective studies on the etiology and treatment of pruritus ani. Dis Colon Rectum. 1982;25(4):358–63.
13. Marks MM. The influence of the intestinal ph. on anal pruritus. South Med J. 1968;61(9):1005–6.
14. Friend WG. The cause and treatment of idiopathic pruritus ani. Dis Colon Rectum. 1977;20(1):40–2.
15. Kahlke V, Jongen J, Peleikis HG, Herbst RA. Perianal streptococcal dermatitis in adults: its association with pruritic anorectal diseases is mainly caused by group B Streptococci. Color Dis. 2013;15(5):602–7.
16. Baral J. Pruritus ani and Staphylococcus aureus. J Am Acad Dermatol. 1983;9(6):962.
17. Bowyer A, McColl I. Erythrasma and pruritus ani. Acta Derm Venereol. 1971;51(6):444–7.
18. Watts PJ, Greenberg HL, Khachemoune A. Unusual primary syphilis: presentation of a likely case with a review of the stages of acquired syphilis, its differential diagnoses, management, and current recommendations. Int J Dermatol. 2016;55:714–28.
19. Birkmann A, Zimmermann H. HSV antivirals—current and future treatment options. Curr Opin Virol. 2016;18:9–13.
20. Long KC, Menon R, Bastawrous A, Billingham R. Screening, surveillance, and treatment of anal intraepithelial neoplasia. Clin Colon Rectal Surg. 2016;29(1):57–64.
21. Zuccati G, Lotti T, Mastrolorenzo A, Rapaccini A, Tiradritti L. Pruritus ani. Dermatol Ther. 2005;18(4):355–62.
22. Gray M, Beeckman D, Bliss DZ, Fader M, Logan S, Junkin J, et al. Incontinence-associated dermatitis: a comprehensive review and update. J Wound Ostomy Continence Nurs. 2012;39(1):61–74.
23. Nasseri YY, Osborne MC. Pruritus ani: diagnosis and treatment. Gastroenterol Clin N Am. 2013;42(4):801–13.
24. Stermer E, Sukhotnic I, Shaoul R. Pruritus ani: an approach to an itching condition. J Pediatr Gastroenterol Nutr. 2009;48(5):513–6.
25. Jillson OF. Pruritus ani: disputing the passage. Cutis. 1984;33(6):537, 41, 44 passim.
26. St Georgiev V. Chemotherapy of enterobiasis (oxyuriasis). Expert Opin Pharmacother. 2001;2(2):267–75.
27. Rezaee E, Goldust M, Alipour H. Treatment of scabies: comparison of lindane 1% vs permethrin 5. Skinmed. 2015;13(4):283–6.
28. Do-Pham G, Monsel G, Chosidow O. Lice. Semin Cutan Med Surg. 2014;33(3):116–8.
29. Daniel GL, Longo WE, Vernava AM 3rd. Pruritus ani. Causes and concerns. Dis Colon Rectum. 1994;37(7):670–4.

30. Murie JA, Sim AJ, Mackenzie I. The importance of pain, pruritus and soiling as symptoms of haemorrhoids and their response to haemorrhoidectomy or rubber band ligation. Br J Surg. 1981;68(4):247–9.
31. Bowyer A, McColl I. A study of 200 patients with pruritus ani. Proc R Soc Med. 1970;63(Suppl):96–8.
32. Nosbaum A, Vocanson M, Rozieres A, Hennino A, Nicolas JF. Allergic and irritant contact dermatitis. Eur J Dermatol. 2009;19(4):325–32.
33. Nahm DH, Lee ES, Park HJ, Kim HA, Choi GS, Jeon SY. Treatment of atopic dermatitis with a combination of allergen-specific immunotherapy and a histamine-immunoglobulin complex. Int Arch Allergy Immunol. 2008;146(3):235–40.
34. Carli P, Cattaneo A, De Magnis A, Biggeri A, Taddei G, Giannotti B. Squamous cell carcinoma arising in vulval lichen sclerosus: a longitudinal cohort study. Eur J Cancer Prev. 1995;4(6):491–5.
35. Neill SM, Tatnall FM, Cox NH. Guidelines for the management of lichen sclerosus. Br J Dermatol. 2002;147(4):640–9.
36. Assmann T, Becker-Wegerich P, Grewe M, Megahed M, Ruzicka T. Tacrolimus ointment for the treatment of vulvar lichen sclerosus. J Am Acad Dermatol. 2003;48(6):935–7.
37. Wang G, Li C, Gao T, Liu Y. Clinical analysis of 48 cases of inverse psoriasis: a hospital-based study. Eur J Dermat. 2005;15(3):176–8.
38. Kalb RE, Bagel J, Korman NJ, Lebwohl MG, Young M, Horn EJ, et al. Treatment of intertriginous psoriasis: from the Medical Board of the National Psoriasis Foundation. J Am Acad Dermatol. 2009;60(1):120–4.
39. Lian P, Gu WL, Zhang Z, Cai GX, Wang MH, Xu Y, et al. Retrospective analysis of perianal Paget's disease with underlying anorectal carcinoma. World J Gastroenterol. 2010;16(23):2943–8.
40. Perez DR, Trakarnsanga A, Shia J, Nash GM, Temple LK, Paty PB, et al. Management and outcome of perianal Paget's disease: a 6-decade institutional experience. Dis Colon Rectum. 2014;57(6):747–51.
41. Lo OS, Li GK, Law WL. Management of perianal extramammary Paget's disease involving the dentate line without abdominoperineal resection. Tech Coloproctol. 2016;20:419–22.
42. Zhan W, Liao X, Tian T, Zhang RY, Li P, Wu XP, et al. Perianal multiple Bowen's disease: a case report. Int J Clin Exp Pathol. 2015;8(11):15039–41.
43. Bath-Hextall FJ, Matin RN, Wilkinson D, Leonardi-Bee J. Interventions for cutaneous Bowen's disease. Cochrane Database Syst Rev. 2013;6:Cd007281.
44. Kfoury LW, Jurdi MA. Uremic pruritus. J Nephrol. 2012;25(5):644–52.
45. Gossard AA. Care of the cholestatic patient. Clin Liver Dis. 2013;17(2):331–44.
46. Laurent A, Boucharlat J, Bosson JL, Derry A, Imbert R. Psychological assessment of patients with idiopathic pruritus ani. Psychother Psychosom. 1997;66(3):163–6.
47. Billingham RP, Isler JT, Kimmins MH, Nelson JM, Schweitzer J, Murphy MM. The diagnosis and management of common anorectal disorders. Curr Probl Surg. 2004;41(7):586–645.
48. Sauer T. The role of the bidet in pruritus ani. Aust Fam Physician. 2010;39(10):715.
49. Tomi N, Weiser R, Strohal R, Mittlboeck M. A liquid-film forming acrylate cream for the treatment of anal pruritus. Br J Nurs. 2012;21(2):98. 100–2.
50. Al-Ghnaniem R, Short K, Pullen A, Fuller LC, Rennie JA, Leather AJ. 1% hydrocortisone ointment is an effective treatment of pruritus ani: a pilot randomized controlled crossover trial. Int J Color Dis. 2007;22(12):1463–7.
51. Lysy J, Sistiery-Ittah M, Israelit Y, Shmueli A, Strauss-Liviatan N, Mindrul V, et al. Topical capsaicin—a novel and effective treatment for idiopathic intractable pruritus ani: a randomised, placebo controlled, crossover study. Gut. 2003;52(9):1323–6.
52. Gooding SM, Canter PH, Coelho HF, Boddy K, Ernst E. Systematic review of topical capsaicin in the treatment of pruritus. Int J Dermatol. 2010;49(8):858–65.
53. Ucak H, Demir B, Cicek D, Dertlioglu SB, Akkurt ZM, Ucmak D, et al. Efficacy of topical tacrolimus for the treatment of persistent pruritus ani in patients with atopic dermatitis. J Dermatolog Treat. 2013;24(6):454–7.
54. Mentes BB, Akin M, Leventoglu S, Gultekin FA, Oguz M. Intradermal methylene blue injection for the treatment of intractable idiopathic pruritus ani: results of 30 cases. Tech Coloproctol. 2004;8(1):11–4.
55. Sutherland AD, Faragher IG, Frizelle FA. Intradermal injection of methylene blue for the treatment of refractory pruritus ani. Color Dis. 2009;11(3):282–7.
56. Samalavicius NE, Poskus T, Gupta RK, Lunevicius R. Long-term results of single intradermal 1% methylene blue injection for intractable idiopathic pruritus ani: a prospective study. Tech Coloproctol. 2012;16(4):295–9.

Anal Fissure and Anal Stenosis

14

Daniel L. Feingold and Steven A. Lee-Kong

Anal Fissure

Introduction

Patients suffering from anal fissure, typically an oval or tear-shaped, posterior midline ulceration distal to the dentate line, are commonly referred to surgeons for diagnosis and treatment. The severity of presenting symptoms ranges from minor, annoying pain or bleeding to severe, consuming, incapacitating pain. The duration of symptoms upon presentation varies, as well, and fissures persisting beyond about 6–8 weeks are arbitrarily categorized as chronic. Given the spectrum of presentation related to fissuring as well as the risk of functional deficit related to operative sphincterotomy, the clinician must consider the unique presentation of each patient and individualize the care plan. The management of pediatric patients with fissures was discussed in Chap. 4.

Pathogenesis

The majority of fissures are ascribed to a traumatic tear or split in the anoderm caused most commonly by straining at a hard bowel movement or, alternatively, the irritation of diarrhea. Doppler and angiographic investigations have demonstrated that the posterior anal commissure has relatively poor blood supply and wounds developing in this location may be difficult to heal due to the aggravation of repeated evacuations and the relative tissue ischemia. Hypothetically, an acute fissure and its associated pain cause spasm and hypertonicity of the internal anal sphincter muscle, which further reduces blood flow and impedes the ability to heal the ulcerated wound. Persistence of the fissure leads to more pain that leads to more spasm in what has been coined the "fissure cycle". Most therapies for anal fissure target sphincter hypertonicity to break the fissure cycle, improve blood flow and promote healing.

Presentation

The typical patient with a fissure is a young adult who experiences pain during defecation that can last for hours afterwards. While some patients may recall the instigating acute event that resulted in the fissure, many patients cannot pinpoint what exactly caused the fissure to develop. The pain, described as sharp, burning or throbbing, can be severe and patients often appreciate themselves the hypertonicity associated with their fissure. More symptomatic patients commonly complain

D. L. Feingold (✉) · S. A. Lee-Kong
Department of Surgery, Columbia University, New York, NY, USA
e-mail: df347@columbia.edu

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_14

that passing a bowel movement feels like getting cut by shards of glass. While most patients will experience bleeding or blood upon wiping as part of their constellation of symptoms, a subset of patients, more commonly women, report bleeding as their main complaint, rather than pain. Some patients experience repeated bouts of healing with symptom resolution followed by reopening of their fissure (cycling) and present to the surgeon seeking definitive care. By the time patients present to the surgeon, many have inevitably tried any of a number of over-the-counter remedies that have failed to control their symptoms or have tried, unsuccessfully, established fissure therapies recommended by prior physicians. Considering prior failed treatments is helpful when deciding the next course of action.

Differential diagnosis for patients presenting with anal fissure might include abscess, external hemorrhoid thrombosis, anal cancer, pruritis ani and a variety of anogential infections. Given the typical history and symptomology of a fissure and the alternative diagnoses in the differential, the astute clinician is able to diagnose a fissure based on history alone in the majority of patients and commonly relies on the physical exam only to confirm the diagnosis.

In terms of diagnosing an anal fissure, gently spreading the buttocks with the patient in the left lateral or prone position will usually reveal the presence and location of the fissure. Signs of fissure chronicity include a sentinel pile or skin tag, raised or heaped-up edges and observing the concentrically oriented white fibers of the internal sphincter muscle at the base of the fissure (Fig. 14.1). There is commonly a lack of granulation tissue at the base of the wound. Given the pain and tenderness associated with fissuring and the usually readily apparent fissure upon simple inspection, it is not required, recommended or helpful to perform a digital or anoscopic examination during the presenting office encounter. Patients will often lament how the doctor they saw previously regarding their anal pain performed an overly-aggressive, traumatic anal exam. Similarly, anorectal physiology testing is not routinely performed at this juncture.

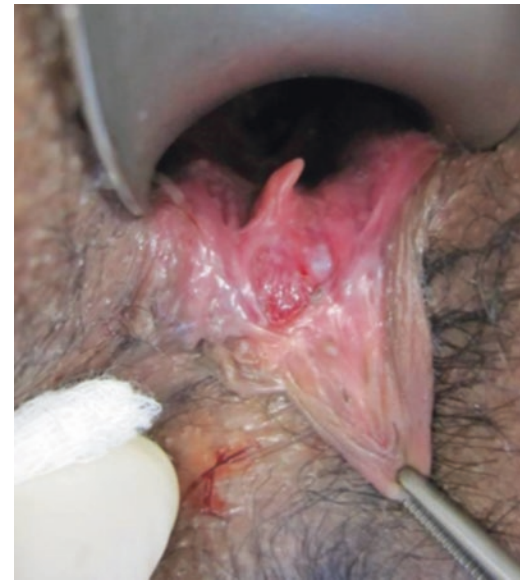


Fig. 14.1 Intra-operative photo demonstrating the classic fissure triad: a chronic fissure, an indurated, fibrotic skin tag and a hypertrophied papilla. Courtesy of Dr. Daniel L. Feingold

Importantly, patients presenting with severe anal pain who do not have a demonstrable fissure should consider examination under anesthesia to confidently establish their diagnosis and to effect treatment. Patients who are too tender to tolerate a limited external examination in the office may have a highly symptomatic anal fissure or may possibly have a more insidious process like an inter-sphincteric abscess or cancer.

While fissures develop around the circumference of the anus, approximately 80–90% of patients will have a single, posterior midline fissure. Up to about 25% of fissures in women and 8% of fissures in men are located anterior midline. Post-partum fissures are also commonly anterior midline. Off-midline or multiple fissures are considered atypical and should alert the clinician to the possibility of an occult underlying etiology (Table 14.1). An asymptomatic fissure should raise the suspicion of Crohn's disease. Atypical fissures and persistent or recurrent fissures after sphincterotomy are commonly considered for biopsy to evaluate for an underlying occult etiology.

Table 14.1 Underlying etiologies for anal fissure

• Psoriasis
• Post-radiation
• Trauma or ano-receptive practices
• Non-healing post-operative wounds
• Crohn's disease
• Anal cancer
• Tuberculosis
• Syphilis
• HIV infection

Medical Therapy

Patients with acute fissures with a constellation of symptoms not severe enough to warrant moving directly to operative treatment are usually treated with a combination of fiber supplementation with adequate water intake, stool softeners and hot baths. Smoking cessation should be addressed, as well. The majority of patients with acute fissures will heal with this management, while only about 10% of patients with chronic fissures will heal with medical therapy. Patients presenting with chronic fissures or more severe pain have traditionally been offered partial lateral internal sphincterotomy (PLIS), a highly successful treatment that is associated with varying degrees of incontinence. In an effort to minimize the potential morbidity of treatment, a number of non-operative, pharmacy-based alternatives have been studied and are routinely offered to patients in an effort to avoid PLIS.

A variety of peri-anal topical or injection therapies, used in conjunction with the medical therapy outlined above, relax the internal anal sphincter, improve blood flow and can facilitate fissure healing. The literature reports a wide range of healing rates related to the variety of available compounds that is difficult to reconcile. These therapies are generally not FDA-approved for the treatment of anal fissure and their use in this setting is considered "off-label". Intra-anal application is painful, does not improve efficacy over topical therapy and should be dissuaded. Thrice daily application of topical therapy may improve efficacy as compared with twice a day dosing. Patients with anal fissure refractory to a particular medical therapy may benefit from trying a different compound. Office-based silver nitrate cauterization, oral low-dose diazepam, topical analgesics or metronidazole ointment, in conjunction with medical therapy, may be helpful in certain patients.

Nitric oxide donors like glyceryl trinitrate 0.2% ointment (also known as nitroglycerin) applied twice or thrice daily for 8 weeks can promote healing. The variable potency of compounded products can reduce efficacy. A commercially available, FDA-approved 0.4% formulation may be easier for patients to acquire, rather than relying on a compounding pharmacy, and may be a more reliable product [1]. This therapy causes nitrate-induced headaches in most patients, which are frequently disabling and lead to non-compliance and treatment failure. Pre-treating with over-the-counter non-steroidals or switching to a different topical agent may be advantageous. Topical calcium-channel blockers (diltiazem 2% or nifedipine 0.2%) used twice or thrice daily for 8 weeks is generally considered as effective as nitroglycerin but causes fewer headaches and may have fewer recurrences. These agents, in some patients, cause pruritis severe enough to interfere with therapy.

Chemical sphincterotomy (chemodenervation) by botulinum neurotoxin A injection addresses anal hypertonicity by inhibiting acetylcholine release at neuromuscular junctions. Muscle relaxation occurs within days and may last for 2–4 months. Injection of 10–100 units at various locations in and around the anal fissure has been described and may account for the highly variable reported success rates of this intervention. As with topical anal fissure therapies, botulinum injection has a high risk of recurrence after initial healing. Botulinum therapy may be contra-indicated in pregnancy or in patients with neuromuscular disorders. Patients should be counselled regarding the potential incontinence after botulinum toxin injection, which is uncommon and is almost always transient. Fissurectomy at the time of botulinum toxin injection freshens the wound and may facilitate healing [2].

An updated Cochrane review of non-surgical therapy for anal fissure including 77 randomized, controlled trials with 5031 patients found nitro-

glycerin to be marginally but statistically significantly better than placebo in healing fissures (48.9% versus 35.5%) [3]. Across these studies, the fissure recurrence rate after initially healing with nitroglycerin-based therapy was approximately 50%. The efficacy of calcium-channel blocker therapy or botulinum therapy was equivalent to the efficacy of using nitroglycerin but these agents were associated with fewer adverse events. Other meta-analyses have reported similar disappointing clinical outcomes for medical therapy.

Operative Therapy

Given the high failure and recurrence rates associated with medical therapy in the setting of chronic anal fissure and the persistent symptoms of recalcitrant fissures, many patients undergo surgery to facilitate healing. The standard operative treatment for patients with refractory anal fissure persisting despite medical therapy is partial lateral internal sphincterotomy (PLIS) [4]. This operation, highly effective at reducing anal manometric pressures, heals fissures with success rates typically quoted as 90–95% or higher and restores pre-fissure quality of life. Most patients are highly satisfied after undergoing PLIS and experience pain relief within a few days and heal their fissure after a few weeks. Recurrent fissure after PLIS occurs in up to 10% of patients and is commonly treated with medical therapy rather than re-operation. Post-PLIS complications are relatively uncommon and may include incontinence, prolonged pain, delayed wound healing, bleeding, abscess, infection, fistula or persistent or recurrent fissure.

The most significant long-term complication of PLIS is derangement of anal function, which is variably reported to occur, to some degree, in as many as 30% patients or more. It is generally accepted that the incidence of incontinence is under-reported among patients and their surgeons whether due to embarrassment or a degree of denial on the part of patients or inadequate post-procedure follow-up or reporting bias on the part of surgeons. The most common dysfunction after PLIS is typically for controlling flatus or liquid stool and major incontinence of stool is rare, especially with appropriate patient selection. Prior to performing PLIS, it is important to consider the details of a patient's unique history with regards to prior sphincter damage, previous anal surgery or vaginal delivery, frequency of diarrhea and baseline continence and to appropriately counsel patients regarding alternatives, risks and benefits of PLIS.

The concern over potential PLIS-related anal dysfunction is greater when you consider that the muscle disruption from PLIS is permanent. Even when function is preserved in the short-term after PLIS, patients may be at greater risk for future incontinence given the age-related decrease in resting tone as well as possible sphincter damage from future obstetric trauma or anal surgery. Muscle-sparing alternatives to PLIS can be considered in patients who want to reduce the risk of post-operative dysfunction [5].

PLIS Operative Techniques

Open PLIS: An appropriately sized Hill-Ferguson of Sawyer retractor accentuates the bow-stringing of the internal anal sphincter muscle (Fig. 14.2). The muscle is palpated and the caudal extent of the muscle is appreciated at the inter-sphincteric groove. A short, radial incision over the internal muscle and the medial aspect of inter-sphincteric grove is made in the lateral position. The distal most aspect of the internal anal sphincter muscle is visualized and a curved clamp is passed under the targeted muscle. The anatomy is confirmed by observing the white, concentric muscle fibers of the internal anal sphincter and demonstrating that these fibers do not fasciculate when stimulated by cautery. The appropriate length of muscle is divided with electro-cautery and pressure is held for hemostasis and to release any residual muscle fibers. Transecting a portion of the internal anal sphincter in the mid-portion of the muscle instead of at the most distal aspect of the muscle may reduce the success rate of PLIS and may result in fistula formation. This technical failure can be avoided by confirming the location of the inter-sphincteric groove and visualizing the

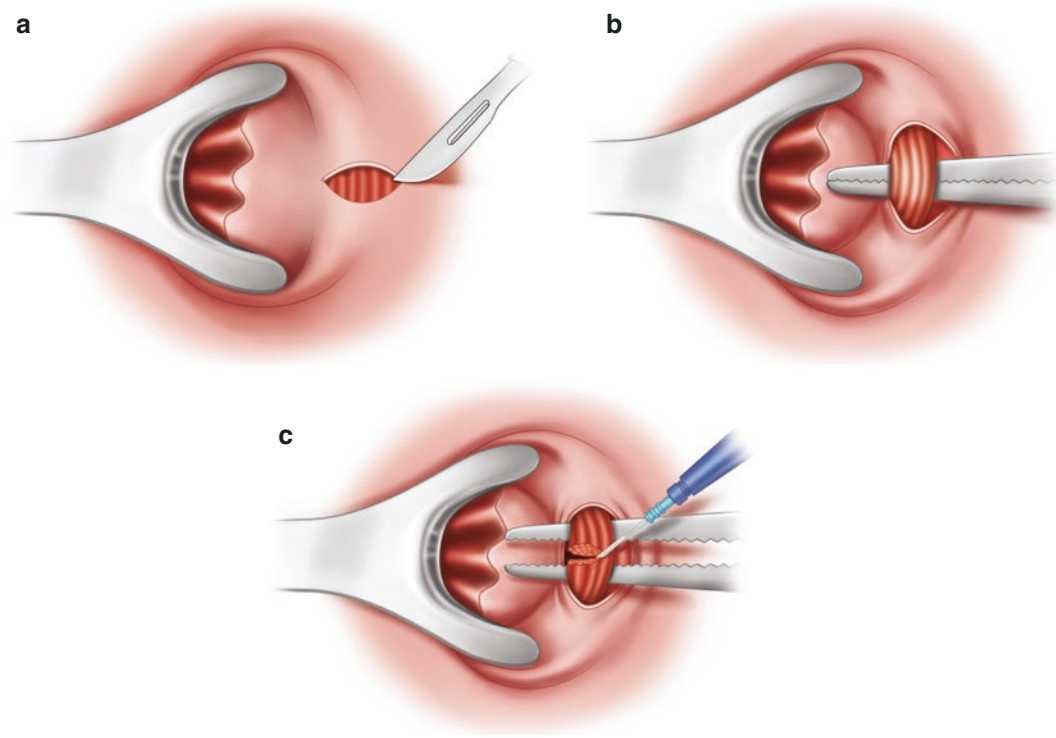


Fig. 14.2 Open sphincterotomy. (**a**) A radial incision exposes the muscle (**b**). The distal most internal sphincter muscle is dissected. (**c**) The muscle is divided with cautery

most distal fibers of the internal muscle before performing the sphincterotomy.

Closed PLIS: The "reverse Notaras" is similar to the open approach but omits the skin incision and the tissue dissection (Fig. 14.3). An appropriately sized Hill-Ferguson or Sawyer retractor accentuates the bow-stringing of the internal anal sphincter muscle. The muscle is palpated and the caudal extent of the muscle is appreciated at the inter-sphincteric groove. A narrow, angled scalpel (like #11) is passed through a stab incision in the lateral position in the inter-sphincteric groove flush with the internal sphincter muscle. With the surgeon's index finger in the anal canal as a guide, the blade is turned perpendicularly inward toward the anal canal. Fine motion of the pointed tip of the scalpel during its removal produces blind, sharp division of the distal aspect of the internal anal sphincter muscle with, as described by Notaras, a "characteristic gritty sensation that is felt through the scalpel handle". Care should be taken to avoid cutting through the mucosa as this can result in abscess or fistula. Dividing the internal sphincter muscle causes an immediate release in tension across the retractor. As with the open technique, pressure is held for hemostasis and to fracture any remaining muscle fibers.

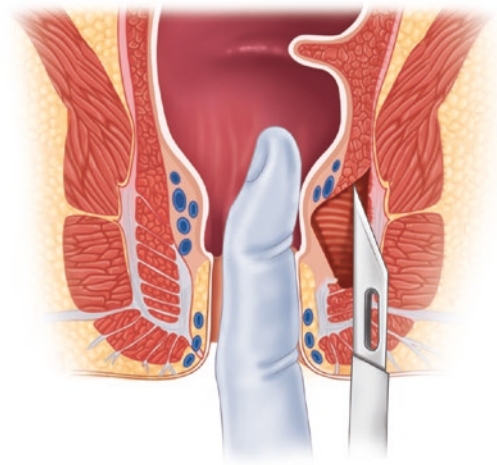


Fig. 14.3 Closed sphincterotomy. The distal most internal sphincter muscle is divided taking care not to incise the mucosa

The closed technique, originally described with placing the blade under the anoderm and dividing the muscle by turning the blade outward toward the inter-sphincteric groove, was modified for simplification and reproducibility and to reduce unwanted injury to the external sphincter muscle. Unintentional damage to the external anal sphincter during PLIS has been implicated in the development of post-PLIS dysfunction.

Laterality of PLIS is usually chosen based on the presence or absence of lateral internal hemorrhoid cushions. Patient positioning, type of anesthesia and closing the wound after PLIS are decided according to the preference of the surgeon and, likely, do not influence outcomes. Associated skin tags and papillas are typically excised or fulgurated concurrently with PLIS and debriding the fissure (fissurectomy) may facilitate healing. It is rare to have symptomatic hemorrhoids requiring operative treatment at the time of PLIS and, depending on the circumstances, addressing the chronic fissure and leaving the hemorrhoids alone is usually the better course of action. Post-PLIS, patients are given standard post-anal surgery instructions regarding stool softeners, hot baths, multi-modality analgesia and "red flag" symptoms to watch out for.

Since the original descriptions of PLIS for the treatment of fissure, the technique has been studied in terms of the ideal location of the sphincterotomy around the circumference of the anal canal as well as the preferred approach (open versus closed). Early descriptions of PLIS involved posterior midline sphincterotomy which was associated with prolonged healing times and risked causing a deep groove-like defect that interfered with complete closure of the anal canal at rest and resulted in leakage ("keyhole" deformity). Sphincterotomy in the lateral position effectively avoids this anal canal furrow and supplanted posterior sphincterotomy as the standard location for PLIS.

In terms of the operative approach to PLIS, a large retrospective study relying on mailed patient questionnaires obtained clinical follow-up information an average of 3 years after PLIS [6]. The authors compared 324 open PLIS patients with 225 closed PLIS patients and demonstrated comparable success in terms of healing and recurrence and that the closed technique was associated with statistically significantly less anal dysfunction (41% versus 33%). A randomized, controlled study comparing 40 patients who underwent open PLIS with 36 patients who underwent closed PLIS with 1 year of follow-up demonstrated no statistically significant differences in post-operative pain or incontinence [7]. A Cochrane review also demonstrated that properly performed lateral sphincterotomy using the open or closed approach yielded equivalent outcomes [8]. The PLIS approach should be chosen based on surgeons' preference and familiarity with the procedure.

The evolving recognition and appreciation of unwanted functional consequences related to sphincter muscle division have influenced which patients are recommended to undergo PLIS and how the operation is technically performed. As the risk of incontinence and the risk of fissure persistence are related to the degree of muscle division, the extent of sphincterotomy during PLIS remains controversial. Traditionally, in order to effectively relax the hypertonic internal sphincter muscle, PLIS was recommended up to the level of the dentate line. More recently, a refinement in the technique has been recommended limiting the extent of sphincterotomy to the apex of the actual fissure. "Tailored" PLIS was studied in a randomized, controlled trial including 46 patients who underwent traditional PLIS and 46 patients who underwent PLIS to the level of the apex of their fissure [9]. These authors demonstrated that female patients who had a least one prior vaginal delivery who underwent a more extensive PLIS had faster pain relief and faster fissure healing but were more likely to have some degree of post-operative incontinence as compared with patients who had a more limited PLIS. Other similarly constructed randomized, controlled trials have also demonstrated quicker healing but higher anal dysfunction rates associated with more extensive sphincterotomy and higher recurrence rates and less incontinence after more limited PLIS [10]. "Calibrated" PLIS has been suggested, a well, in an effort to standardize the extent of muscle division. This method utilizes a conical, calibrated scale to control the degree of PLIS.

An alternative to traditional, tailored or calibrated PLIS was suggested in a prospective study of 31 women with chronic anal fissure who failed medical therapy and underwent subsequent PLIS up to the level of the apex of their fissure [11]. After healing, patients underwent three-dimensional anal ultrasonography demonstrating that women who had less than 25% of their internal anal sphincter muscle divided at the time of PLIS were less likely to experience post-operative functional complications. This length of sphincterotomy amounted to less than 1 cm. Surgeons must weigh the risks of cutting too much muscle and jeopardizing continence with not cutting enough muscle and leading to fissure persistence due to inadequate relief of sphincter hypertonicity. Adopting a prudent "less is more" approach to PLIS and appreciating that women typically have less bulky sphincter muscle and shorter length of muscle as compared with men is important.

Another potential contributing factor influencing the rate of post-operative incontinence includes pre-existing occult sphincter injury from prior anal surgery or obstetric trauma. It is important to consider that patients with asymptomatic anal sphincter injury, commonly due to vaginal delivery, may manifest with anal dysfunction after additional sphincter disruption from subsequent PLIS. A retrospective study relying on mailed patient questionnaires obtained clinical follow-up information an average of 4 years after PLIS and demonstrated that women who had more than one vaginal delivery were more likely to experience long-term gas incontinence [12].

Alternative Treatment Concepts

Given the potential functional consequences of PLIS, a number of alternative treatments have been proposed. Patients with prior sphincter damage, baseline incontinence, chronic diarrhea, hypotonic muscle or desire to reduce the risk of incontinence may consider muscle-sparing treatment options. Combining fissurectomy with botulinum toxin injection was reviewed earlier. Other novel applications, like sacral nerve stimulation, will not be reviewed in detail.

Subcutaneous Fissurotomy

The presence of a short sinus or fistula emanating from a fissure bed is a poorly described entity related to chronic anal fissure ("fissure-fistula"). The tract, when present, is typically a short, subcutaneous sinus extending from the distal apex of the fissure towards or under the sentinel skin tag. This is generally considered a manifestation of the chronicity and severity of inflammation related to the fissure, rather than the result of an infection, and is treated by simply laying open the tract at the time of PLIS. The tract is not always readily apparent, and the surgeon should carefully evaluate the fissure for the presence of such a tract. In rare situations where a fistula is present involving muscle, the operative plan or degree of sphincterotomy may need to be adjusted.

A potential muscle-sparing alternative to PLIS involves treating the chronic anal fissure for what it is, a chronic, non-healing wound, and incorporates minimal dilation (enough to accommodate a conventional anoscope) with debridement and cauterization of the fissure and subcutaneous fissurotomy with laying open of the sinus tract. Unroofing the sinus widens the distal anal canal, theoretically, obviating the need for PLIS and fissurectomy effectively freshens a chronic fissure creating an acute fissure that may go on to heal without muscle division [13]. This approach has been combined with triamcinolone injection into the base of the fissure with encouraging results. It is important that patients follow standard post-anal surgery instructions to facilitate fissure healing and avoid re-opening or aggravating a healing fissure. The concept of treating fissures as chronic, non-healing wounds is supported by the anecdotal success of hyperbaric oxygen therapy in healing recalcitrant fissures.

Dilation

Performing uncontrolled, aggressive (four fingers or more) manual anal dilation to relieve the hypertonia of anal fissure (similar to the procedure described by Lord for the treatment of hemorrhoids) traumatizes the sphincter complex, unreasonably jeopardizes function, and has been relegated to historical mention. Meanwhile, controlled, standardized anal dilation using a 40 mm diameter pneumatic balloon

in the setting of chronic anal fissure has been studied in randomized, controlled fashion and may be a viable alternative to PLIS [14]. The 24 patients who underwent controlled dilation, as compared with 25 patients who underwent PLIS, had reasonable healing rates (83% versus 92%) and less incontinence after 24 months of follow up (0% versus 16%). Further study regarding efficacy, safety and recurrence rates will determine the utility of this technique.

Flaps

Introducing healthy, well-perfused tissue to the ischemic wound of a chronic fissure has a high chance of success and carries minimal risk of anal dysfunction. Before flaps are advanced into the anal canal, the fissure base is prepared with curettage and the fibrotic edges are excised (fissurectomy). A more detailed review of flaps follows in the section on anal stenosis.

Simple Cutaneous Advancement Flap

A trapezoid, broad-based skin flap with a length at least 1.5 times the length of the fissure and a base at least twice the width of the apex of the flap preserves the blood supply of the flap and affords tension-free reach to cover the fissure. These full-thickness flaps consist of skin and subcutaneous fat dissected up off the subcutaneous external sphincter muscle. Once advanced, the flap is secured to the mucosa along its apex and to the anoderm along its sides (Fig. 14.4).

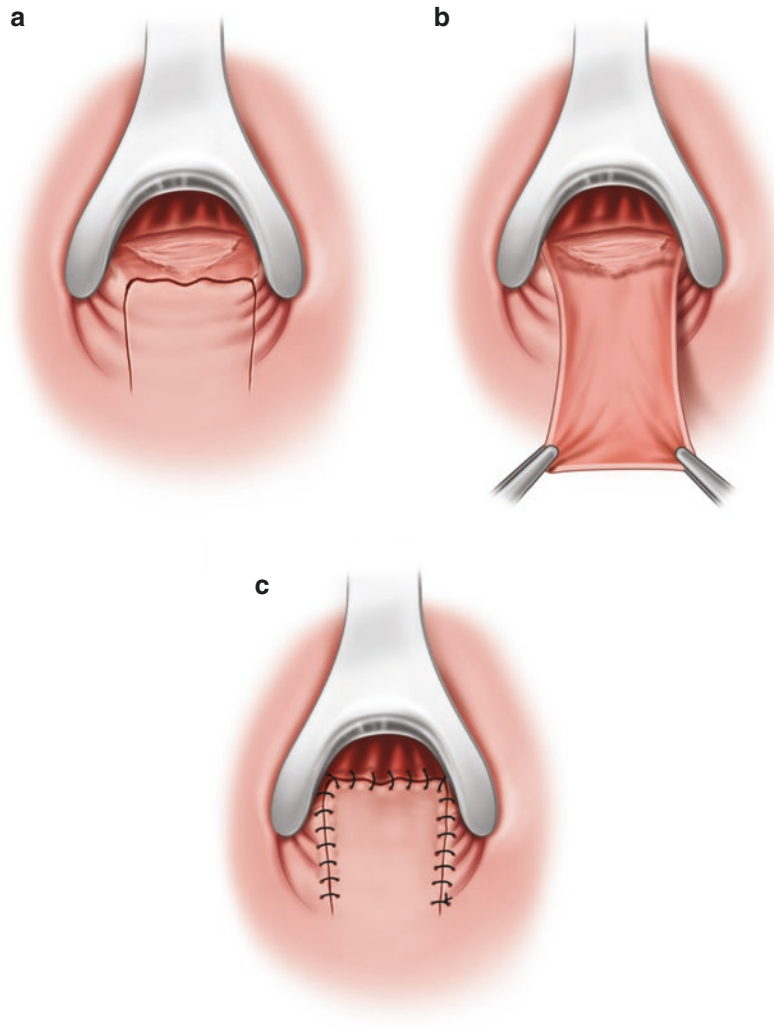


Fig. 14.4 Simple cutaneous advancement flap. (**a**) The fissure bed is prepared and the sides of the flap are incised. (**b**) The full thickness dermal flap is raised. (**c**) The flap is sutured in place

V-Y Advancement Flap

These flaps, oriented pointing toward the buttock, are mobilized with minimal undermining to preserve vascularity. Flaps are advanced into the anal canal without tension and are sutured to the dentate line. Closing the donor site wound helps advance the "V" into the anal canal. Primary closure of the wound facilitates healing and recovery. V-Y advancement flaps are simple to construct and can also be fashioned obliquely to avoid using midline skin (Fig. 14.5).

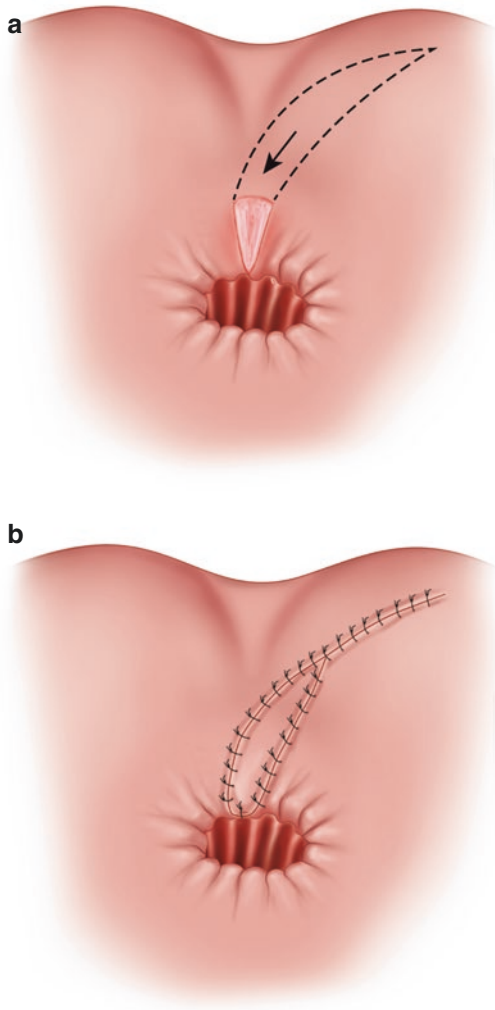


Fig. 14.5 V-Y advancement flap. (**a**) The fissure bed is prepared and the "V" flap is marked. (**b**) The lateral aspect of the donor wound is closed first to advance the flap into the anal canal and then the flap is secured in place

Unique Situations

Post-PLIS Fissure

Persistence or recurrence of fissure after PLIS is usually due to inadequate sphincterotomy that fails to adequately relieve the hypertonia of the internal sphincter muscle. Alternatively, this circumstance raises the possibility of an atypical fissure and a careful assessment, possibly with fissure biopsy, should be performed. Before proceeding with repeat PLIS, patients are often managed initially non-operatively to try to effect healing and frequently undergo anorectal physiology testing to objectively assess the sphincter complex. Repeat PLIS is usually done at the contralateral position across from the original PLIS and, in selected patients, is associated with excellent healing rates and low incontinence rates. Muscle-sparing alternatives, like flaps, are often considered in this situation in order to reduce the risk of anal dysfunction. Patients with fissures who have had a prior fistulotomy or other anal sphincter injury are typically managed according to the same algorithm as patients with post-PLIS fissure.

Hypotonic Fissure

Absence of hypertonicity (normal or hypotonic "low pressure" sphincter) is more commonly seen in patients who are elderly, post-partum, female or who have anterior-based fissures. Patients with chronic fissure without the typical hypertonic internal anal sphincter should be considered for muscle-sparing therapy as sphincterotomy in this situation risks non-healing and anal dysfunction. Anal manometry may be helpful to objectively determine resting tone and can be useful when counseling patients.

Extreme Pain

A subset of patients present with severe pain greatly affecting their life. Often these patients cannot sit, miss work due to their disabling fissure and have become professionally and personally dysfunctional. Patients with this degree of symptoms commonly use a combination of topical anesthetics, narcotics and oral laxatives that produce liquid movements to blunt the fis-

sure pain. Fissure patients with this extreme presentation may actually be fistulizing through the base of their fissure. While counselling highly symptomatic fissure patients about non-operative treatment is standard, many of these patients will opt for expedited examination under anesthesia to confirm their diagnosis and effect therapy. In patients with extreme pain without evidence of a fissure or overt signs of infection on external exam, fever, difficulty voiding or rapidly worsening pain over a few days raises the suspicion of an occult inter-sphincteric abscess, or other soft tissue infection, and these patients should be diagnosed and treated by prompt examination under anesthesia.

Inflammatory Bowel Disease

Fissures occur more frequently in patients with IBD than in the general population and IBD related fissures are commonly atypical appearing (deep, broad), off-midline or multiple (Fig. 14.6). Compared with patients with ulcerative colitis, the rate of fissuring is higher in patients with Crohn's disease and for unclear reasons, a subset of Crohn's disease patients have asymptomatic fissures. Classically, fissures in patients with Crohn's disease are accompanied by large, edematous skin tags ("elephant ears"), which often are the reason for presentation. Patients with pain commonly have a degree of anal stenosis as well and are frequently taken for examination under anesthesia to exclude a suppurative process or fistula and to define the anatomy.

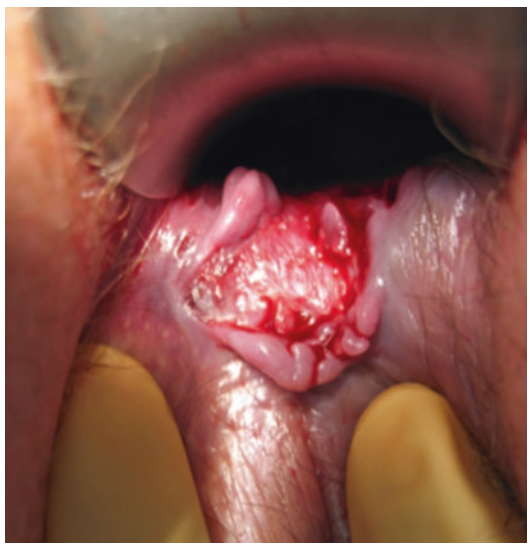


Fig. 14.6 Intra-operative photo of a patient with Crohn's disease demonstrating a broad, deep fissure. Courtesy of Dr. Daniel L. Feingold

Fissures in Crohn's disease patients pose unique diagnostic and therapeutic challenges and a multi-disciplinary approach is helpful to evaluate the presence and extent of proximal Crohn's disease and to coordinate medical and surgical therapy. As these patients often have chronic diarrhea, are at risk for requiring future anal surgery to address fistulizing disease, and are purported to have poor wound healing ability, they are routinely first treated non-operatively. While standard medical therapy options used to treat patients with idiopathic fissures are also applicable to IBD patients, patients who fester on medical therapy are at risk for developing abscess or fistula at the site of their fissure [15]. Small case series describe that in carefully selected, symptomatic, non-healing Crohn's disease patients without active proctitis, PLIS is safe and efficacious [16].

HIV-Related Fissure

Patients with HIV may present with typical, idiopathic fissures that may be treated in similar fashion as fissures found in sero-negative patients. Alternatively, some patients develop atypical anal ulcerations similar to fissures related to Crohn's disease that can appear deep, broad-based or cavitating (Fig. 14.7). These lesions may be due to a variety of infections and are often associated with lax sphincter tone. The evaluation and treatment of these patients must be individualized and coordination with patients' infectious disease doctors is often helpful.

Non-healing Wounds

Patients with persistent wounds from excisional hemorrhoidectomy or other anal operation, from trauma or ano-receptive practices or in the setting of prior radiotherapy require careful consideration before proceeding with operation. Appreciating that these patients do not have typical, idiopathic fissures is important and consid-

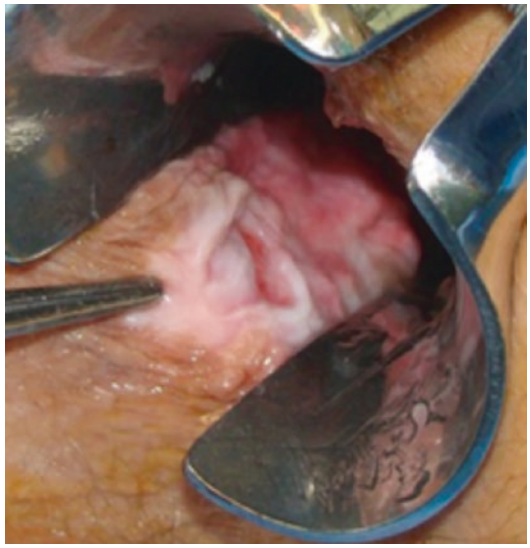


Fig. 14.7 Intra-operative photo of a patient with HIV demonstrating an infiltrative, deep, off-midline fissure. Courtesy of Dr. Scott R. Steele

ering underlying etiologies with tissue biopsy or culture may be required. Often, in this situation, the anal canal lacks hypertonicity and muscle-sparing treatment options should be considered.

Anal Stenosis

Introduction

Anal stenosis is a rare, potentially incapacitating narrowing of the anal canal due to loss of epithelium and scarring. Treatment options, modulated depending on the severity of stenosis, range from medical therapy with stool softeners and bulking agents to dilation to anoplasty. The surgical management of anal stenosis can be particularly technically challenging.

Pathogenesis

The majority of cases of anal stenosis are caused by excessive or abnormal scarring after multi-quadrant hemorrhoidectomy. To reduce the occurrence of this complication, it is important, when performing hemorrhoidectomy, to leave muco-cutaneous bridges of healthy tissue in between the columns being excised. Radical anal surgery can replace the normally pliable anoderm and mucosa with fibrotic, unforgiving, non-compliant scar that can gradually progress to stenosis that may not dilate adequately during defecation. Stenosis may result from other anorectal operations such as Delorme, transanal tumor excision, excision and fulguration procedures or anal anastomoses. Anal stenosis can also occur after stapled hemorrhoid surgery, though this is technically rectal stenosis due to the nature of the mucosectomy performed. Other causes of acquired anal stenosis include chronic diarrhea, long-term mineral oil or other laxative abuse (“paraffin anus”), trauma, IBD, radiotherapy, tuberculosis, perineal sepsis, and a variety of infections.

Presentation

Anal stenosis causes difficult or painful evacuation and patients often present with bleeding and narrow caliber stools. Patients with more severe stenosis can have truly debilitating symptoms. Similar to patients with highly symptomatic fissures, some stenotic patients experience “food fear” whereby they limit oral intake to decrease the frequency of difficult, painful bowel movements. The majority of patients report antecedent hemorrhoidectomy. Symptoms or bouts of fecal impaction lead many patients to rely on combinations of diet modification, oral laxatives and enemas to ameliorate symptoms. Patients may report leakage, tenesmus, frequency, incomplete evacuation or other anal dysfunction. Physical examination with visual inspection and careful digital exam usually confirms the diagnosis. Patients with more severe stenosis will not tolerate office digital exam and require examination under anesthesia. Differential diagnosis for patients presenting with anal stenosis might include malignancy, fissure, constipation or hemorrhoid disease.

Stenotic patients are classified subjectively according to the severity of anal stenosis. Mild stenosis describes a tight anal canal that can be

relatively easily examined with a well-lubricated examining finger. A moderate stenosis requires some degree of forceful dilation to insert an index finger and severe stenosis requires even more force to insert the smallest Hill-Ferguson retractor or fifth digit. Stenoses can also be categorized according to their length ranging from a focal, short, veil or diaphragm to a ring-like, annular segment typically less than 2 cm in length to a tubular or diffuse stenosis longer than 2 cm. Describing stenoses according to their height in relation to the dentate line as low (the majority of stenoses), middle or high is also helpful.

Medical Treatment

While all patients with stenosis can be initially managed non-operatively, patients with a mild stenosis are most amenable and most likely to respond to this treatment. Stool softeners and fiber supplementation with adequate water intake to bulk up the stools provide gradual and natural dilation for these patients. An adequately long course of medical therapy is warranted before moving to more invasive treatment.

Dilation

Daily self-dilation using a well-lubricated, smooth mechanical dilator, like a Hegar cervical dilator, can, over time, gradually expand the anal canal and improve symptoms of stenosis. Typically, the first dilation is done under anesthesia, which may be combined with longitudinal, releasing anotomies or sticturotomies. The benefit of these relaxing incisions is questionable and depends on the degree and length of stenosis and the quality of the tissues. There is a concern that relaxing incisions can actually cause scarring and fibrosis along the anal canal further exacerbating the stenosis. Dilation may be particularly helpful for stenosed patients with Crohn's disease or prior radiotherapy in whom surgical options are limited. Although successful in many patients with mild stenosis, some patients do not tolerate self-dilation. Dilation of more severe stenosis may cause trauma resulting in counter-productive fibrosis and further contracture and deterioration in function; these patients usually require augmentation anoplasty.

Operative Therapy

Operative intervention is usually reserved for patients with moderate or severe stenosis who have failed the medical therapy outlined above. In cases where a functional stenosis contributes to narrowing of the anal canal, open PLIS (reviewed previously) can be helpful in alleviating symptoms, and, after careful consideration, PLIS may be performed in conjunction with anoplasty, depending on the anatomy and circumstances.

Stricturoplasty

A short mucosal stricture after stapled hemorrhoid surgery may be corrected by dividing the stricture longitudinally and then closing the defect transversely similar to a small bowel stricturoplasty. For more effective stricturoplasty, this release and closure can be repeated contra-laterally along the circumference of the stricture [17].

Flaps

The ideal operation to correct anal stenosis restores function, prevents recurrent stenosis and has a low risk of post-operative morbidity. Flaps bring in healthy, vascularized tissue to augment the anal canal restoring pliability and capacity and are the procedures of choice when less invasive interventions fail. The type of anoplasty used in a particular patient depends on the surgeon's familiarity and preference and on unique patient anatomic factors like the height, length and degree of the stenosis and the skin available for use (Fig. 14.8).

A simple advancement flap maintains its blood supply across an intact skin bridge (Y-V, mucosal advancement, rotational flaps). An island or pedicle flap lacks a skin bridge and receives its blood supply from the underlying fatty pedicle (V-Y, diamond, house flaps). Careful attention to preserving blood flow when mobilizing flaps and limiting undermining help prevent flap necrosis. Minimizing tension across the flap is important and can be technically challenging. Prior

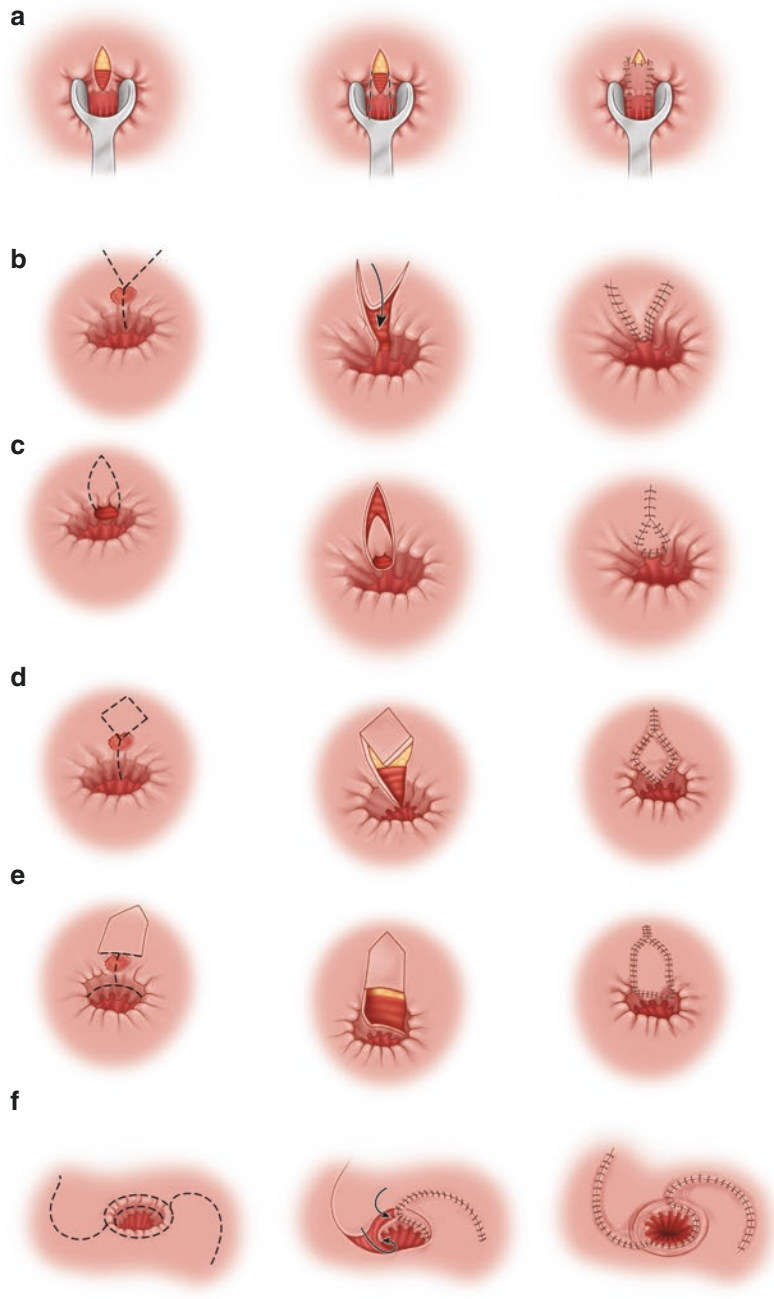


Fig. 14.8 Comparison of the configuration of a variety of anoplasty flaps. (**a**) Mucosal advancement flap. (**b**) Y-V flap. (**c**) V-Y flap. (**d**) Diamond flap. (**e**) House flap. (**f**) Rotational "S" flaps

to securing a flap in the anal canal, the fibrotic bed of the stricture should be divided or excised and freshened to accept the graft. Failing to adequately release or prepare the bed or compromising the vascularity of the flap risks failure of the flap. Flaps are typically performed in prone position with on-table intravenous antibiotic and bowel preparation depends on surgeon preference. Complications after flap procedures may include flap necrosis, sloughing or dehiscence, persistent stenosis or anal dysfunction, infection, pruritis, and non-healing donor sites. In extreme cases of refractory stenosis, patients may require fecal diversion.

Mucosal Advancement Flap

Similar to a rectal advancement flap used to treat fistula-in-ano, this flap survives off the submucosal plexus and is most applicable to mid-level or higher stenosis. In order to prevent the creation of an ectropion, when addressing a more distal stenosis, the external most aspect of the wound may be left uncovered.

Y-V Advancement Flap

While the narrow apex does not augment the anal canal as much as a broad flap and the pointed configuration risks necrosis at the apex, this flap is simple to construct and is effective for strictures distal to the dentate line. A "Y" shaped vertical incision starting at the prepared stenosis bed allows mobilization of the full-thickness "V" shaped flap. The two oblique limbs of the flap are typically 5–8 cm in length. This flap can be created extending radially from the anus or can be configured obliquely, as needed, similar to the V-Y flap reviewed earlier.

V-Y Advancement Flap

This flap, reviewed earlier in the treatment of fissure, can also be used to treat ectropion or stenosis. The configuration of this flap advances well into the anal canal and is useful in severe anal strictures.

House Flap

This is a modification of the V-Y anoplasty and provides a broad pedicle skin flap that can augment the length of the stenotic anal canal and permits primary closure of the donor site despite the width of the flap (Fig. 14.9). This flap of skin and subcutaneous fat maintains its blood supply from underlying perforators and the configuration does not come to a narrow point making it less prone to ischemic necrosis. As with V-Y flaps, closing the donor wound helps advance the flap into the anal canal. The width of the flap should match the width of the mucosal defect to be covered and should not exceed about 25% of the circumference of the canal. As with other configurations, if further augmentation is required, bilateral flaps may be constructed (Fig. 14.10).

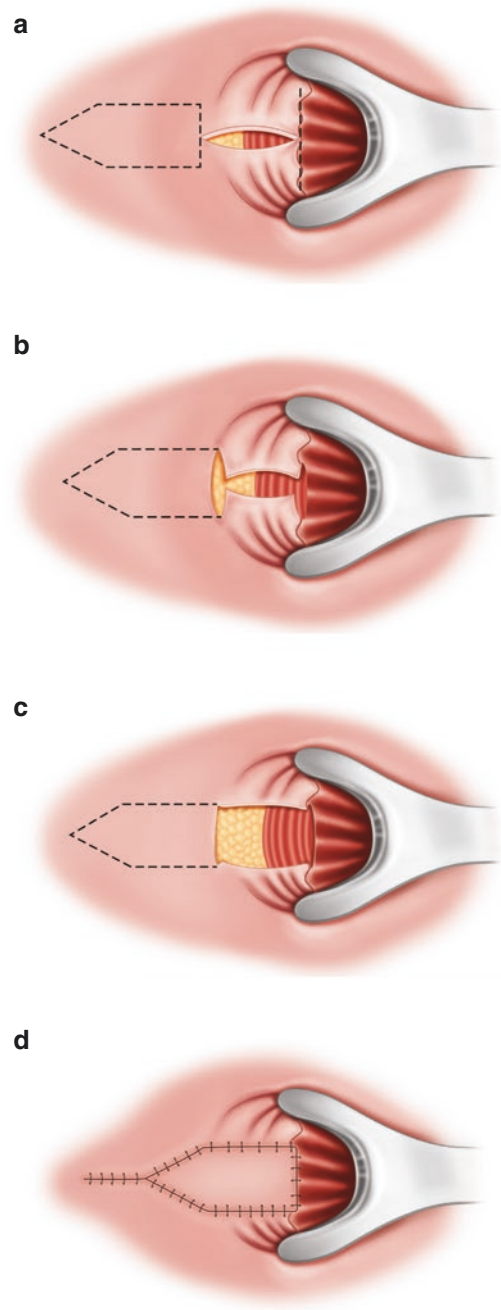


Fig. 14.9 The house flap anoplasty. (**a**) The strictured anal canal is incised longitudinally to release the scar. (**b**) Perpendicular incisions are made. (**c**) The anal canal is prepared to accept the flap. (**d**) The flap is advanced into the anal canal behind the closure of the donor site

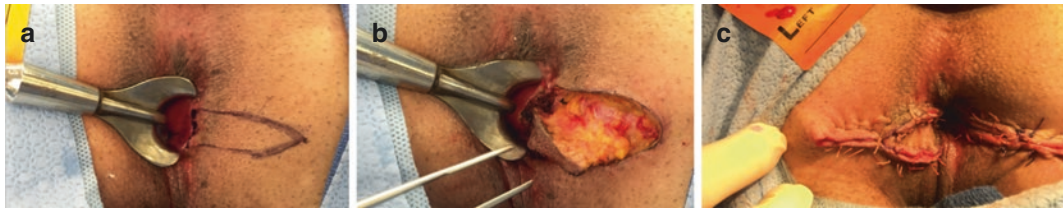


Fig. 14.10 Intra-operative photos of a patient undergoing house flap anoplasty. (**a**) The dimensions of the flap are drawn out. (**b**) The mobilized flap ready for advancement into the anal canal. Minimizing undermining ensures a broad-based pedicle and preserves vascularity. (**c**) The completed bilateral flaps. Courtesy of Dr. Daniel L. Feingold

Diamond-Shaped Flap

This concept is similar to the house flap. Choosing the angled design of a rhomboid or the broad configuration of a house depends on the shape and size of the target defect.

Rotational "S" Flaps

These advancement flaps are more useful for reconstruction after wide, local skin excision for Highgrade Squamous Intraepithelial Lesion or Paget's disease. Typically, the flaps reviewed above augment anal stenoses better than rotational flaps.

References

1. Azarnoff DL, Lee JC, Lee C, Chandler J, Karlin D. Quality of extemporaneously compounded nitroglycerin ointment. Dis Colon Rectum. 2007;50:509–16.
2. Barnes TG, Zafarani Z, Abdelrazwq AS. Fissurectomy combined with high-dose botulinum toxin is a safe and effective treatment for chronic anal fissure. Dis Colon Rectum. 2015;58:967–73.
3. Nelson RL, Thomas K, Morgan J, Jones A. Non-surgical therapy for anal fissures. Cochrane Database Syst Rev. 2012;2:CD003431.
4. Perry WB, Dykes SL, Buie WD, Rafferty JF. Practice parameters for the management of anal fissures. Dis Colon Rectum. 2010;53:1110–5.
5. Hancke E, Rikas E, Suchank K, Völke K. Dermal flap coverage for chronic anal fissure. Dis Colon Rectum. 2010;53:1563–8.
6. Garcia-Aguilar J, Belmonte C, Wong WD, Lowry AC, Madoff RD. Open versus closed sphincterotomy for chronic anal fissure. Dis Colon Rectum. 1996;39:440–3.
7. Wiley M, Day P, Rieger N, Stephens J, Moore J. Open versus closed lateral internal sphincterotomy for idiopathic fissure-in-ano: a randomized, controlled trial. Dis Colon Rectum. 2004;47:847–52.
8. Nelson RL, Chattopadhyay A, Brooks W, Platt I, Paavana T, Earl S. Operative procedures for fissure in ano. Cochrane Database Syst Rev. 2011;11:CD002199.
9. Elsebae MM. A study of fecal incontinence in patients with chronic anal fissure. World J Surg. 2007;31:2052–7.
10. Mentes BB, Ege B, Leventoglu S, Oguz M, Karadag A. Extent of lateral internal sphincterotomy. Dis Colon Rectum. 2005;48:365–70.
11. Murad-Regadas SM, Fernandes GO, Regadas FS, et al. How much of the internal sphincter may be divided during lateral sphincterotomy for chronic anal fissure in women? Dis Colon Rectum. 2013;56:645–51.
12. Casillas S, Hull TL, Zutshi M, Trzcinski R, Bast JF, Xu M. Incontinence after a lateral internal sphincterotomy: are we underestimating it? Dis Colon Rectum. 2005;48:1193–9.
13. Pelta AE, Davis KG, Armstrong DN. Subcutaneous fissurotomy: a novel procedure for chronic fissure-in-ano. A review of 109 cases. Dis Colon Rectum. 2007;50:1662–7.
14. Renzi A, Izzo D, Sarno GD, Talento P, Torelli F, Izzo G, Martino ND. Clinical, manometric, and ultrasonographic results of pneumatic balloon dilatation versus lateral internal sphincterotomy for chronic anal fissure. Dis Colon Rectum. 2008;51:121–7.
15. D'Ugo S, Franceschilli L, Caeddu F, Leccesi L, et al. Medical and surgical treatment of hemorrhoids and anal fissure in Crohn's disease. BMC Gastroenterol. 2013;13:1–7.
16. Lewis RT, Maron DJ. Anorectal Crohn's disease. Surg Clin North Am. 2010;90:83–97.
17. Lee SW, Niec R, Melnitchouk N, Samdani T. Transanal anorectal stricturoplasty using the Heineke-Mikulicz principle. Color Dis. 2016;18:101–5.

Pilonidal Disease

15

Eric K. Johnson, Aaron Womer, and Scott R. Steele

Background

In 1847, Dr. AW Anderson documented a case of "hair extracted from an ulcer" thus describing the first reported case of pilonidal disease [1]. The term "pilonidal" is derived from the Latin terms "pilus" (a hair) and "nidus" (nest). The term, pilonidal disease, was originally described in 1880 by Dr. RM Hodges [2]. For nearly 130 years the diagnoses of pilonidal cyst, sinus, and abscess have been used or confused interchangeably to refer to the same disease process, though we know this categorization is inaccurate. It is perhaps best that we use the broader term of pilonidal disease (PD) to describe this disorder in all encompassing fashion. The first pilonidal disease associated abscess was described in 1854 [3], though it wasn't until World War II when surgeons became much more familiar with this disease entity, likely secondary to the large number of cases seen in members of the military. For a long while, PD was known as "jeep disease" and was thought to be related to modern military service, which required soldiers to ride in vehicles for extended periods of time [4].

It is evident from the earliest publications that the issues confronting those afflicted with this disease have undergone little change over time. The debate over open vs. closed wound management raged even in the early 1950s. In one VA study [5], patients who underwent primary wound closure developed recurrence 40% of the time and required hospital stays of approximately 17 days, while those managed with open technique stayed for 30 days and had a recurrence rate of 35%! While lengths of hospital stay and rates of recurrence have fallen over time, it is clear that we are still far from perfect in the way we manage this condition (Table 15.1).

Etiology

Theories supporting a congenital vs. acquired etiology abound, though most surgeons today would agree that PD is an acquired disease. The initiating event seems to be traumatic injury to the skin and surrounding hair follicles in the natal cleft. This situation most likely occurs secondary to trapping of hairs, not necessarily those growing locally, in the natal cleft. The depth of the natal cleft creates an unfavorable scenario where friction, warmth, moisture, and perhaps local

E. K. Johnson (✉)
Colorectal Surgery, Uniformed Services University of the Health Sciences, Bethesda, MD, USA

Department of Colon and Rectal Surgery, Cleveland Clinic, Cleveland, OH, USA

A. Womer
Case Western Reserve University School of Medicine, Cleveland, OH, USA

S. R. Steele
Department of Colon and Rectal Surgery, Cleveland Clinic, Cleveland, OH, USA

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_15

Table 15.1 Pilonidal disease management and outcomes: literature review

Author	Retro or RCT	# Patients	Type of flap	Surgical site complication rate	PTD recurrence rate
Can et al. 2009 [6]	Retrospective	200	Karydakis	8.9% Karydakis, 30.3% PMC	4.6% Karydakis, 18.4% PMC
Can et al. 2010 [7]	RCT	145	MLF vs. Karydakis	12.9% MLF, 10.3% Karydakis	5.8% Karydakis, 9% MLF
Bessa 2013 [8]	RCT	120	Modified Karydakis & MLF	23% Karydakis, 40% MLF	2% Karydakis, 3% MLF
Gendy et al. 2011 [9]	RCT	73	Cleft lift vs. wide excision	2.6% cleft lift, 26.5% wide excision	2.5% cleft lift, 20.6% wide excision
Dudink et al. 2011 [10]	Retrospective	62	Bascom cleft lift vs. midline closure vs. secondary healing	50% Bascom, 73.7% midline closure, 16.7% secondary healing	4.8% Bascom, 16.7% midline closure, 11.8% secondary wound healing
Guner et al. 2013 [11]	RCT	122	Limberg flap vs. Bascom cleft lift	19.67% Limberg, 19.67% Bascom	1.6% Limberg, 0% Bascom
Altintoprak et al. 2014 [12]	Retrospective	324	Limberg flap	NR	3.9% Limberg
Kaya et al. 2012 [13]	Retrospective	94	Modified Limberg flap	17% modified Limberg	4.2% modified Limberg
Osmanoglu et al. 2011 [14]	Retrospective	767	Primary closure vs. marsupialization vs. Limberg	NR	11.7% primary, 4.4% marsupialization, 4.7% Limberg
Khan et al. 2013 [15]	RCT	120	Limberg vs. primary closure	18.3% primary closure, 1.7% Limberg	8.3% primary closure, 0% Limberg
Sit et al. 2013 [16]	Retrospective	401	Karydakis vs. modified Limberg vs. Limberg	Highest in Limberg, lowest in modified Limberg, NR	8% Karydakis, 0.9% modified Limberg, 4.6% Limberg
Arslan et al. 2014 [17]	RCT	295	Limberg vs. modified Limberg vs. Karydakis	Highest in Karydakis, NR	6.3% Limberg, 1.9% modified Limberg, 11% Karydakis
Saylam et al. 2011 [18]	Retrospective	354	Primary closure vs. D-flap vs. Karydakis vs. Limberg	16.5% primary closure, 29.7% D-flap, 13.5% Karydakis, 17.3% Limberg	7.5% primary closure, 9.9% D-flap, 13.5% Karydakis, 8.7% Limberg
Ates et al. 2011 [19]	RCT	269	Karydakis vs. Limberg	11.1% Karydakis, 20.8% Limberg	3.1% Karydakis, 6.9% Limberg

Retro retrospective, *RCT* randomized control trial, *NR* not reported

hypoxia lead to this local trauma secondary to the texture of the hair. A granulomatous foreign body type reaction results. There is even evidence that PD and hidradenitis suppurativa may be similar on a histological and immunohistochemical level [20]. Disease will typically start as a small sinus that may drain fluid or cause irritation, but then can progress to numerous sinuses with associated cystic dilation and potential abscess formation. In cases where disease is ignored and unfavorable conditions persist, PD can become more widespread. Disease can range from the asymptomatic single sinus discovered incidentally by a primary care physician, up to a locally destructive process associated with significant disability.

In rare cases PD may involve areas other than the natal cleft, as is supported by reports of disease occurring in the interdigital areas in hair dressers [21], as well as in areas such as the umbilicus that may similarly trap hair and other debris [22]. The presence of a disease process that appears similar to PD in these additional areas lends further support to the theory of etiology proposed above. PD is often said to affect

males more commonly than females, however recent data from the armed forces supports a similar incidence between the sexes at 1.9 and 1.7 per 1000 person-years in males and females respectively [23]. Many proposed risk factors have been implicated in the development of PD including family history of disease, higher body mass index (BMI > 25), poor personal hygiene habits, hirsutism, deep natal cleft anatomy, occupations that require prolonged sitting, and excessive sweating [24–26]. Disease is often encountered in patients who lack many or all of these risk factors however. A study of prospectively gathered data comparing 587 patients with PD to 2780 healthy controls showed that hirsute individuals that sit down for more than 6 h/day and who bathe two or fewer times per week have a 219-fold increased risk for sacrococcygeal PD [26]. A family history of PD may not only predispose to disease occurrence, but can also be associated with higher recurrence rates after definitive surgery and earlier onset of disease [25].

Clinical Presentation/Diagnosis

Patients may present along a wide spectrum with something as simple as an asymptomatic sinus all the way up to someone with a large and chronically draining open wound. Common scenarios include the patient who has an acute pilonidal abscess requiring drainage, as well as the routine office referral for a discussion of definitive excisional surgery after abscess drainage or persistent disease causing an impact on the patient's quality of life.

Making or confirming the diagnosis of pilonidal disease is straight forward and typically only requires history taking and a good physical exam. Afflicted individuals will complain of pain over the sacrococcygeal area that may be accompanied by drainage of clear fluid or bleeding. In the case of abscess, fever and local swelling may also occur. Examination will reveal "pits" in the midline which is a major clue to this diagnosis. Pits may occur singly or in multiples. A solitary pit in a minimally symptomatic individual may be easily overlooked. Induration just lateral to midline may also be palpated and this can occur unilaterally or bilaterally. Inflamed draining sinuses may also be present. In severe cases, there may be open wounds ranging widely in size. Acute abscess is associated with erythema of the affected skin, fluctuance, and local tenderness. Occasionally PD can be mistaken for and anorectal fistula if a sinus is present close to the anus. It is important to examine the natal cleft for pits. If pits are noted, then pilonidal sinus should be included in the differential diagnosis in these individuals.

Disease recurrence is unfortunately a commonly encountered scenario, though examination of the published literature would for the most part make one believe otherwise. Early recurrence is defined as that occurring within 1 year of definitive surgery, while any recurrence occurring after that is considered late. Recurrent PD, especially early "recurrent" PD is actually persistence of an open wound that failed to heal after surgery. It is debatable whether or not to consider this recurrent pilonidal disease or simply a persistent chronic wound. Incisions placed in the midline will often demonstrate delayed healing or non-healing. The reasons behind a non-healing wound may be different than the etiology of PD, however the techniques we use to treat them are similar. Recurrences present much like primary PD, and can have association with poor surgical technique, patient non-compliance, or failure to recognize and modify the risk factors that predisposed to disease in the first order. Recurrence may also be an unavoidable result of the natural history of disease.

Principles of Treatment

There are several basic principles that should be considered when treating pilonidal disease such that the best outcome can be achieved:

1. Control of Sepsis—drain acute abscesses and avoid any attempt at definitive surgical management in the setting of active infection. All PD will be colonized with bacteria, but this is not the same as active infection. Primary closure with or without flap reconstruction will fail in the setting of infection and will make future management more difficult. Do not burn bridges.

2. Disease Severity and Operative Approach Should Match—the anatomy or severity of disease should drive the treatment method that is selected. If the disease is minor, yet the patient requests surgery, a pit-picking procedure (as described below) plus or minus a small amount of additional excision may be all that is needed. Complex and recurrent disease typically requires a wide excision and flap reconstruction.
3. Avoid Too Much Excision—the old method of excising all disease down to the post-sacral fascia results in an extremely large and complex wound. This technique should be avoided if at all possible. Excision that is too deep or aggressive has been shown to correlate with disease recurrence/treatment failure.
4. Un-Roof All Disease, Debride Granulation Tissue, Remove Hair—this principle goes with principle 3 above. Removal or un-roofing of skin overlying active disease may be essential, but do not be tempted to dissect any deeper. It is important however to account for all disease. Any hair or debris should be removed and granulation tissue should be curetted or cauterized. It may be helpful to inject sinuses with methylene blue to ensure that no extensions are missed. Probes may also be used. If the wound is to be closed, adequate irrigation of the wound with saline is encouraged.
5. Use an Off-Midline Excision and Closure When Possible—it is essential to attempt to perform an off-midline excision and closure. Wounds located in the midline of the gluteal cleft just do not seem to heal as well as those located elsewhere. While it may be impossible to keep the entire wound out of the midline, there should be significant effort to minimize the amount of wound in the midline.
6. If the Wound is Closed, Tension Must Be Minimized—because of the inherent difficulty with wounds located in the region of the gluteal cleft, every effort should be taken to minimize wound morbidity. A "tension-appropriate" closure should be utilized. If this cannot be achieved initially, then tissue undermining or use of a flap should be considered. When flaps are used, it is important to ensure a lack of tension at both the excision and donor site. Tension seems to be better tolerated at the donor site, as is separation of the operative wound—especially since these sites are off the midline.
7. Change the Anatomy/Flatten the Natal Cleft—since it is believed that deep natal cleft anatomy contributes to formation of pilonidal disease, it seems reasonable that any procedure designed to flatten cleft anatomy would lead to lower recurrence rates. Most flap procedures, and certainly the Bascom cleft lift procedure, are designed to accomplish this goal. The cleft lift procedure, in particular, combines most if not all of the above principles into one operation which has likely contributed to its success. That stated, not all PD requires these maneuvers.

Treatment

A discussion of all available treatment options for PD is beyond the scope of this text. As with many disease processes treated by surgeons, the presence of numerous options may be helpful but usually indicates that no single option is perfect. It is essential that the treatment should be tailored to the patient's expectations, anatomy of disease, and disease severity. Therapeutic options range from non-operative therapies to large local excisions with local flap reconstruction. The debate between open wound management and primary closure remains, and even when closure is performed, local wound care and physical limitations may be required for long periods of time. It would not be reasonable to expect a single surgeon to be familiar with every available operative technique. If a surgeon is familiar with three or four operative techniques ranging in complexity, this will likely provide acceptable option for the entire spectrum of disease they may encounter.

Non-operative Management

The simplest solution for asymptomatic or minimally symptomatic PD is to avoid invasive intervention. For the occasional individual referred for the evaluation of asymptomatic midline pits

in the natal cleft without concerning physical exam findings suggesting infection, no operative management is required. Operating in this scenario will lead to a situation where the treatment is worse than the disease. Patients can be counseled on strategies to prevent the development of symptomatic disease. Risk factor reduction such as weight loss, avoidance of prolonged sitting at work, improved hygiene, and weekly clipping of hair in and adjacent to the natal cleft may diminish the likelihood of a patient developing symptomatic PD. These same nonoperative measures are also appropriate in the individual with active symptomatic disease. In the patient presenting with mild disease, these simple methods of risk factor modification may lead to improvements in symptoms and potentially even quiescence. A 1994 study demonstrated that these measures, combined with limited lateral incision and drainage in the setting of acute abscess, led to fewer occupied hospital bed days when compared to excisional procedures [27]. Over 17-years of follow up, only 23 of 101 patients went on to require excisional therapy.

Due to the success associated with periodic shaving in and around the natal cleft, some have recommended laser hair removal as a long-lasting alternative for the conservative management of PD. Enthusiasm for this method of treatment aside, robust data to supporting its use do not exist. Small series of less than 20 patients have shown some benefit to laser epilation in the setting of recurrent PD [28, 29]. The procedure itself is uncomfortable for the patient and often requires local anesthetic. Treatments are performed over 3–11 sessions at 6–8 week intervals and are expensive. An investigation of this technique in teenagers with PD, 25/28 of which were managed initially with surgery, revealed only a single recurrence over a mean follow up of 2 years [30]. The conclusion of this study was that use of laser epilation was a safe method for addressing hair growth associated recurrence.

A randomized comparison of laser hair removal to traditional methods as an adjunctive therapy after surgery for PD demonstrated a lower recurrence rate in the laser treated group [31]. In this particular trial however, the higher recurrence in the traditional group appeared to be related to noncompliance with traditional hair removal methods after 1 year. There is debate over the benefit of hair removal/shaving in the setting of PD that has been operatively managed. A retrospective study of patients previously surgically treated for PD was performed focusing on those who performed razor hair removal vs. those who did not [32]. Recurrence was noted to be higher in the group who shaved (30%) vs. those who did not shave (19%) ($p = 0.01$), suggesting a potential negative effect of postoperative razor epilation. It would be beneficial to see future comparisons between laser hair removal and no hair removal in the adjunctive setting.

While some form of hair removal may lead to reduced recurrence rates as well as reduced rates of excisional therapy, hair removal and other nonoperative methods alone are unlikely to cure disease of more significant severity. Many surgeons have noted that the hair found inside of sinus tracts is clearly noted to be much longer than that which grows in the region of the natal cleft. Most surgeons believe that longer hairs fall into the natal cleft, become trapped, and result in disease. If this theory is in fact true, local epilation alone could potentially have only minimal effect.

Methods employing the use of phenol or fibrin glue injection to ablate sinus tracts are often considered nonoperative since they do not involve tissue excision, and have been investigated in small series by many investigators [33–40]. While the focus is typically on the substance utilized for injection, these procedures employ curettage of sinus tracts, tissue debridement, and hair removal, which contribute to their success. Use of phenol as an ablative agent has been associated with success rates of 60–95% [33–35]. Fibrin glue injection combined with a variety of techniques has shown success rates from 90–100% [36–39]. A recent evaluation of individuals treated with fibrin glue revealed that 79% of patients were satisfied, 71% were back to normal activities within 2 weeks, and 74% required no further treatment [40]. A video-assisted ablative technique has also been described using a 4 mm rigid hysteroscope with a 5-Fr working channel [41]. Continuous irrigation is used, hair removal performed, and the cavity and tract walls are ablated using radiofrequency energy

via a bipolar electrode. Only one recurrence was reported during 1 year of follow up of 27 patients. A recent systematic review identified 9 studies in which with 497 patients of a mean age of 25 years underwent Endoscopic Pilonidal Sinus Treatment (EPSiT). The mean operative time was 34.7 minutes and all procedures was performed on an outpatient basis. The mean Visual analogue score of pain within the first week was 1.35. Failure of the technique was recorded in 40 (8.04%) patients, 20 (4.02%) had persistence and 20 (4.02%) developed recurrence. The weighted mean failure rate of the technique was 6.3%, the mean time to complete healing was 32.9 days, and the mean time to return to work was 2.9 days [42]. This method may represent a potential option for minimally invasive therapy and deserves further investigation. The advantages of these therapies over excisional methods include a more rapid recovery and less post-procedural pain. One must be cautious when interpreting the data reported on these procedures as there is quite a bit of heterogeneity among studies, and the studies investigating minimally invasive therapies seem to involve patients with lower disease severity.

Operative/Excisional Management

There are a large number of interventions available for the operative management of PD. The literature is full of publications reporting results from a variety of procedures. Many of the published studies are retrospective reviews examining the results from small series of patients that have undergone a single type of operative procedure. There are a number of published randomized trials evaluating one surgical method vs. another with extremely heterogeneous results. If one procedure is preferred, there is almost certainly evidence available to support its superiority over another. Study results are most likely heavily influenced by variations in how patients are managed postoperatively as well as by differences in surgical technique and skill. Since a description of every available method is beyond the scope of this text, we will review some of the more common methods of operative management beginning with those that are considered simple and progressing to the complex.

Basic Procedures

Perhaps the simplest procedure to perform is laying open of the cyst and all associated sinus tracts, referred to as "unroofing" of disease. Unroofing and wide local excision of all involved tissue, were the treatments utilized most commonly in the early days of surgical PD management. Many surgeons have combined unroofing with marsupialization of the wound. High recurrence rates of 15–35% [5] resulted in the quest for more effective methods of surgical management. One major key to pilonidal surgery is to ensure that as much of the surgical wound as possible be kept off the midline, as midline wounds in the natal cleft are resistant to heal. Simple tract unroofing and curettage is particularly helpful in the setting of minor disease affecting the perianal area (often mistaken as an anal fistula). The majority of this wound will lie off the midline and will quickly heal (Fig. 15.1). While we con-

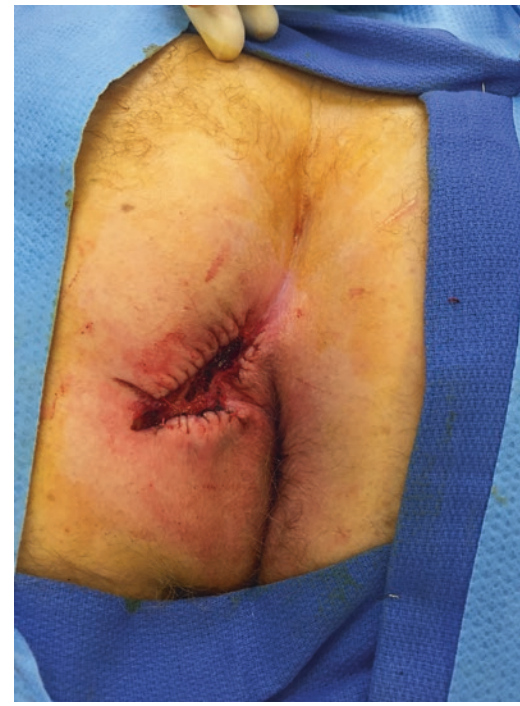


Fig. 15.1 Unroofing or laying-open technique. (**a**) Overlying tissue is excised. (**b**) Appearance of wound at completion of the procedure

tinue to debate which procedure is superior, recent data would suggest that the higher the volume of excised specimen, the higher the rate of surgical site infection (SSI) and hence risk of recurrence [43]. While many surgeons employ techniques utilizing open wound management, some surgeons advocate excision combined with primary wound closure which can often require the mobilization of minor skin flaps.

Because of a perceived increase in SSI risk with primary closure, some surgeons have recommended drainage of the wound through a variety of methods with a wide variation in results. Drainage has been studied, but has not been shown to result in improved results as far as patient satisfaction, healing, or infection [44]. A meta-analysis of the impact of drainage in the setting of primary closure showed that there were no statistically significant differences in outcomes with or without the use of a drain [45]. A randomized controlled trial comparing the lay open method to wide excision with primary closure showed that patients healed faster in the primary closure group with no differences in the groups noted at 1 year of follow up [46]. Interestingly, this group of investigators made no effort to keep the surgical wound off the midline. In 2010 a prospective randomized study was published comparing the lay-open technique to primary closure augmented by the placement of gentamicin impregnated collagen [47]. The antibiotic impregnated material was placed in the base of the wound with overlying tissue closure. The results showed improved healing at 4 weeks, improved postoperative pain, and lower cost in the primary closure group. Recurrence rates were no different at 5 years.

A four-arm randomized trial comparing primary closure, primary closure with hydrogen peroxide irrigation, wide local excision, and wide local excision with hydrogen peroxide irrigation showed different results [48]. The wide local excision/peroxide irrigation group showed the lowest recurrence rate and the fastest time to healing. The investigators concluded that this was related to the ability to clearly delineate all tracts and disease with peroxide irrigation, thereby allowing them to perform a more precise and low volume excision. Similarly, another group performed a retrospective analysis of PD patients that had undergone surgery and concluded that use of methylene blue injection to delineate disease was associated with a lower recurrence rate [49].

There have been several different descriptions of "pit picking" procedures published. These are relatively minor procedures in terms of the amount of tissue excised, the resulting wounds are small, and they may be best suited for those with mild to moderate levels of disease. These procedures are not ideal for the patient with a large open wound or for those with extensive disease. Regardless of the subtle differences between the variety of procedures described, all methods seem to include central pit excision with minimal surrounding tissue, hair and debris removal, and excision of the old adjacent abscess cavity or "cyst" via a lateral incision using an undermining technique. Pit excision sites are then primarily closed, and the lateral incision is partially closed to allow for drainage. The end result is a fairly cosmetic procedure with minimal pain, early return to normal activities, and rapid healing (Fig. 15.2) [50]. A circular punch knife of appropriate size may be used for pit excision and is ideal for this application. There are several modifications of this procedure described, but the basic principles persist in each technique. The

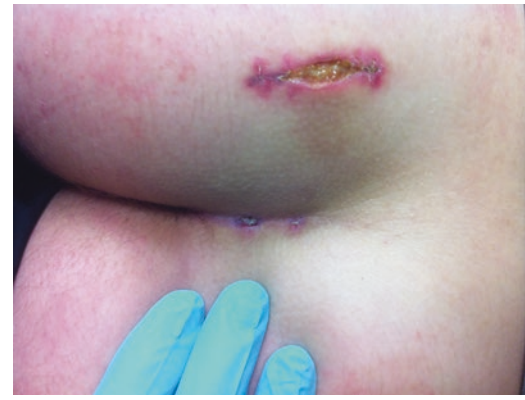


Fig. 15.2 Removal of a midline pit with a small incision after lateral incision and debridement

use of phenol as a sclerosing agent has been combined with pit excision and has resulted in good outcomes [51].

Complex Procedures

The commonality throughout all "complex" procedures is the mobilization of an adjacent tissue flap to achieve primary wound closure after excision of some volume of tissue and/or skin. Some procedures combine wide local excision of a large volume of diseased tissue with flap reconstruction, while others focus on the preservation of as much local tissue as possible. These procedures also range from simple to complex. While there are a number of available options, our attention will focus on the discussion of the Karydakis flap, the Bascom cleft-lift procedure, and the rhomboid or Limberg flap procedure and its modifications. There are additional flap procedures such as the z-plasty, V-Y advancement flap, and other rotational flap techniques that will not be discussed in this chapter. Keep in mind however that these flaps may be useful in the setting of recurrent disease after failure of a prior complex procedure. The use of flap procedures in primary PD is a topic of debate, with many discouraging their use outside of the realm of recurrence. Proponents of their primary use cite that they are more effective in curing disease, because they result in a modification of the natal cleft anatomy. The majority of these techniques result in a flattening of the natal cleft, which may in theory prevent disease recurrence.

Karydakis Flap

This procedure is begun by first excising the affected tissue in the midline, which will typically leave an elliptical defect. A beveled skin flap is then created and mobilized across the midline to facilitate a primary closure that is lateral of the midline (Fig. 15.3). A closed suction drain may or may not be used. The theoretical advantages of this procedure are the tension free closure that is out of the midline combined with some flattening of the natal cleft. This flap is probably the easiest procedure to perform. This procedure has been shown to be more effective than simple primary midline closure in terms of patient satisfaction, recurrence rate, and rate of postoperative complications [6]. It has also been reported to be comparable to other more complex flap procedures such as the modified Limberg flap [7, 8].

Cleft Lift Procedure

The cleft lift procedure was originally described and popularized by Dr. John Bascom. This is a simple but intricate procedure that is designed to "lift" the natal cleft and result in an incision that is closed off the midline. Wide excision is

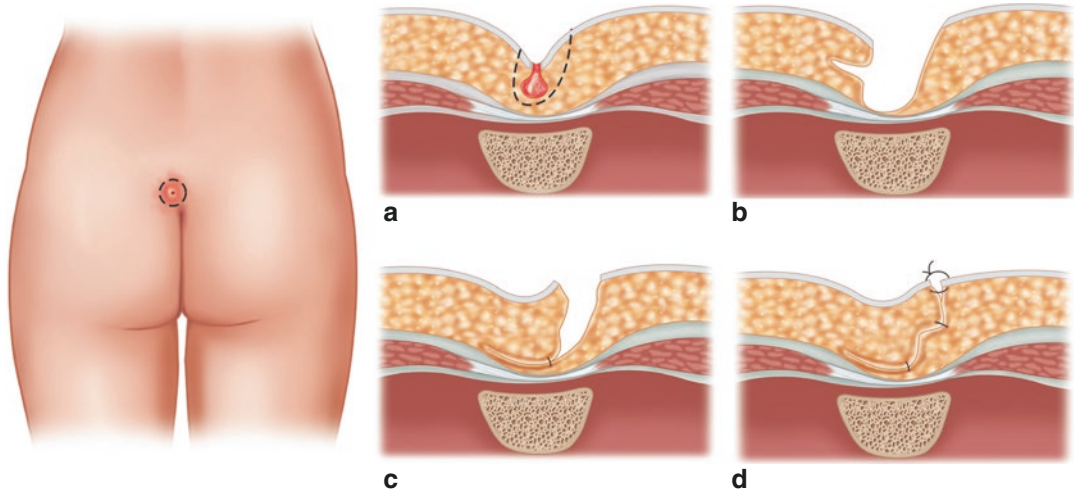


Fig. 15.3 Karydakis flap

not required, and this may be one reason for the procedure's success in theory. The only tissue excised is the skin overlying the disease on one side of the cleft. This procedure requires that the patient be marked prior to incision to establish a "safe zone", beyond which no dissection is performed. The authors prefer to perform the marking of the operative area prior to skin preparation. The patient is placed in the prone position and the buttocks are squeezed together. The area where the skin on both sides of the natal cleft touches is marked with a magic marker. This establishes the safe zone. The buttocks are then taped apart exposing the disease. After skin preparation, the area to be excised is marked with another marking pen (Fig. 15.4a). This proposed incision will be partially elliptical and should extend from the midline pits out to one side of the safe zone. The distal portion of this incision is scimitar shaped in order to facilitate closure near the anus without causing local deformity.

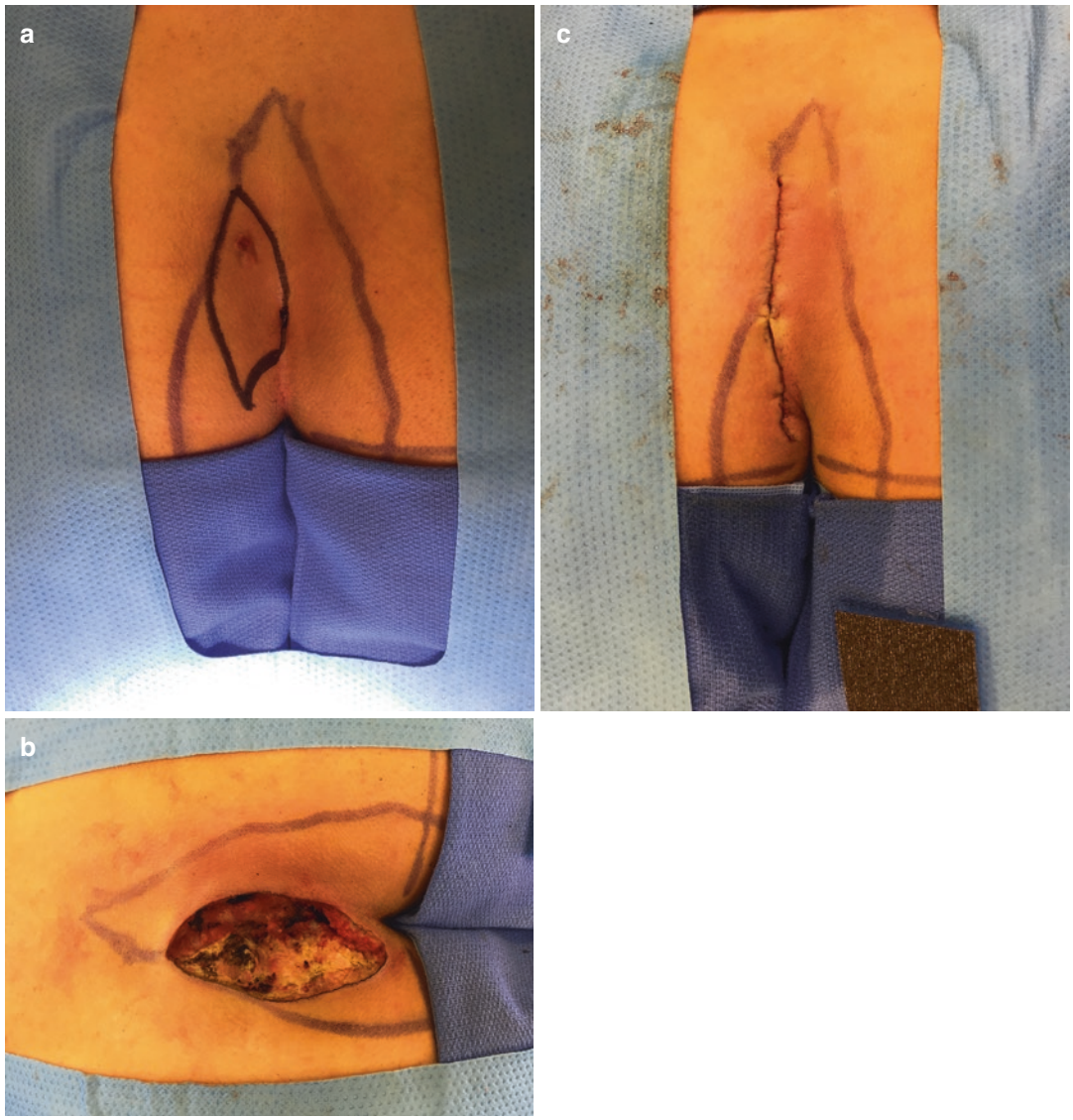


Fig. 15.4 (**a**–**c**) Cleft lift procedure (as described by Bascom)

Local anesthetic is infiltrated into the area to be excised and the incision is made down to the level of the subcutaneous fat. The overlying skin is excised taking care to leave the subcutaneous fat in place. A flap is then raised across the midline out to the opposite safe zone border. The thickness of this flap should approximate that of a breast flap that would be created during a mastectomy in order to ensure its viability. When creating the flap down toward the distal portion of the incision (near the anus), the flap should be thicker to prevent dimple formation near the anus. Any disease related debris or granulation tissue should be gently debrided with a surgical sponge and irrigation with saline should be performed. Any remaining "cyst wall" or tissue contracture can be divided into squares with a scalpel or electrocautery device. The subcutaneous tissue is then closed in layers with an absorbable suture. The superficial layers are reapproximated in layers, lastly with a subcuticular suture. In some cases, even though there has not been a large volume of tissue excision, there will be a very deep wound. This occurs in those with particularly deep natal clefts. While evidence is lacking, the authors would encourage the use of a closed suction drain in this setting. We have anecdotally seen some failures in this setting when a drain is not used. The drain should be left in place until the output is 20 mL or less for 2 consecutive days.

A 2011 study compared the results of the cleft lift procedure to wide excision and packing in 70 patients [9]. A total of 97% of patients undergoing cleft lift healed completely while only 73% of wide excision patients healed. Three of nine patients with chronic wounds underwent subsequent cleft lift with a 100% success rate. Recurrence was noted in 2.5% of cleft lifts and in 20% of wide excisions. Others have shown similar success in rates of healing with the cleft lift procedure as compared to wide excision and packing and excision and primary midline closure [10]. This technique has also been compared to the Limberg flap in a randomized prospective fashion [11]. Short term outcomes of 122 patients were analyzed and revealed that those undergoing the cleft lift had shorter operative durations, less excised tissue weight, improved pain scores, and fewer physical limitations on postoperative day 10. There were no differences in healing, complications, or early recurrences.

This technique is certainly easier to perform, takes less time, and removes less tissue than the more complex flap procedures such as the rhomboid flap. It results in flattening of the natal cleft which is a desired goal. Unfortunately, not every patient with PD is a candidate for this procedure. Individuals with complex recurrent disease and large open wounds may not be ideal candidates, and may require more extensive flap procedures. Disease that is very close to the anus may cause difficulty with this technique, though if open wounds are able to be moved off the midline, they may still heal.

The authors have noted some early wound dehiscences in some cases treated with this technique (Fig. 15.5). As with any flap procedure, it is important to limit the patient's activity for several weeks to allow for healing. A traumatic wound disruption can easily occur. Also noted is the relatively short healing time when these wounds

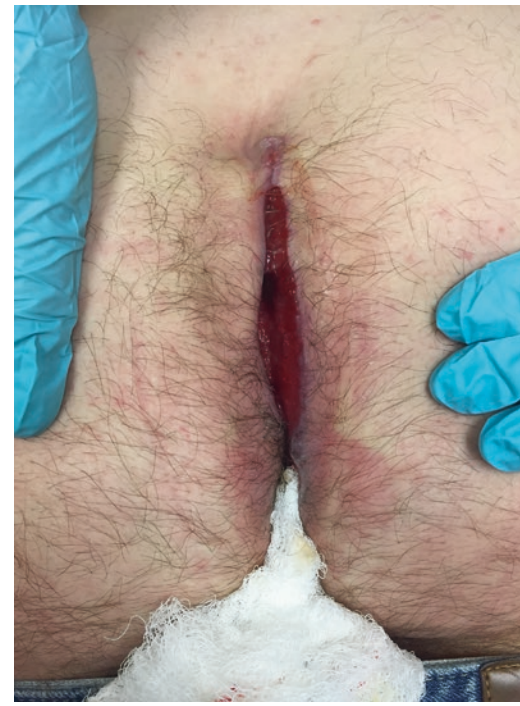


Fig. 15.5 Wound dehiscences after cleft lift procedure

do separate—again very likely related to the fact that the wound is off the midline (perhaps just barely off midline—and the cleft is now flat). If an early wound separation does occur, just simply treat the patient as you would for any open wound. One can expect healing in 2–6 weeks with proper hygiene and wound care. We would also recommend avoidance of any flap procedure in an active smoker or other patient with modifiable risk factors for poor wound healing. These procedures are elective and should be performed in patients whose conditions have been optimized.

Rhomboid/Limberg Flap

The rhomboid flap is a useful but more complex procedure that can be used in any setting of PD, but is typically reserved for more severe cases. The procedure involves wide excision of a rhombus shaped area of tissue encompassing all disease in the midline (Fig. 15.6). While most will excise tissue down to the level of the post-sacral fascia, this is not entirely necessary. Excision down to a depth one would use in an unroofing procedure is acceptable. It must be ensured however that the thickness of the mobilized lipocutaneous flap approximates the thickness of the tissue that is excised. This technique works well in the setting of complex recurrent disease. The planned incision is marked, and after disease excision the flap is raised with electrocautery. It is recommended to handle the flap gently during mobilization. It is important to take care to undermine the areas adjacent to the flap so that the most tension-free closure can be obtained. Once the flap is completely mobilized, it is centrally anchored to the post-sacral tissues with an absorbable suture. A closed-suction drain is placed and a layered closure takes place using absorbable suture. The skin can be closed using a variety of techniques, none of which has proven to be superior. Some surgeons will cover the final closure with glue to create a water-tight seal (Fig. 15.7). A modification of this procedure was created in order to keep the caudal point of the incision away from the anus.

The drain can be left in place for 48 h or until it has produced 20 mL or less daily for 2 consecutive days. The patient should avoid any strenuous activity for 2–4 weeks. It is not uncommon for these wounds to separate slightly in one or two areas over the ensuing 2 weeks (Fig. 15.8). These open wounds require some minor wound care and is usually well tolerated. Occasionally it will take 4–8 weeks for the wound to completely heal. In some cases, the disease spans a very large area over the sacrum extending from the perianal area

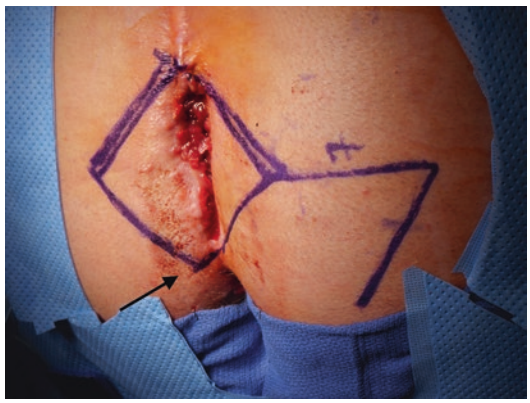


Fig. 15.6 Rhomboid/Lindberg flap

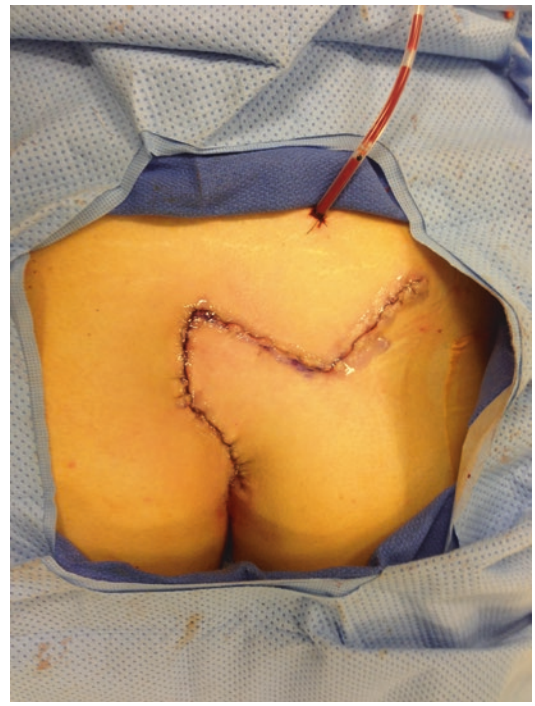


Fig. 15.7 Wound closure after rhomboid flap

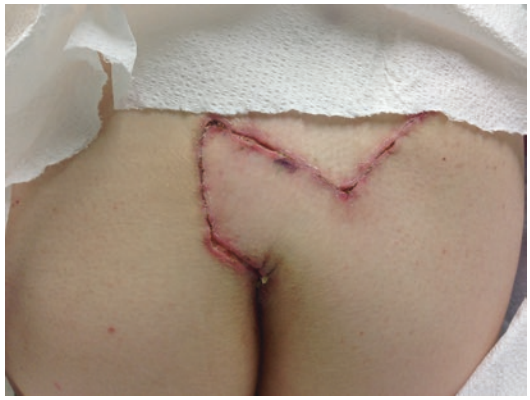


Fig. 15.8 Wound separation after rhomboid flap

for a long distance cephalad. Surgeons may be uncomfortable with creating such a large area of excision and flap in this setting. When this trepidation is present, the technique can still be used but may be modified. The most difficult area in which to achieve healing is the caudal midline. An excision can be performed, and flap created such that the caudal midline is covered leaving an open wound cephalad. The remaining wound can be managed in a variety of ways, but the use of a negative pressure wound therapy device makes this management easy (Fig. 15.9). This device can be used in the standard fashion until the remaining wound is small enough to manage using standard dressings. The area will typically heal quickly, and does not impair the flap in any way.

Potential surgical site related postoperative complications include wound dehiscence, flap necrosis, hematoma, wound infection, and seroma. These complications occur at rates of 4%, 0–2%, 1%, 3–5%, and 3% respectively [12, 13]. Recurrence can be seen in approximately 4% [13]. Several series have compared outcomes associated with the Limberg flap (LF), modified Limberg flap (MLF), and excision with primary midline closure [14, 15, 52, 53]. The evidence indicates that the LF or MLF is associated with faster return to work, lower rates of surgical site infection, lower recurrence, and lower rates of wound dehiscence. Comparisons of the MLF, LF, and Karydakis flap show similar superiority for the LF and MLF [16, 17], while others have shown equivalence [18].

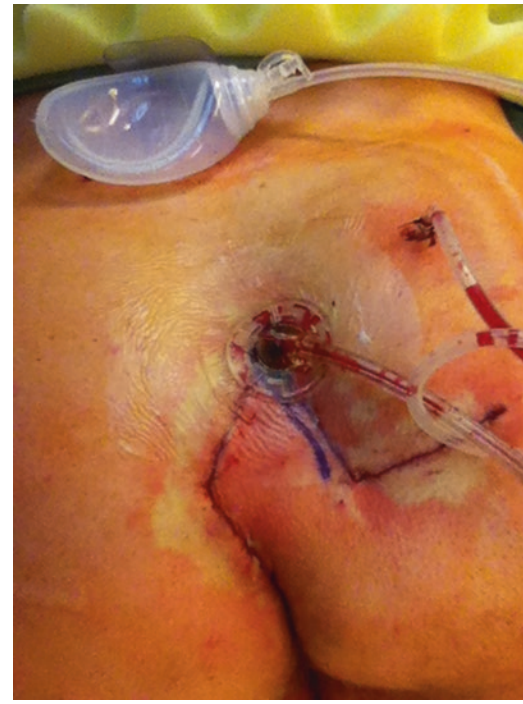


Fig. 15.9 Negative pressure wound device in pilonidal wound

Disease Recurrence

There are several known risk factors that predispose to the occurrence of PD, and many authors have attempted to investigate factors that may predict disease recurrence. Familial history of disease, increased sinus number, larger cavity diameter, and primary wound closure have been shown to be associated with higher rates of recurrence [54]. Interestingly, tobacco smoking and body mass index >25 have NOT been shown to increase recurrence [55]. As stated above, the authors recommend optimization of modifiable risk factors for surgical site occurrence, such as smoking cessation and glycemic control prior to performing these elective procedures, despite a lack of robust evidence supporting this in pilonidal disease. Recurrence has been shown to be lower in patients who undergo surgical incision and drainage prior to definitive surgery as compared to patients who have spontaneous abscess rupture [56]. This finding could be related to low

grade ongoing sepsis secondary to incomplete drainage in those who undergo definitive surgery, though we have no evidence to support this directly. Along these lines, surgery performed in the "after-hours" and potentially emergent setting has been associated with higher recurrence rates [57]. Many publications that report on recurrence are criticized secondary to a lack of long-term follow up. A study of German military members was able to demonstrate recurrence rates that were 22% higher than previously reported through collection of data over a longer period of follow up [58]. Recurrences up to 20 years after surgery were seen, and they recommended that studies investigating long-term outcomes should have at least 5 years of follow up.

Conclusion

Pilonidal disease is a chronic inflammatory process that can present with a wide spectrum of severity, but invariably leads to disability in affected individuals and results in a substantial decrease in their quality of life. While treatment of this disease process can be viewed as less "glamourous" than many others, it most certainly results in a grateful patient. Pilonidal disease is quite common and any general or colorectal surgeon can be expected to care for a number of affected individuals. In order to ensure optimal treatment and outcomes, it is critical to tailor recommendations to the severity of disease, anatomy of disease, and our patient's expectations of risks and expected outcomes.

References

1. Anderson AW. Hair extracted from an ulcer. Boston M S J. 1847;36:74.
2. Hodges RM. Pilonidal sinus. Boston M S J. 1880;103:485–6.
3. Warren JM. Abscess, containing hair, on the nates. Am J Med Sci. 1854;28:113.
4. Buie LA. Jeep disease (pilonidal disease of mechanized warfare). South Med J. 1944;37:103–9.
5. Close AS. Pilonidal cysts: an analysis of surgical failures. Ann Surg. 1955;141:523–6.
6. Can MF, Sevinc MM, Yilmaz M. Comparison of Karydakis flap reconstruction versus primary midline closure in sacrococcygeal pilonidal disease: results of 200 military service members. Surg Today. 2009;39:580–6.
7. Can MF, Sevinc MM, Hancerliogullari O, Yilmaz M, Yagci G. Multicenter prospective randomized trial comparing modified Limberg flap transposition and Karydakis flap reconstruction in patients with sacrococcygeal pilonidal disease. Am J Surg. 2010;200:318–27.
8. Bessa SS. Comparison of short-term results between the modified Karydakis flap and the modified Limberg flap in the management of pilonidal sinus disease: a randomized controlled study. Dis Colon Rectum. 2013;56:491–8.
9. Gendy AS, Glick RD, Hong AR, Dolgin SE, Soffer SZ, Landers H, Herrforth M, Rosen NG. A comparison of the cleft lift procedure vs wide excision and packing for the treatment of pilonidal disease in adolescents. J Pediatr Surg. 2011;46:1256–9.
10. Dudink R, Veldkamp J, Nienhuijs S, Heemskerk J. Secondary healing versus midline closure and modified Bascom natal cleft lift for pilonidal sinus disease. Scand J Surg. 2011;100:110–3.
11. Guner A, Boz A, Ozkan OF, Ileli O, Kece C, Reis E. Limberg flap versus Bascom cleft lift techniques for sacrococcygeal pilonidal sinus: prospective, randomized trial. World J Surg. 2013;37:2074–80.
12. Altintoprak F, Gundogdu K, Ergonenc T, Dikicier E, Cakmak G, Celebi F. Retrospective review of pilonidal sinus patients with early discharge after limberg flap procedure. Int Surg. 2014;99:28–34.
13. Kaya B, Eris C, Atalay S, Bat O, Bulut NE, Mantoglu B, Karabulut K. Modified Limberg transposition flap in the treatment of pilonidal sinus disease. Tech Coloproctol. 2012;16:55–9.
14. Osmanoglu G, Yetisir F. Limberg flap is better for the surgical treatment of pilonidal sinus. Results of a 767 patients series with an at least five years follow-up period. Chirurgia (Bucur). 2011;106:491–4.
15. Khan PS, Hayat H, Hayat G. Limberg flap versus primary closure in the treatment of primary sacrococcygeal pilonidal disease; a randomized clinical trial. Indian J Surg. 2013;75:192–4.
16. Sit M, Aktas G, Yilmaz EE. Comparison of the three surgical flap techniques in pilonidal sinus surgery. Am Surg. 2013;79:1263–8.
17. Arslan K, Said Kokcam S, Koksal H, Turan E, Atay A, Dogru O. Which flap should be preferred for the treatment of pilonidal sinus? A prospective randomized study. Tech Colorpoctol. 2014;18:29–37.
18. Saylam B, Balli DN, Duzgun AP, Ozer MV, Coskun F. Which surgical procedure offers the best treatment for pilonidal disease? Langenbeck's Arch Surg. 2011;396:651–8.
19. Ates M, Dirican A, Sarac M, Aslan A, Colak C. Short and long-term results of the Karydakis flap versus the Limberg flap for treating pilonidal sinus disease: a prospective randomized study. Am J Surg. 2011;202(5):568–73.
20. Von Laffert M, Stadie V, Ulrich J, Marsch WC, Wohlrab J. Morphology of pilonidal sinus disease: some evi-

dence of its being a unilocalized type of hidradenitis suppurativa. Dermatology. 2011;223:349–55.
21. Uysal AC, Alagoz MS, Unlu RE, Sensoz O. Hair dresser's syndrome: a case report of an interdigital pilonidal sinus and review of the literature. Dermatol Surg. 2003;29:288–90.
22. Coskun A, Bulus H, Akinci OF, Ozgonul A. Etiological factors in umbilical pilonidal sinus. Indian J Surg. 2011;73:54–7.
23. Armed Forces Health Surveillance Center (AFHSC). Pilonidal cysts, active component, U.S. Armed Forces, 2000-2012. MSMR. 2013;20:8–11.
24. Bolandparvaz S, Moghadam DP, Salahi R, Paydar S, Bananzadeh M, Abbasi HR, Eshraghian A. Evaluation of the risk factors of pilonidal sinus: a single center experience. Turk J Gastroenterol. 2012;23:535–7.
25. Doll D, Matevossian E, Wietelmann K, Evers T, Kriner M, Petersen S. Family history of pilonidal sinus predisposes to earlier onset of disease and a 50% long-term recurrence rate. Dis Colon Rectum. 2009;52:1610–5.
26. Harlak A, Mentes O, Kilic S, Coskun K, Duman K, Yilmaz F. Sacrococcygeal pilonidal disease: analysis of previously proposed risk factors. Clinics. 2010;65:125–31.
27. Armstrong JH, Barcia PJ. Pilonidal sinus disease. The conservative approach. Arch Surg. 1994;129:914–7.
28. Odili J, Gault D. Laser depilation of the natal cleft—an aid to healing the pilonidal sinus. Ann R Coll Surg Engl. 2002;84:29–32.
29. Landa N, Aller O, Landa-Gundin N, Torrontegui J, Azpiazu JL. Successful treatment of recurrent pilonidal sinus with laser epilation. Dermatol Surg. 2005;31:726–8.
30. Lukish JR, Kindelan T, Marmon LM, Pennington M, Norwood C. Laser epilation is safe and effective therapy for teenagers with pilonidal disease. J Pediatr Surg. 2009;44:282–5.
31. Ghnnam WM, Hafez DM. Laser hair removal as adjunct to surgery for pilonidal sinus: our initial experience. J Cutan Aesthet Surg. 2011;4:192–5.
32. Petersen S, Wietelmann K, Evers T, Huser N, Matevossian E, Doll D. Long-term effects of postoperative razor epilation in pilonidal sinus disease. Dis Colon Rectum. 2009;52:131–4.
33. Schneider IH, Thaler K, Kockerling F. Treatment of pilonidal sinus by phenol injections. Int J Color Dis. 1994;9:200–2.
34. Dogru O, Camci C, Aygen E, Girgin M, Topuz O. Pilonidal sinus treated with crystallized phenol: an eight-year experience. Dis Colon Rectum. 2004;47:1934–8.
35. Hegge HG, Vos GA, Patka P, Hoitsma HF. Treatment of complicated or infected pilonidal sinus disease by local application of phenol. Surgery. 1987;102:52–4.
36. Stansby G, Greatorex R. Phenol treatment of pilonidal sinuses of the natal cleft. Br J Surg. 1989;76:729–30.
37. Lund JN, Leveson SH. Fibrin glue treatment of pilonidal sinus: results of a pilot study. Dis Colon Rectum. 2005;48:1094–6.
38. Seleem MI, Al-Hashemy AM. Management of pilonidal sinus using fibrin glue: a new concept and preliminary experience. Color Dis. 2005;7:319–22.
39. Greenberg R, Kashtan H, Skornik Y, Werbin N. Treatment of pilonidal sinus disease using fibrin glue as a sealant. Tech Coloproctol. 2004;8:95–8.
40. Elsey E, Lund JN. Fibrin glue in the treatment for pilonidal sinus: high patient satisfaction and rapid return to normal activities. Tech Coloproctol. 2013;17:101–4.
41. Milone M, Musella M, Di Spiezio Sardo A, Bifulco G, Salvatore G, Sosa Fernandez LM, Bianco P, Zizolfi B, Nappi C, Milone F. Video-assisted ablation of pilonidal sinus: a new minimally invasive treatment—a pilot study. Surgery. 2014;155:562–6.
42. Emile SH, Elfeki H, Shalaby M, Sakr A, Giaccaglia V, Sileri P, Wexner SD. Endoscopic pilonidal sinus treatment: a systematic review and meta-analysis. Surg Endosc. 2018 32(9):3754–62. https://doi.org/10.1007/s00464-018-6157-5.
43. Alptekin H, Yilmaz H, Kayis SA, Sahin M. Volume of excised specimen and prediction of surgical site infection in pilonidal sinus procedures (surgical site infection after pilonidal sinus surgery). Surg Today. 2013;43:1365–70.
44. Milone M, Musella M, Salvatore G, Leongito M, Milone F. Effectiveness of a drain in surgical treatment of sacrococcygeal pilonidal disease. Results of a randomized and controlled clinical trial on 803 consecutive patients. Int J Color Dis. 2011;26:1601–7.
45. Milone M, Di Minno MN, Musella M, Maietta P, Ambrosino P, Pisapia A, Salvatore G, Milone F. The role of drainage after excision and primary closure of pilonidal sinus: a meta-analysis. Tech Colorpoctol. 2013;17:625–30.
46. Lorant T, Ribbe I, Mahteme H, Gustafsson UM, Graf W. Sinus excision and primary closure versus laying open in pilonidal disease: a prospective randomized trial. Dis Colon Rectum. 2011;54:300–5.
47. Rao MM, Zawislak W, Kennedy R, Gilliland R. A prospective randomized study comparing two treatment modalities for chronic pilonidal sinus with a 5-year follow-up. Int J Color Dis. 2010;25:395–400.
48. Aldagal SM, Kensarah AA, Alhabboubi M, Ashy AA. A new technique in management of pilonidal sinus, a university teaching hospital experience. Int Surg. 2013;98:304–6.
49. Doll D, Novotny A, Rothe R, Kristiansen JE, Wietelmann K, Boulesteix AL, Dusel W, Petersen S. Methylene blue halves the long-term recurrence rate in acute pilonidal sinus disease. Int J Color Dis. 2008;23:181–7.
50. Colv EP, Bertelsen CA. Short convalescence and minimal pain after out-patient Bascom's pit pick operation. Dan Med Bull. 2011;58:A4348.
51. Olmez A, Kayaalp C, Aydin C. Treatment of pilonidal disease by combination of pit excision and phenol application. Tech Coloproctol. 2013;17:201–6.
52. Horwood J, Hanratty D, Chandran P, Billings P. Primary closure or rhomboid excision and Limberg

flap for the management of primary sacrococcygeal pilonidal disease? A meta-analysis of randomized controlled trials. Color Dis. 2012;14:143–51.
53. Dass TA, Zaz M, Rather A, Bari S. Elliptical excision with midline primary closure versus rhomboid excision with limberg flap reconstruction in sacrococcygeal pilonidal disease: a prospective, randomized study. Indian J Surg. 2012;74:305–8.
54. Onder A, Girgin S, Kapan M, Toker M, Arikanoglu Z, Palanci Y, Bac B. Pilonidal sinus disease: risk factors for postoperative complications and recurrence. Int Surg. 2012;97:224–9.
55. Sievert H, Evers T, Matevossian E, Hoenemann C, Hoffman S, Doll D. The influence of lifestyle (smoking and body mass index) on wound healing and long-term recurrence rate in 534 primary pilonidal sinus patients. Int J Color Dis. 2013;28:1555–62.
56. Doll D, Matevossian E, Hoenemann C, Hoffman S. Incision and drainage preceding definitive surgery achieves lower 20-year long-term recurrence rate in 583 primary pilonidal sinus surgery patients. J Dtsch Dermatol Ges. 2013;11:60–4.
57. Doll D, Evers T, Krapohl B, Matevossian E. Is there a difference in outcome (long-term recurrence rate) between emergency and elective pilonidal sinus surgery? Minerva Chir. 2013;68:199–205.
58. Doll D, Krueger CM, Schrank S, Dettmann H, Petersen S, Duesel W. Timeline of recurrence after primary and secondary pilonidal sinus surgery. Dis Colon Rectum. 2007;50:1928–34.

Perianal Hidradenitis Suppurativa

16

Emily Steinhagen and Michael F. McGee

Abbreviations

CD	Crohn's disease
HS	Hidradenitis suppurativa
SCC	Squamous cell carcinoma
VAC	Vacuum assisted closure

Introduction

Hidradenitis suppurativa (HS) is a chronic inflammatory skin disorder characterized by recurrent, chronic, and inflammatory lesions of terminal hair follicles in the axillae, scalp, groin, and perineum. The pathophysiology of HS is multifactorial, encompassing genetic, immunologic, hormonal, and infectious factors. Rather than an isolated dermatologic condition, emerging evidence suggests HS is primarily a systemic inflammatory disease with secondary skin manifestations [1]. Compared with other dermatologic diseases, HS profoundly impacts patient quality of life and can inflict significant psychosocial morbidity requiring coordinated care between primary care physicians, dermatologists, and surgeons [2].

Epidemiology and Risk Factors

Approximately 1–4% of the population is affected by HS [3], with a female predominance of approximately 3:1 in most series. Typically, HS begins after puberty [4]. HS is more commonly seen in black/African descent patients, and it has been suggested that race/ethnicity may impact disease severity [5]. HS patients demonstrate higher rates of smoking, obesity, dyslipidemia, diabetes, and metabolic syndrome compared to healthy controls [6]. Hypertension, thyroid disorders, psychiatric disorders, arthropathies, and polycystic ovary syndrome are also associated with HS [3]. There is a relatively high incidence of concomitant HS and Crohn's disease (CD). A 2010 survey suggests up to 17% of CD patients report a history of axillary and/or inguinal "recurrent painful boils" suggestive of HS [7].

E. Steinhagen
University Hospitals, Cleveland, OH, USA
e-mail: Emily.Steinhagen@uhhospitals.org

M. F. McGee (✉)
Department of Surgery, Division of Gastrointestinal and Oncologic Surgery, Section of Colon and Rectal Surgery, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA
e-mail: mmcgee1@nm.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_16

Pathogenesis

HS is hypothesized to originate with occlusion of the terminal follicular acrofundibuulum of the folliculopilosebaceous unit, leading to recurrent apocrinitis that manifests as cysts, draining sinuses, and subsequent scar formation [8].

Aberrant immunity may play a role in HS as it is associated with other immune-mediated diseases such as Crohn's disease and pyoderma gangrenosum. Increases in peri-lesional immune cells and TNF-α mRNA precede the clinical development of HS [9–11]. Pro-inflammatory cytokines IL-1 and IL-17, also involved in CD and psoriasis, have also been implicated [9, 12, 13]. T-cell deregulation has been implicated both in the pathogenesis of CD and HS. Furthermore the efficacy of anti-TNF-α agents for both CD and HS suggests each entity shares, at minimum, partially overlapping signaling pathways.

Approximately one-third of HS patients have a familial form of HS felt to pass through an autosomal dominant pattern [14]. HS has been associated with mutation of the *PSENEN* gene which encodes a subunit of the γ-secretase protein; however, mutations affecting the secretase protein are present in only 15% of patients [15–17].

Bacteria

Not surprisingly, skin flora is frequently implicated in HS, however the role of causation versus colonization versus contamination is unclear. *Staphylococcus aureus* is the most commonly implicated organism in HS. Coagulase negative *staphylococci*, *streptococci viridans*, *beta-hemolytic streptococci*, and *enterococci* make up the majority of other bacteria involved in HS. Commonly, skin swab cultures of infected HS lesions reveal normal skin flora and may not reflect subcutaneous pathogens, which may misguide initial antimicrobial treatment.

Differential Diagnosis

HS is diagnosed clinically upon appearance, location, and chronicity. Since HS is diagnosed primarily based on clinical findings, biopsy is usually not performed. When evaluating suspected HS, differential considerations should include cutaneous infections (e.g., furuncles, lymphogranuloma venereum, and dermoid/epidermoid cysts), lymphadenopathy, lymphoma, soft tissue malignancy, CD, and tuberculosis.

Crohn's Disease and HS

There is often a fine and blurry line between HS and perianal CD. The cumulative risk of an inflammatory bowel disease (IBD) patient developing HS is approximately 1 and 3% at 10 and 30 years; and the overall risk of developing HS in IBD is nine times that of the general population [18]. Since perianal CD and HS may be indistinguishable, evaluation and management of perianal disease requires experience with both entities and the anorectum. Suspicion of perianal CD or HS with associated gastrointestinal symptoms merits endoscopic evaluation of the entire ileocolon. Exam under anesthesia is often required to exclude and manage anal fistula.

Imaging

Clinical assessment, based on palpation and visual inspection, guides treatment for the majority of HS patients; however, peri-lesional inflammation, induration, and scarring may overestimate the burden of HS. Imaging has been selectively used by some groups to characterize the true nature and extent of HS involvement. Imaging may be used pre-operatively to develop a surgical strategy by mapping subcutaneous inflammation, sinuses, and fistulae [19]. Duplexed ultrasound permits visualization of the skin and subcutaneous structures and characteristic peripheral hypervascularity surrounding fluid collections and fistulae in HS. Imaging proponents report that routine use of duplexed ultrasound altered management in over 80% of patients initially assessed clinically, with the majority of clinical examinations underestimating disease severity [20]. Imaging may be useful in the perianal region where HS may be confused with CD, or

in cases where both are present and need to be distinguished. MRI, CT, fistulography, and endo-anal ultrasound (US) may all be useful to assess the location and origin of fistulas and sinus tracts.

Medical Treatment

Antibiotics

Spartan high-quality evidence supports the use of antibiotics to treat HS absent infection or cellulitis. Tetracycline, clindamycin, and other combinations of systemic antibiotics are initially useful when there are widespread areas of infection. Topical clindamycin 1% solution decreased the number of abscesses, inflammatory nodules, and pustules in HS patients [21]. A pilot study revealed a decrease in HS severity when patients were treated with a 6 week course of ertapenem, and continued to improve when transitioned to a "consolidation" regimen of rifampicin/moxifloxacin/metronidazole for 6 weeks [22]. This strategy may be used to effectively downstage disease burden to facilitate a more focused surgery.

Steroids

Intralesional corticosteroid injections have been used to treat acute flares and persistent nodules with a clinical response within 2–3 days [23]. While somewhat effective, intra-lesional steroid injections are relatively contraindicated when local super-infection is suspected, and injections may cause skin pigment changes and telangiectasia. Systemic corticosteroid "bursts" with a rapid taper can be used for acute HS flares, but long-term use of systemic steroids is not recommended.

Anti-TNF Agents

Anti-TNF-α agents can effectively treat HS. Infliximab has been shown to decrease HS severity by over 50% and improve quality of life in HS patients [24]. Similarly, adalimumab effectively decreased HS disease severity in 80% of a 154 patient trial [25]. Etanercept showed some promise in small cohort studies [26, 27], but a randomized double blind trial showed no difference after 12 weeks of treatment [28]. Currently, adalimumab is the only FDA approved TNF-α agent for treating HS. Notably, however, the efficacy of anti TNF-α agents in patients with HS and concomitant inflammatory disorders may be decreased when compared to those with HS alone [29]. As a result, patients with HS and concomitant inflammatory disease frequently require dose escalations [30].

Surgical Treatment

Surgery offers both acute temporization of HS via incision and drainage and long-term cure via wide local excision of affected skin. Wide local surgical excision is the most effective treatment for severe or advanced HS and in many cases, offers the only hope at cure [4, 31]. Consequently, some have advocated early and aggressive surgical treatment of HS, given the relative futility of medical treatments [32]. For many patients suffering with intractable HS, the punishment of a sometimes large surgery and protracted recovery is worth the crime of chronic suffering inflicted by a chronic and otherwise non-curable disease.

Incision and drainage is commonly performed to relieve pain and control active infection. Since drainage alone does not address the underlying inflammatory process, incised HS lesions tend to recur. Surgical un-roofing implies opening a lesion more fully to remove keratinous debris on the lesion floor [33, 34]. Un-roofing is typically guided by probing sinus openings to explore the extent of the lesion(s). The roof of each structure is excised to allow debridement of granuloma and purulence whereby exposing the epithelialized lesion base, and the wound heals secondarily. Un-roofing is generally recommended for limited and focal disease as it may spare more tissue than wide local excision [35].

Wide local excision removes the entirety of active and at-risk HS tissue, not just the actively infected areas (Fig. 16.1). The breadth of excision is determined by the size of the lesion and the distance between adjacent lesions; while the

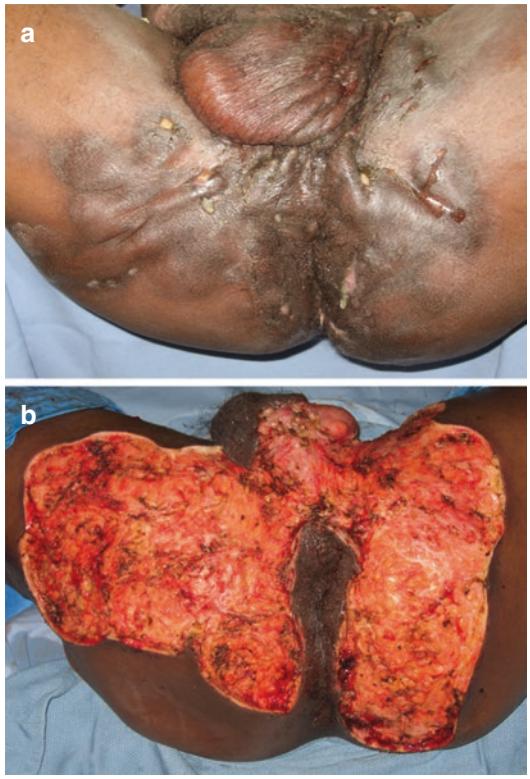


Fig. 16.1 (**a**) Pre-operative perianal, inguinal, and scrotal hidradenitis suppurativa. (**b**) Following wide local excision. Photos courtesy of Randolph M. Steinhagen, MD

depth is to the portions of subcutaneous fat deep to all inflammatory tracts. Since there is no benefit to extra-wide margins, 1 cm margins are adequate [32]. Wide or radical excisions should be performed cautiously in areas with neurovascular structures such as the axilla and inguinal regions. Un-roofing is acceptable in areas where excision is not feasible due to anatomic constraints, such as the perigenital skin.

After limited excision, HS may recur in 43% of patients with a disease-free interval of 11 months. HS recurrence following wide excision was 27% after 20 months [36]. In a large series of 182 patients undergoing 229 excisions, 60% of patients had resolution of HS at 1 year follow up, but, 32% noted interval development of lesser severe lesions at the same or adjacent site. It should be noted that in the same study, nearly 9% of patients experienced no improvement in symptoms despite wide excision, likely owing to the difficulty in treating this entity [37]. Excisions can leave large wounds that must be either closed, reconstructed with tissue transfer techniques, or allowed to heal secondarily. Appropriate pre-operative planning, often in conjunction with a plastic surgeon, can assist with determining an effective strategy for wound management.

Following excision, primary closure may be employed for small defects that approximate well with no tension. When possible it may confer faster healing, and improved cosmetic and functional outcomes; however high recurrence and infection rates render primary closure a suboptimal treatment in most cases. Moreover, primary closure should be avoided in high tension or inflamed areas—which is often present in most cases of chronic HS. Wounds can be closed loosely to allow for outflow of drainage as necessary or packing with wicks between stitches or staples can be employed [32]. Meta-analysis demonstrated the recurrence rates for wide excision, local excision, and un-roofing to be 13%, 22%, and 27%, respectively [38].

Healing by secondary intention will occur in even the largest wounds but can be a time and resource consuming process for patients. Secondarily intended healing occurs through wound granulation, contraction, and epithelialization. Following several weeks to months, the final scar from secondary healing is typically considerably smaller than the initial defect [39]. In areas of joint mobility, such wound and scar shrinkage rarely can cause joint contractures. The use of vacuum assisted closure (VAC) devices has been described for large, open wounds after excision for HS. VAC therapy is postulated to shorten the time to wound closure, decrease bacterial counts, control wound fluid losses, and promote granulation tissue growth. However, VAC placement may often be challenged with HS since the inguinal, axillary, and perianal regions may be extraordinarily difficult to sustain an adequate dressing seal.

Skin grafts are an option for coverage of larger defects. Split-thickness, meshed grafts are commonly used. The benefits include low risks for serious complication and the functional outcome

is usually good. There are typically some differences in the color and texture of the graft after healing compared with surrounding skin. Skin grafts may be placed on granulated wounds with no signs of infection, though some also place them directly after excision. Compared with secondary intention, skin grafting has a shorter time to closure but may be more uncomfortable during healing and mobility may be limited to allow for the graft to heal.

A variety of local advancement, rotational, and free soft tissue flaps can be used to reconstruct HS wounds. Flap surgery, however, may be technically more difficult to perform, more invasive, and have the potential for failure when compared to secondary healing or skin grafting. Flap coverage should be strongly considered when HS debridement results in areas of exposed nervous, vascular, or skeletal structures (e.g. tendons, bones). One factor in surgical planning is that the size of the defect is often underestimated preoperatively so the flap needs to be large enough for adequate coverage [32]. Complex flap reconstruction is most beneficial when planned in advance in conjunction with a soft tissue surgical expert, such as a plastic surgeon. Recurrence rates following primary healing, flap, and skin grafting were noted to be 15%, 8%, and 6%, respectively [38].

A combined approach of several surgical modalities may be required for complex HS. A combination of incisional drainage, un-roofing, debridement, and primary and secondary intention is often used for complex cases. For large, extensive areas of disease, staged excision is often employed. The authors prefer to divide areas of HS disease into functional anatomic regions and address each separately, with an eye on preserving anatomic function for the treatment duration. For instance, a patient with bilateral perianal, perineal, and inguinal disease may be treated with four smaller staged debridements, with each debridement addressing a quadrant of active disease (right inguinal, left inguinal, left anal margin, right anal margin) whereby preserving relatively normal function in the remaining three quadrants. Such staged strategies allow a patient to rest or weight-bear on healed (or yet-to-be treated) tissue until the active surgical area heals.

Rarely, a diverting stoma may be sought prior to extensive debridements to theoretically decrease bacterial contamination of healing wounds. Commonly, plastic surgeons may request temporary fecal diversion prior to perianal skin grafting or complex healing of extensive perineal wounds. Although temporary fecal diversion makes putative sense for severe perianal HS awaiting complex reconstruction, the benefits of diversion remain controversial. As has been reported anecdotally for small series of necrotizing perianal soft tissue infections, conscientious and careful perianal wound care with tube-based fecal management systems may facilitate wound healing without a stoma [40].

Special consideration should be paid to patients with concomitant CD and HS with regard to surgery. If infra-inguinal HS is felt to be arising from fistulizing perianal disease a combined approach of medical and surgical management is often required. If extensive perianal HS can be attributed to a solitary fistula-in-ano, wide local cutaneous debridement plus seton control of the fistula can be performed. Complicated fistulas, anal stenosis, or refractory mucosal inflammation may require proctectomy in association with cutaneous debridement.

Squamous Cell Carcinoma

Squamous cell carcinoma is a rare but serious complication of HS that typically occurs after long periods of uncontrolled inflammation [41]. The pattern of development is similar to Marjolin's ulcers in burns and carcinoma of fistulous tracts in CD. Though there are only a total of 86 cases reported in the literature [42], one cohort study demonstrated a prevalence of 4.6% [43]. SCC is more common in males and in patients with gluteal, perianal, or perineal disease affecting large areas. The median time from diagnosis of HS is 20–30 years [41]. The treatment is wide local excision, and postoperative radiotherapy has been used for regional lymph nodes or unresectable disease due to proximity to sensitive neurovascular structures [44]. The mortality rate is up to 50% in some series [41].

References

1. van Rappard DC, Mekkes JR, Tzellos T. Randomized controlled trials for the treatment of hidradenitis suppurativa. Dermatol Clin. 2016;34(1):69–80.
2. Zouboulis CC, Desai N, Emtestam L, Hunger RE, Ioannides D, Juhasz I, et al. European S1 guideline for the treatment of hidradenitis suppurativa/acne inversa. J Eur Acad Dermatol Venereol. 2015;29(4):619–44.
3. Shlyankevich J, Chen AJ, Kim GE, Kimball AB. Hidradenitis suppurativa is a systemic disease with substantial comorbidity burden: a chart-verified case-control analysis. J Am Acad Dermatol. 2014;71(6):1144–50.
4. Jemec GB. Clinical practice. Hidradenitis suppurativa. N Engl J Med. 2012;366(2):158–64.
5. Vlassova N, Kuhn D, Okoye GA. Hidradenitis suppurativa disproportionately affects African Americans: a single-center retrospective analysis. Acta Derm Venereol. 2015;95(8):990–1.
6. Miller IM, Ellervik C, Vinding GR, Zarchi K, Ibler KS, Knudsen KM, et al. Association of metabolic syndrome and hidradenitis suppurativa. JAMA Dermatol. 2014;150(12):1273–80.
7. van der Zee HH, van der Woude CJ, Florencia EF, Prens EP. Hidradenitis suppurativa and inflammatory bowel disease: are they associated? Results of a pilot study. Br J Dermatol. 2010;162(1):195–7.
8. Attanoos RL, Appleton MA, Douglas-Jones AG. The pathogenesis of hidradenitis suppurativa: a closer look at apocrine and apoeccrine glands. Br J Dermatol. 1995;133(2):254–8.
9. Kelly G, Hughes R, McGarry T, van den Born M, Adamzik K, Fitzgerald R, et al. Dysregulated cytokine expression in lesional and nonlesional skin in hidradenitis suppurativa. Br J Dermatol. 2015;173(6):1431–9.
10. van der Zee HH, Prens EP. The anti-inflammatory drug colchicine lacks efficacy in hidradenitis suppurativa. Dermatology. 2011;223(2):169–73.
11. Emelianov VU, Bechara FG, Glaser R, Langan EA, Taungjaruwinai WM, Schroder JM, et al. Immunohistological pointers to a possible role for excessive cathelicidin (LL-37) expression by apocrine sweat glands in the pathogenesis of hidradenitis suppurativa/acne inversa. Br J Dermatol. 2012;166(5):1023–34.
12. van der Zee HH, Laman JD, de Ruiter L, Dik WA, Prens EP. Adalimumab (antitumour necrosis factor-alpha) treatment of hidradenitis suppurativa ameliorates skin inflammation: an in situ and ex vivo study. Br J Dermatol. 2012;166(2):298–305.
13. Schroder K, Tschopp J. The inflammasomes. Cell. 2010;140(6):821–32.
14. Canoui-Poitrine F, Le Thuaut A, Revuz JE, Viallette C, Gabison G, Poli F, et al. Identification of three hidradenitis suppurativa phenotypes: latent class analysis of a cross-sectional study. J Invest Dermatol. 2013;133(6):1506–11.
15. Pink AE, Simpson MA, Desai N, Dafou D, Hills A, Mortimer P, et al. Mutations in the gamma-secretase genes NCSTN, PSENEN, and PSEN1 underlie rare forms of hidradenitis suppurativa (acne inversa). J Invest Dermatol. 2012;132(10):2459–61.
16. Gao M, Wang PG, Cui Y, Yang S, Zhang YH, Lin D, et al. Inversa acne (hidradenitis suppurativa): a case report and identification of the locus at chromosome 1p21.1-1q25.3. J Invest Dermatol. 2006;126(6):1302–6.
17. Wang B, Yang W, Wen W, Sun J, Su B, Liu B, et al. Gamma-secretase gene mutations in familial acne inversa. Science. 2010;330(6007):1065.
18. Yadav S, Singh S, Edakkanambeth Varayil J, Harmsen WS, Zinsmeister AR, Tremaine WJ, et al. Hidradenitis suppurativa in patients with inflammatory bowel disease: a population-based cohort study in Olmsted County, Minnesota. Clin Gastroenterol Hepatol. 2016;14(1):65–70.
19. Wortsman X. Imaging of hidradenitis suppurativa. Dermatol Clin. 2016;34(1):59–68.
20. Wortsman X, Moreno C, Soto R, Arellano J, Pezo C, Wortsman J. Ultrasound in-depth characterization and staging of hidradenitis suppurativa. Dermatol Surg. 2013;39(12):1835–42.
21. Clemmensen OJ. Topical treatment of hidradenitis suppurativa with clindamycin. Int J Dermatol. 1983;22(5):325–8.
22. Join-Lambert O, Coignard-Biehler H, Jais JP, Delage M, Guet-Revillet H, Poiree S, et al. Efficacy of ertapenem in severe hidradenitis suppurativa: a pilot study in a cohort of 30 consecutive patients. J Antimicrob Chemother. 2016;71(2):513–20.
23. Jemec GBE, Revuz J, Leyden J, editors. Hidradenitis suppurativa. Berlin: Springer; 2006. p. 138–40.
24. Grant A, Gonzalez T, Montgomery MO, Cardenas V, Kerdel FA. Infliximab therapy for patients with moderate to severe hidradenitis suppurativa: a randomized, double-blind, placebo-controlled crossover trial. J Am Acad Dermatol. 2010;62(2):205–17.
25. Kimball AB, Kerdel F, Adams D, Mrowietz U, Gelfand JM, Gniadecki R, et al. Adalimumab for the treatment of moderate to severe hidradenitis suppurativa: a parallel randomized trial. Ann Intern Med. 2012;157(12):846–55.
26. Cusack C, Buckley C. Etanercept: effective in the management of hidradenitis suppurativa. Br J Dermatol. 2006;154(4):726–9.
27. Giamarellos-Bourboulis EJ, Pelekanou E, Antonopoulou A, Petropoulou H, Baziaka F, Karagianni V, et al. An open-label phase II study of the safety and efficacy of etanercept for the therapy of hidradenitis suppurativa. Br J Dermatol. 2008;158(3):567–72.
28. Adams DR, Yankura JA, Fogelberg AC, Anderson BE. Treatment of hidradenitis suppurativa with etanercept injection. Arch Dermatol. 2010;146(5):501–4.
29. Machet L, Samimi M, Delage M, Paintaud G, Maruani A. Systematic review of the efficacy and adverse events associated with infliximab treatment of hidradenitis suppurativa in patients with coexistent inflammatory diseases. J Am Acad Dermatol. 2013;69(4):649–50.
30. Kamal N, Cohen BL, Buche S, Delaporte E, Colombel JF. Features of patients with Crohn's disease and

hidradenitis suppurativa. Clin Gastroenterol Hepatol. 2016;14(1):71–9.
31. Cosmatos I, Matcho A, Weinstein R, Montgomery MO, Stang P. Analysis of patient claims data to determine the prevalence of hidradenitis suppurativa in the United States. J Am Acad Dermatol. 2013;68(3):412–9.
32. Janse I, Bieniek A, Horvath B, Matusiak L. Surgical procedures in hidradenitis suppurativa. Dermatol Clin. 2016;34(1):97–109.
33. Mullins JF, McCash WB, Boudreau RF. Treatment of chronic hidradenitis suppurativa: surgical modification. Postgrad Med. 1959;26:805–8.
34. Culp CE. Chronic hidradenitis suppurativa of the anal canal. A surgical skin disease. Dis Colon Rectum. 1983;26(10):669–76.
35. van der Zee HH, Prens EP, Boer J. Deroofing: a tissue-saving surgical technique for the treatment of mild to moderate hidradenitis suppurativa lesions. J Am Acad Dermatol. 2010;63(3):475–80.
36. Ritz JP, Runkel N, Haier J, Buhr HJ. Extent of surgery and recurrence rate of hidradenitis suppurativa. Int J Color Dis. 1998;13(4):164–8.
37. Bieniek A, Matusiak L, Okulewicz-Gojlik D, Szepietowski JC. Surgical treatment of hidradenitis suppurativa: experiences and recommendations. Dermatol Surg. 2010;36(12):1998–2004.
38. Mehdizadeh A, Hazen PG, Bechara FG, Zwingerman N, Moazenzadeh M, Bashash M, et al. Recurrence of hidradenitis suppurativa after surgical management: a systematic review and meta-analysis. J Am Acad Dermatol. 2015;73(5 Suppl 1):S70–7.
39. Morgan WP, Harding KG, Hughes LE. A comparison of skin grafting and healing by granulation, following axillary excision for hidradenitis suppurativa. Ann R Coll Surg Engl. 1983;65(4):235–6.
40. Eray IC, Alabaz O, Akcam AT, Ulku A, Parsak CK, Sakman G, et al. Comparison of diverting colostomy and bowel management catheter applications in Fournier gangrene cases requiring fecal diversion. Indian J Surg. 2015;77(Suppl 2):438–41.
41. Losanoff JE, Sochaki P, Khoury N, Levi E, Salwen WA, Basson MD. Squamous cell carcinoma complicating chronic suppurative hydradenitis. Am Surg. 2011;77(11):1449–53.
42. Pena ZG, Sivamani RK, Konia TH, Eisen DB. Squamous cell carcinoma in the setting of chronic hidradenitis suppurativa; report of a patient and update of the literature. Dermatol Online J. 2015;21(4)
43. Lavogiez C, Delaporte E, Darras-Vercambre S, Martin De Lassalle E, Castillo C, Mirabel X, et al. Clinicopathological study of 13 cases of squamous cell carcinoma complicating hidradenitis suppurativa. Dermatology. 2010;220(2):147–53.
44. Herschel S, Laske J, Stein A. Squamous cell carcinoma arising in hidradenitis suppurativa. J Dtsch Dermatol Ges. 2014;12(5):417–9.

Hemorrhoidal Disease

17

David E. Beck

Introduction

Hemorrhoids and the symptoms they produce have plagued mankind throughout recorded history [1]. In the Bible, the Old Testament of 1 Samuel, Chaps. 5 and 6 describe the Philistines after taking the Ark of the Covenant from the Israelis as being smitten by god with *aphelim* or *techorim*. Both words are believed by scholars to relate to hemorrhoids [2, 3]. Many centuries ago Maimonides described a variety of soothing medications, ointments, and even suppositories for the treatment of hemorrhoids and argued against surgery as a treatment for the condition [4].

The term hemorrhoid has, from the patient's perspective, always signified a variety of anal complaints varying from minor itching to acute disabling pain. As the presence of some hemorrhoidal tissue is normal, hemorrhoidal disease should be thought of as hemorrhoidal tissue that causes significant symptomatology. Large sums of money are spent on products to control these symptoms, and the amount of work lost because of hemorrhoids is economically important [5]. Our understanding of etiology and symptoms helps us to make recommendations for therapy. This chapter discusses the anatomy, pathophysiology, and methods of treatment of symptomatic hemorrhoids.

D. E. Beck (✉)
Department of Colon and Rectal Surgery, Ochsner Clinic, New Orleans, LA, USA

Anatomy

Hemorrhoids are cushions of vascular tissue found in the anal canal [2]. Hemorrhoidal tissue is present at birth and in nonpathologic conditions. Microscopically, this tissue contains vascular structures whose walls do not contain muscle. Thus hemorrhoids are not veins (which have muscular walls) but are sinusoids (Fig. 17.1) [6]. Studies have also demonstrated that hemorrhoidal bleeding is arterial and not venous. When these sinusoids are injured (disrupted), hemorrhage occurs from presinusoidal arterioles. The arterial nature of the bleeding explains why hemorrhoidal hemorrhage is bright red and has an arterial pH [7].

Cutaneous sensation in the perianal area is mediated through the pudendal nerve and the sacral plexus, both arising from sacral nerve roots 2 through 4, as described in Chap. 1. Some of the pressure sensation in this area may also be mediated by sacral nerve endings (S-2 to S-4) located in the lower rectum and pelvic floor [5].

In humans, hemorrhoidal tissue is thought to contribute to anal continence by forming a spongy bolster, which cushions the anal canal and prevents damage to the sphincter mechanism during defecation [2]. In addition, this tissue acts as a compressible lining which allows the anus to close completely. The three main cushions (or bundles) lie at the left lateral, right anterolateral, and right posterolateral portion of the anal canal. Smaller secondary cushions may occasionally

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_17

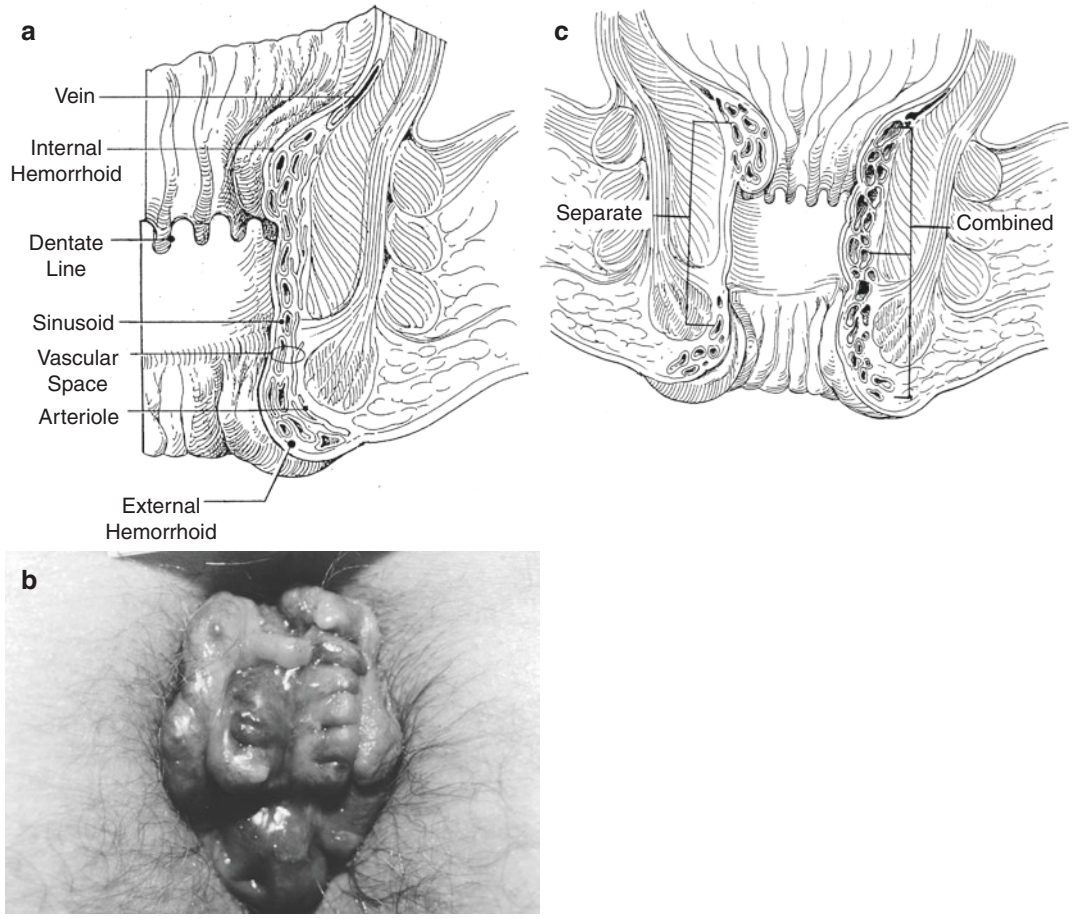


Fig. 17.1 Hemorrhoidal anatomy. (**a**) Arteriovenous anastomosis (AV shunts) forming hemorrhoidal plexus. (**b**) Fourth degree hemorrhoids. (**c**) Usual position of the hemorrhoids. Separate external and internal hemorrhoids are seen on the left and a combined internal-external hemorrhoidal complex is seen on the right

lie between these main cushions. Each bundle starts superiorly (cranially) in the anal canal and extends inferiorly (caudally) to the anal margin. The superior portion of the hemorrhoidal tissue (above the dentate line) is covered by anal mucosa and the inferior portion (below the dentate line) is covered by anoderm or skin.

Pathophysiology

Etiology

Enlargement or pathologic changes in hemorrhoidal tissue result in symptoms of the "hemorrhoidal syndrome." Proposed etiologic factors for these changes include constipation, prolonged straining, pregnancy, and derangement of the internal sphincter [2]. Constipation and the associated straining with defecation as suggested by Burkitt and Graham-Stewart [8] are related to eating habits, specifically, to a low-residue diet. The typical American low fiber diet may explain the high prevalence of constipation, straining, and hemorrhoidal symptoms in America [9]. With time (aging) the anatomic structures supporting the muscularis submucosae weaken which leads to slippage or prolapsation of the hemorrhoidal tissue. Haas et al. confirmed microscopically that anal supporting tissues deteriorate by the third decade of life [10]. Finally, several authors have demonstrated that patients with hemorrhoids have increased activity of the internal anal sphincter [11, 12]. In addition to the

hemorrhoidal plexuses lying superficial to the sphincter mechanism, it has been theorized that a dysfunctional sphincter could lead to venous outflow obstruction and congestion, followed by engorgement of the hemorrhoids, and subsequent symptoms [13]. All of these conditions contribute toward stretching and slippage of the hemorrhoidal tissue. The overlying skin or mucosa is stretched and additional fibrous and sinusoidal tissue develops. The extra tissue tends to move caudally toward the anal verge making it susceptible to injury and causing symptoms to develop. A survey into the prevalence of benign anorectal disease demonstrated that 9% of adults had previous treatment of hemorrhoidal disease and 8% had hemorrhoidal symptoms [14].

Hemorrhoids are not related to portal hypertension [7]. With increased portal venous pressure, the body develops portosystemic communications in several locations. In the pelvis, communications enlarge between the superior and middle hemorrhoidal veins which result in development of rectal varices. These varices are located in the lower rectum, not the anus. Due to the rectum's large capacity, they rarely bleed. Older literature suggested a relationship between portal hypertension and hemorrhoids partly due to the fact that hemorrhoids are common and therefore many portal hypertensive patients will have hemorrhoids. If portal hypertension was an etiologic factor, hemorrhoidal bleeding would be venous blood rather than arterial bleeding as described above. Hemorrhoidal symptoms may be difficult to manage in patients with portal hypertension as their liver disease frequently is associated with coagulation and platelet problems.

Classification

For anatomic and clinical reasons hemorrhoidal tissue has been divided into two types: External and Internal. **External hemorrhoids** are located in the distal one third of the anal canal (distal to the dentate line) and are covered by anoderm (modified squamous epithelium that bears no skin appendages) or skin (Fig. 17.1a). As this overlying tissue is innervated by somatic nerves, it is sensitive to touch, temperature, stretch, and pain. Symptoms from external hemorrhoids usually result from thrombosis of the hemorrhoidal plexus. The rapid tissue expansion produced by the clots and edema causes pain. Physical effort is felt to be an etiologic factor in thrombosis of external hemorrhoids. Physical examination reveals one or more tender blue colored masses at the anus; additional symptoms are discussed below.

Internal hemorrhoids are located proximal (cranial) to the dentate line and covered by columnar mucosa or transitional epithelium. Based on size and clinical symptoms, internal hemorrhoids can be further subdivided by Grades [2, 15]. **Grade 1** hemorrhoids protrude into, but do not prolapse out of the anal canal. **Grade 2** hemorrhoids prolapse out of the anal canal with bowel movements or straining, but spontaneously reduce. **Grade 3** hemorrhoids prolapse during the maneuvers described above and must be manually reduced by the patient. **Grade 4** hemorrhoids are prolapsed out of the anus and cannot be reduced (Fig. 17.1b). Hemorrhoids that remain prolapsed may develop ischemia, thrombosis, or gangrene. Patients may have both internal and external hemorrhoids (mixed or combined) (Figs. 17.1c and 17.2).

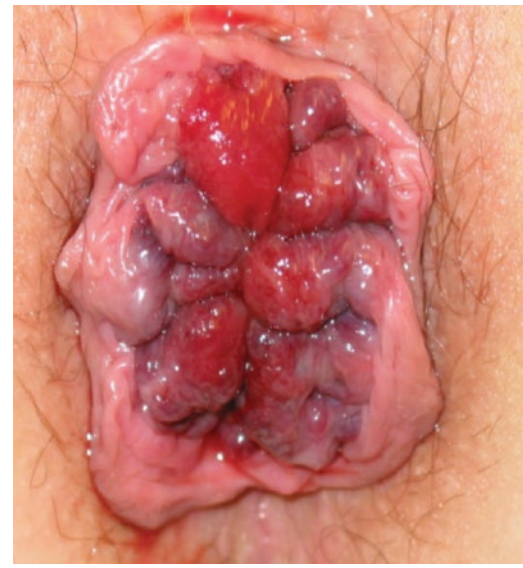


Fig. 17.2 Prolapsed thrombosed internal hemorrhoids that have caused swelling of the external hemorrhoids as well

Evaluation

Symptoms

Patients with any anal complaints commonly present to physicians complaining of "hemorrhoids." Careful exploration of their symptoms will often lead to the correct diagnosis.

Symptoms associated with hemorrhoidal disease include: mucosal protrusion, pain, bleeding, a sensation of incomplete evacuation, mucous discharge, difficulties with perianal hygiene, and cosmetic deformity. General disorders of bowel function such as diarrhea and constipation, and associated disorders such as bleeding problems should be considered. A dietary and medication history should always be taken.

Except when thrombosis or edema occurs, hemorrhoids are painless. Painless bleeding occurs from internal hemorrhoids, is usually bright red, and is associated with bowel movements. The blood will occasionally drip into the commode and stain the toilet water bright red. After trauma by firm stools or forceful bowel movements, bleeding may continue to occur with bowel movements for several days. The bleeding will often then resolve for a variable period of time. It is unusual for hemorrhoidal bleeding to be severe enough to cause anemia but has been reported to occur in 0.5 patients per 100,000 population [16].

Prolapse may be appreciated by the patient as an anal mass, a feeling of incomplete evacuation, or a mucous discharge. The patient's requirement to manually reduce prolapsed hemorrhoids should be ascertained. If thrombosis or gangrene occurs, it will be apparent on physical examination and may be associated with systemic symptoms.

Examination

Examination of the anal area is usually undertaken with the patient in a prone position on a special proctologic table. If the patient is elderly or uncomfortable in this position, however, the modified left lateral decubitus (Sims) position (Fig. 2.1) is an acceptable alternative. Inspection of the anus should be done slowly, with calm reassurance by the examiner. The skin about the perianum, genitalia, and sacrococcygeal areas should be scrutinized. Gentle, steady spreading of the buttocks will allow for close inspection of the majority of the squamous portion of the anal canal.

Digital examination gives the examiner an appreciation for the amount and location of any pain in the anal canal. It enables assessment of the sphincter tone and helps exclude other diseases such as palpable tumors or abscesses in the lower rectum and anal canal. Hemorrhoids are not generally palpable unless quite large or thrombosed.

Anoscopy, usually done with a side-viewing instrument, permits visualization of the condition of the anoderm and internal hemorrhoidal complexes. As the patient strains, the hemorrhoids bulge into the lumen of the anoscope. The degree of prolapse may be assessed by gently withdrawing the anoscope as the patient strains.

Rigid proctosigmoidoscopy and flexible sigmoidoscopy form an important part of the initial examination and are performed to exclude more proximal disease. If the patient is less than 40 years old and hemorrhoidal disease compatible with symptoms is seen on physical examination, most authors feel that no additional work-up is required. If the patient is older than 40, hemorrhoidal disease is not observed, or additional symptoms are present, a barium enema or colonoscopy is obtained to identify other etiologies for bleeding not observed by the proctoscopy.

Differential Diagnosis

It is extremely important that other causes of bleeding, itching, or discharge be considered as listed in Table 17.1. Although patients invariably attribute anal pain to hemorrhoids, acute anal pain is almost always caused by either anal fis-

Table 17.1 Differential diagnosis in hemorrhoidal disease

Symptoms	Other diseases	Hemorrhoidal problems
Acute pain	Fissure Abscess/fistula	Thrombosed Prolapsed thrombosed
Chronic pain	Fissure Abscess/fistula Perianal Crohn's disease	
Bleeding	Fissure Colorectal polyp Colorectal cancer	Internal hemorrhoid Thrombosed external hemorrhoid
Itching/discharge	Hypertrophic anal papilla Fistula Condylomata (anal warts) Rectal prolapse Anal incontinence	Prolapse
Lump or mass	Hypertrophic anal papilla Abscess Anal tag Crohn's disease	Thrombosed Prolapsed
Unusual	Anal or rectal tumor (benign or malignant) Ulcerative colitis	

sure or anorectal abscess. Pain from hemorrhoids occurs only in association with thrombosis or prolapse.

Treatment

General Principles

Treatments are many and varied with some treatments, as described earlier, dating back to biblical times [17]. Modern therapy includes identification and correction of gastrointestinal (GI) tract dysfunction, minimization of symptoms, and in some patients, correction of anal abnormalities, excision of excess hemorrhoidal tissue and prevention of slippage or prolapse. Treatment can be nonoperative or operative. Nonoperative techniques include dietary modifications, topical medications and measures (such as Sitz baths) to reduce symptoms. Operative techniques, many of which can be performed in an office setting, include tissue fixation, major tissue excision, or physiologic alterations of the anal canal (Lord dilation or lateral internal sphincterotomy). The method chosen is usually related to the type of hemorrhoidal tissue causing symptoms, and the experience and judgment of the treating physician [2].

Internal Hemorrhoids

Diet and Stool Bulking Agents

Dietary modification is a mainstay for any therapy for hemorrhoidal disease [17]. If the patient is constipated or straining, a diet high in fiber (usually at least 20–30 g/day) is recommended, striving for a soft, formed compressible stool that is easy to pass. This type of stool reduces the requirement to strain with bowel movements and lessens the chance of hemorrhoidal injury. Moesgaard and colleagues [18] conducted a prospective double-blind trial, which demonstrated that psyllium fiber, when added to the diet of patients with anal bleeding and pain with defecation, improved their symptoms over a 6-week period. Patients with diarrhea and hemorrhoidal disease, after an evaluation of the underlying cause of their loose stools, should also receive dietary manipulation with fiber and antidiarrheals as indicated.

Table 17.2 Fiber products

Type of fiber	Dosage (g)	Trade name	Manufacturer
Bran			
Psyllium	3.5	Metamucil™	Procter & Gamble, Cincinnati, OH
	6.0	Konsyl™	Konsyl Pharmaceuticals, Fort Worth, TX
Methylcellulose	1–3	Citrucel™	Merrell Dow Pharmaceuticals, Cincinnati, OH
Calcium Polycarbophil	1–3	Fibercon™	Lederle Laboratories American Cyanamid Co, Pearl River, NY
	1–3	Konsyl™ Fiber Tablets	Konsyl Pharmaceuticals, Fort Worth, TX

Table 17.3 Treatment of internal hemorrhoids by degree of prolapse

Severity	Treatment
First degree (no prolapse)	Dietary Infrared coagulation OR banding, or sclerotherapy
Second degree (spontaneously reducible)	Dietary Plus banding OR infrared coagulation, or sclerotherapy
Third degree (manual reduction necessary)	Dietary Plus banding OR infrared coagulation, or sclerotherapy OR Excisional hemorrhoidectomy[a]
Fourth degree (irreducible)	Excisional hemorrhoidectomy Rarely, multiple rubber band ligations
Acutely prolapsed and thrombosed	Emergency hemorrhoidectomy

[a]Excisional hemorrhoidectomy is recommended if external tags are also present

Dietary fiber is more appropriately referred to as a stool normalizer rather than a stool softener. It is uncommon for dietary fiber to cause complications, and allergic reactions to the active or inactive ingredients are exceptionally rare. The most common clinical difficulty is non-compliance due to problems with taste or symptoms of bloating and crampy abdominal pain. Fiber products currently available are listed in Table 17.2. Manufacturers have attempted to improve the palatability of these products in several ways. Adding flavoring and sweeteners has improved taste but usually at a higher cost and less fiber per unit volume. The different fiber sources may produce variable effects in different patients. It is advisable, therefore, to try alternate products if the first selection does not produce the desired results. To minimize symptoms, many providers find it helpful to start patients at a lower dose of the fiber supplement and to slowly increase the amount of fiber ingested until the desired stool consistency is achieved. It is also important to counsel patients to ingest an appropriate amount of water with their fiber; generally 80–120 oz. (240–360 mL) per day. Fiber consumption of greater than 35 g/day with inadequate water intake can predispose to bezoar formation. Polyethylene glycol (PEG) supplementation (e.g. Miralax, Bayer Health Care, Whippany, NJ) aids in the retention of water in the stool. It can be helpful in patients that are less compliant with fiber especially females. If dietary manipulations fail to relieve symptoms, additional therapy is indicated (Table 17.3).

Flavonoids

Flavonoids are plant products that have been prescribed to reduce hemorrhoidal bleeding. A meta-analysis of 14 randomized trials (1514 patients) found limitations in methodological quality, heterogeneity, and potential publication bias [19]. The authors had questions on the beneficial effects in the treatment of hemorrhoids. These products have not been used widely in North America.

Topical Medications and Measures

Sitz baths, a bidet, or soaks in a warm tub are used to soothe the acutely painful anal area. Dodi and associates [20] demonstrated a significant reduction in anal pressure after patients with anorectal disorders soaked in warm (40 °C)

water. Soaking time should be limited as prolonged exposure to water can lead to edema of the perineal skin and subsequent pruritus. Some patients prefer to apply ice packs to the anal area. Again, as long as contact is not prolonged, this option is acceptable if it reduces symptoms.

The pharmaceutical industry has actively promoted multiple products such as creams, foams, and suppositories. One per cent hydrocortisone may temporally reduce the symptoms caused by pruritus associated with hemorrhoidal disease. However, prolonged use of topical steroids may attenuate the skin, predisposing it to further injury. Suppositories, after insertion, end up in the lower rectum rather than in the anal canal where hemorrhoids are located. Outside of providing a little lubrication of the stool, they have little to no pharmacologic rationale in the management of hemorrhoidal disease [21]. Ointments can cause or exacerbate pruritus ani, and again except for those that contain a topical anesthetic (e.g. 1% pramoxine hydrochloride) offer little benefit except for thrombosed external hemorrhoids. Success in reducing symptoms associated with thrombosed external hemorrhoids has also been reported with topical nitroglycerin [20]. Effective marketing of over the counter medications, the placebo effect of any medication placed on the bothersome area, and the intermittent nature of hemorrhoidal symptoms explain the large volumes of these products purchased in the United States.

Rubber Band Ligation

Rubber band ligation was originally described by Blaisdell in 1958 [22] and subsequently refined and popularized by Barron in 1963 [23]. Placement of a tight rubber band around excess hemorrhoidal tissue constricts the blood supply to the contained tissue, which sloughs over 5–7 days. This leaves a small ulcer, which heals fixing the tissue to the underlying muscle. Due to its simplicity, safety and effectiveness, rubber band ligation is currently the most widely used technique in the United States for treating first, second and some third degree internal hemorrhoids [5].

To accomplish this procedure, informed consent is obtained and an anoscope is inserted into the anus (the author prefers a slotted lighted scope) (Fig. 17.3e). A hemorrhoid bundle is identified and through the anoscope, a band is placed using one of two types of ligators (Fig. 17.3).

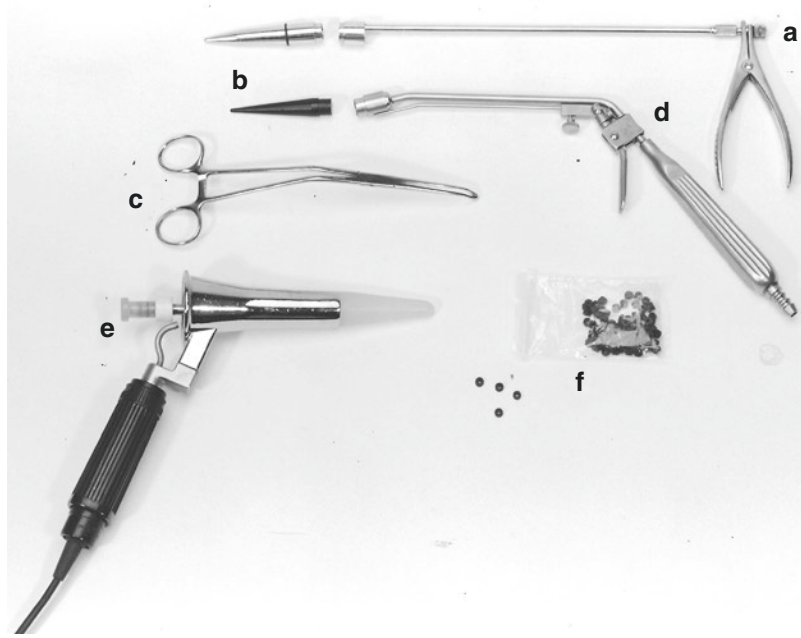


Fig. 17.3 Hemorrhoidal banders. (**a**) Band ligator (McGivney type). (**b**) Band loaders. (**c**) Avascular clamp. (**d**) Suction ligator (McGown). (**e**) Fiberoptic anoscope. (**f**) Rubber bands (From Beck DE. Hemorrhoids. In Beck DE. (ed) Handbook of Colorectal Surgery. 3rd ed. JP Medical, London, 2013. With permission)

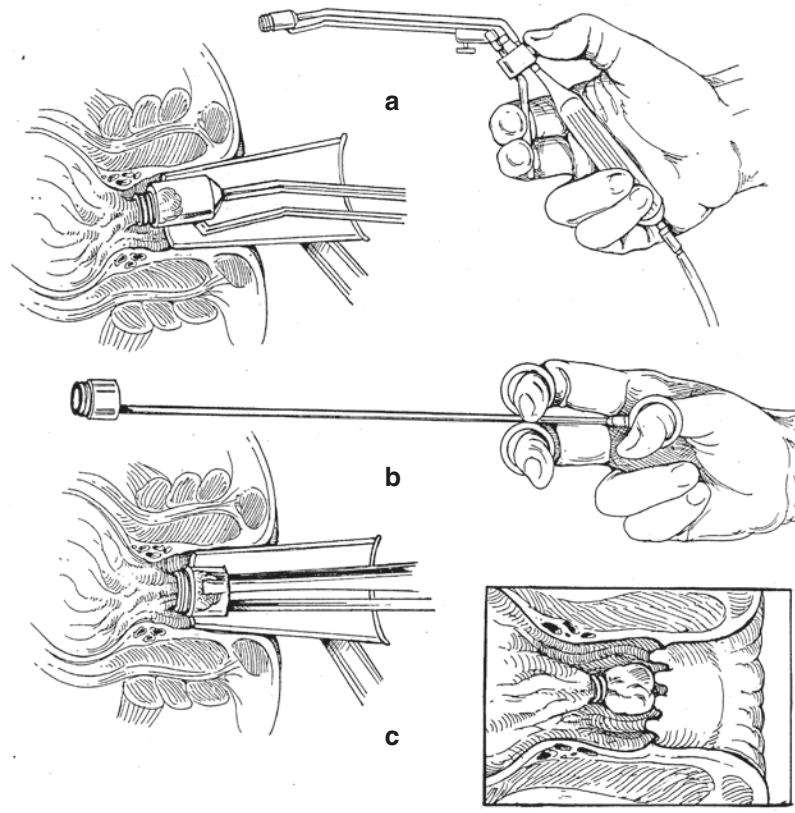


Fig. 17.4 Banding an internal hemorrhoid. The internal hemorrhoid is teased into the barrel of the ligating gun with (**a**), a suction (McGown) ligator, or (**b**), a McGivney ligator. (**c**) The apex of the banded hemorrhoid is well above the dentate line in order to minimize pain

A suction ligator (McGown, Pembroke Pines, Florida) draws the hemorrhoid bundle into the ligator barrel and closing the handle places the band around the hemorrhoidal tissue. With a Barron or McGivney ligator (Electro-Surgical Instrument Co, Rochester, NY), an atraumatic clamp (Fig. 17.4) is used to retract mucosa and redundant hemorrhoidal tissue at the apex of the bundle into the applicator and a small rubber band is placed. This tight band causes ischemia of the enclosed tissue. After it necroses, the tissue sloughs, forming a small ulcer. Excess tissue is eliminated and as healing occurs, the remaining lining becomes fixed in the anal canal. Rubber band ligation works best for Grade 2–3 internal hemorrhoids.

Several points require additional elaboration. First, it is crucial that the bands be placed on tissue entirely covered by anal mucosa. If bands are placed too distal and include any somatically enervated skin, the patient will develop excruciating pain. The pain is usually so severe that the patient will demand removal of the band. To prevent this from occurring, it is recommended that bands be placed at the apex of the hemorrhoid bundle or just cranial to it. As an additional check, the proposed site of banding is tested by placing a clamp on the mucosa. If the patient feels the pain, the procedure should be abandoned. It is important that the clamp is not pulled after being applied. As the anal and rectal mucosa is sensitive to stretch, traction on the mucosa will produce inappropriate pain.

A second consideration, when using a Barron type ligator, is to resist too forceful retraction of the hemorrhoidal tissue. If pulled too hard, the hemorrhoidal tissue may be torn, resulting in hemorrhage that is sometimes difficult to control. This type of bander also requires two hands and an assistant to stabilize the anoscope during the procedure. The McGown ligator can be used with one hand, but it is more difficult to control the amount of tissue drawn into the bander. Finally some providers preload two bands on the

applicator to ensure tissue constriction and guard against slippage and breakage [5]. Other providers have advocated injecting the pedicle of tissue contained within the band with saline or xylocaine. This injection causes the pedicle to swell, which reduces the chance of the bands slipping off prematurely.

Controversy exists about the appropriate number of hemorrhoidal bundles that can be banded at one session [24]. The author prefers to treat one or two bundles at a time. Banding this number eliminates symptoms in most patients, does not produce too large an amount of banded tissue in the anal canal or cause excessive discomfort, and probably leads to efficient care [25, 26].

Before leaving the office, patients are instructed both verbally and in writing that after banding they may experience a feeling of incomplete evacuation. The sensation of fullness is from the bunched tissue in the anal canal. If the urge to defecate or urinate is noted, patients are instructed to sit and try to pass the stool. If no stool is produced, they should refrain from prolonged straining. At 5–7 days after treatment the bands and necrotic tissue will slough which may be associated with a small amount of bleeding. If the symptoms have not resolved at reexamination 2–6 weeks later, additional bands are placed. Normal activities can otherwise be resumed immediately after banding.

Complications are infrequent with rubber band ligation (<2%) [17]. They vary from transient problems such as a vasovagal response on placement of the bands, to anal pain, or rarely pelvic sepsis. The vasovagal response to banding includes diaphoresis, bradycardia, nausea and mild hypotension. Reassuring the patient, elevating their feet, and applying a cold compress to the patient's forehead are frequently all that is necessary. Symptoms should resolve in 10–15 min. Despite the rarity of pelvic sepsis, the devastating sequelae make it worthwhile to explain the heralding symptoms as part of the office discharge instructions. Accordingly, patients must know that if the pain increases instead of decreases, urinary retention or fever develop, they should immediately contact their physician.

Pain occurs due to incorporation of somatically enervated tissue into the band. This occurs when the band is placed too close to the dentate line or the internal sphincter muscle is included into the band (i.e. too much tissue included within the band). In this case, the pain is acute in onset at the time of banding. Mild pain can be managed with analgesics such as propoxyphene napsylate and acetaminophen or injection of a local anesthetic (e.g. 0.5% xylocaine hydrochloride or 0.25% bupivacaine hydrochloride). More intense pain is best managed by removal of the band by hooked scissors or a hooked cutting probe (Fig. 17.5). Most patients will require injection of local anesthetic in order to remove the band. Pain and swelling that develop several hours after banding may be due to edema and thrombosis distal to the banded area, which can usually be managed by conservative measures. Increasing rather than decreasing pain may require emergency evaluation by the surgeon.

Not infrequently, younger patients with high anal tone may experience mild to severe anismus. Also, fear of pain may cause patients to delay defecation as long as possible, leading to harder stools that are more difficult to pass. For these reasons patients should be carefully counseled as to what to expect after banding. Fecal impaction is best avoided by limiting narcotic use, adding stool softeners and maintaining adequate hydration.

Secondary thrombosis of external hemorrhoids may occur in 2–11% of patients [27]. As with spontaneous thrombosis, mild symptoms can be treated with topical preparations and Sitz baths. More severe complaints may require excision. Urinary retention is not common with rubber band ligation. When it does occur, onset is shortly after banding and will often resolve spon-

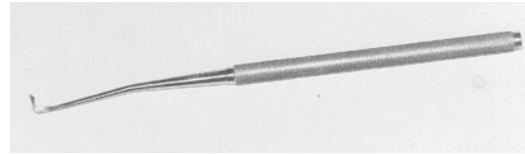


Fig. 17.5 Hooked probe for use in cutting misplaced rubber bands

taneously, or may require one time catheterization. The development of difficult urination or urinary retention days after the procedure may herald pelvic sepsis as described below.

Delayed hemorrhage may also occur, usually 7–10 days postprocedure as the banded tissue sloughs. Patients should be cautioned that they might notice a small amount of bleeding which usually requires no treatment. Major bleeding is fortunately very rare, 0.5% out of 600 patients reviewed by Rothberg and others [27, 28]. Significant bleeding demands immediate attention and may require suture ligation in the operating room. To minimize the risk of hemorrhage after banding, some providers ask their patients to refrain from any aspirin products before and after banding. However, little prospective data are available on the risks associated with aspirin use and post-banding hemorrhage. The experience with other anticoagulants such as warfarin is even less. With the increasing use and need for anticoagulants, individual decisions must be made on the risks of stopping the anticoagulant and potential thrombosis compared to the risk of bleeding while remaining on the medication. The author currently bands patients on anticoagulation and has not seen significant post banding bleeding.

The most serious complication is post-banding sepsis, which is believed related to necrosis from the banded tissue, allowing adjacent soft tissue to become infected [2]. First reported in 1980, it is associated with fever, perineal or pelvic pain or both, and difficulty urinating [29, 30]. Development of these symptoms after banding mandates urgent evaluation. A pelvic CT scan will often demonstrate changes compatible with pelvic sepsis. Some patients may require an anesthetic to adequately evaluate the perineum. Large doses of broad-spectrum antibiotics to include Clostridial coverage are indicated for empirical treatment to reduce the risk of potentially fatal sepsis. Operative debridement and removal of the bands is reasonable, and in cases of overwhelming infections a diverting colostomy may also be required [17]. This problem is discussed in greater detail in Chap. 10.

The results with rubber band ligation have been excellent with patient satisfaction of 80–91% in large series, but probably only 60–70% of patients have been completely cured of symptoms by one treatment session [31–33]. If two banding sessions do not ameliorate the symptoms, an alternative form of therapy (hemorrhoidectomy) should be contemplated.

Infrared Photocoagulation

A newer technique, first described by Neiger [34], is photocoagulation. Infrared radiation, generated by a tungsten-halogen lamp, is focused onto the hemorrhoidal tissue from a gold-plated reflector housing through a solid quartz glass light guide (Redfield Corporation, Montvale, NJ) using technology similar to laser devices [2]. The infrared coagulator (IRC) (Fig. 17.6) light penetrates tissue to the submucosal level and is converted to heat, leading to inflammation, destruction, and eventual scarring of the treated area [35]. The tip of the instrument is applied to the base of the hemorrhoid and a 1–1.5 s pulse of energy is delivered. This produces an immediate area of coagulation of 3–4 mm^2 in diameter. This area ulcerates and eventually scars over the subsequent 2 weeks. Three or four applications are applied to the base of each treated hemorrhoid (Fig. 17.7). Most authors have recommended treating only one or two bundles per visit. Additional treatment if necessary can be performed every 3–4 weeks. However, clinicians need to be aware that Medicare has placed a 90-day global on reimbursement for IRC.

Fig. 17.6 Infrared photocoagulator

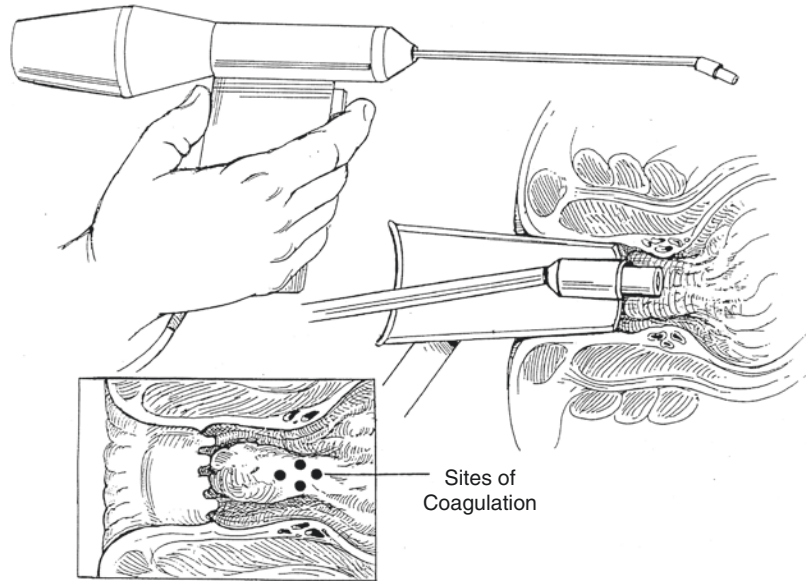


Fig. 17.7 The infrared photocoagulator creates a small thermal injury. Thus several applications are required for each hemorrhoidal column (From Beck DE. Hemorrhoids. In Beck DE. (ed) Handbook of Colorectal Surgery. 3rd ed. JP Medical, London, 2013. With permission)

Complications with this technique have been infrequent. Pain can occur if the energy is inappropriately delivered to the anoderm rather than the base of the hemorrhoid (Fig. 17.5). Excessive application can also lead to bleeding. Most authors report the incidence of bleeding is considerably less with photocoagulation compared with banding [5]. In one study of 51 patients, three developed anal fissures after treatment, and no other complications were noted after a median follow-up of 8 months [36]. As mentioned, ulcer formation is an expected result of both rubber band ligation as well as IRC. The resultant scarring creates fixation. However, large ulcers may rarely be associated with fissure formation and persistent complaints.

The IRC works best on patients with small bleeding hemorrhoids (first or second degree). The number of bundles treated is similar to that described for banding. An advantage of this technique is that the maximum discomfort occurs at the time of IRC treatment and not at a later time as seen with incorrectly placed bands. Disadvantages of this technique are the cost of the instrument is significantly higher than a bander and this method is less effective in eliminating bulky hemorrhoids [17].

Sclerotherapy

Sclerotherapy, one of the oldest forms of therapy, aims to cause scaring, thereby fixation, and eventual shrinking of hemorrhoidal tissue. Sclerotherapy works by obliterating the vascularity of the hemorrhoids, fixing them to the adjacent anorectal muscularis propria and preventing prolapse. In 1869, John Morgan described injection of iron persulphate into external hemorrhoids [37]. Since then, various substances have been used [38]. Quinine and urea (5% solution), phenol (5% in almond oil), and sodium tetradecyl sulfate (1–3% solution) are the agents currently in use. Most practitioners inject three to five milliliters of the sclerosing solution into the submucosa of each hemorrhoidal bundle, 1 cm or more above the dentate line using a 25-gauge spinal needle or a specialized hemorrhoid (Gabriel) needle. The proper site of injection is just proximal to the hemorrhoidal plexus and the injection should be sufficiently deep to not blanch the mucosa, but not too deep as to injure the underlying muscle. Pain occurs if the needle is too deep causing spasm of the sphincter muscle or too distal in the anal canal with sclerosant irritating the sensitive somatic nerves distal to the dentate line [2]. Contraindications to sclerotherapy include inflammatory bowel disease, portal hypertension,

immunocompromised states, anorectal infection, and prolapsed thrombosed hemorrhoids [2].

Complications of sclerotherapy are related to incorrect placement or excess injection of sclerosing agent [17]. The most frequent problem is superficial sloughing of the hemorrhoidal mucosa, which generally heals without treatment. Excessive sloughing may lead to scarring and stricture. Sclerotherapy may also precipitate thrombosis of an adjacent hemorrhoidal complex. If the thrombosis is severe, it may require excision. Most patients, however, can be managed with Sitz baths, a high fiber diet, and local measures. Due to the potential for scarring and stricture, repetitive use of sclerotherapy is not recommended. More unusual complications of sclerotherapy are abscess or oleoma, a granulomatous reaction to an oil-based sclerosant [30].

Results of sclerotherapy have been sparsely reported and difficult to compare to other forms of treatment [2]. Alexander-Williams and Crapp [39] compared injection to freezing and rubber band ligation and found it "satisfactory" over short-term follow-up in Grade 1 (first degree) hemorrhoids. Denckner and associates [40] compared sclerotherapy to a variety of other treatments and found it to be satisfactory in only 21% of patients. Although the results produced by this method are similar to IRC, sclerotherapy is being used with less frequency. Similar to IRC, sclerotherapy works best for Grade 1 or 2 hemorrhoids [6].

Cryotherapy

Cryotherapy is discussed for completeness, but it is infrequently used. Through a cryoprobe inserted into the anus, cold (liquid nitrogen) is delivered to freeze a hemorrhoidal bundle. One disadvantage is the inability to control the amount of destruction that occurs. A prolonged, necrotic tissue slough results, causing increased pain and an unpleasant anal discharge [28].

Cryotherapy is based on rapid freezing and thawing of tissue, which theoretically causes analgesia and tissue destruction. The "ice ball" that forms around the cryoprobe approximates the extent of tissue destruction. Although initial reports were optimistic [41, 42], subsequent experience demonstrated significant problems [2, 17]. After therapy, patients experienced significant pain and a profuse foul discharge from the treatment sites. Healing frequently took 6 weeks or more [43]. Smith and colleagues [44] randomly treated 26 hemorrhoid patients with cryotherapy on one side of the anus and a closed hemorrhoidectomy on the other side. Pain was more prolonged and a foul-smelling discharge persisted on the cryotherapy side, and six of the seven patients who required additional treatment needed it at the cryosurgical site [44]. The expensive cumbersome equipment and significant side effects have led to almost total abandonment of this technique.

Electrocautery

Bipolar and direct current devices are currently available for electrocautery. **Bipolar diathermy** uses a bipolar radio frequency (RF) electric current to generate a coagulum of tissue at the end of a cautery-tipped applicator (Circon ACMI, Stamford, CT). Patient grounding is not necessary and a 2-s pulse is applied to the base of each hemorrhoid. Yang and colleagues treated 25 patients with bipolar electrocautery (BPEC) in a prospective controlled trial [45]. Ulcerations developed in six patients (24%) and caused minor rectal pain and self-limited fever. One patient experienced prolonged pain lasting greater than 1 day after therapy and two patients (8%) developed uncontrolled bleeding. In another study of 51 patients, fissures were seen in 2 patients (4%) [36]. This technique has not been widely accepted because of the expense of the equipment and lack of results superior to results with other methods.

Direct current therapy uses a special probe (Ultroid, Microvasive, Watertown, MA) to deliver an electrical current (of up to 16 mA) to the internal hemorrhoid. The technique entails delivering the current for up to 10 min to each hemorrhoid. In the randomized study of 25 patients by Yang et al. [45], 5 patients (20%) had to have the procedure terminated due to pain, 4 patients (16%) had prolonged pain after the procedure, and 1 patient (4%) had uncontrolled bleeding. The equipment for both methods is expensive, and neither method offers any advantage over the methods previously described [17].

Dilatation

In 1968, Lord described his technique of dilatation for the treatment of symptomatic

hemorrhoids [46, 47]. The treatment is based on the premise that increased anal pressure contributes to hemorrhoid symptoms [13]. The procedure entails careful but firm dilatation of the anal canal. Two lubricated fingers of the surgeon's hand are inserted into the anorectum and the anus is pulled laterally, then two fingers of the other hand are inserted and counter traction is applied. With increasing dilatation and traction additional fingers are inserted until the lower rectum can accommodate up to eight of the operator's fingers. The amount of dilation varies: the purpose is to dilate and "iron out" the anorectum until no "constrictors" remain. Lord cautions that it is safer to do too little than too much. Patients were also instructed to use a dilating cone after the procedure. The necessity of this postoperative dilation has been questioned [13]. Although used extensively in Europe with excellent results, some patients complain of incontinence after the procedure. An unacceptably high rate of incontinence occurred in 40% of patients during the first month after dilatation in one study [48]. Fortunately most episodes were minor and resolved with additional follow-up. This treatment option has not gained wide acceptance in North America [13]. A new a variation on dilatation uses a hydrostatic balloon dilator, which allows the operator to control the pressure and volume in a more graduated and reproducible fashion.

Internal Anal Sphincterotomy

This treatment has been recommended for hemorrhoids for precisely the same theories to which Lord subscribed. Sphincterotomy seems an inherently more controlled technique to lower anal pressure [49]. The technique may be done under local anesthesia, but in 25% of cases, some degree of minor transient incontinence may occur [50]. However, sphincterotomy does not address associated tags or external hemorrhoids.

A controlled study by Arabi and colleagues [50] showed no improvement in results when an internal anal sphoncterotomy was compared to rubber band ligation in early hemorrhoids, and Shouten and van Vroonhoven [51] demonstrated only a 75% success rate with sphincterotomy alone. Leong and colleagues found no improvement when internal sphincterptomy was combined with other procedures such as hemorrhoidectomy [52]. Although sphincterotomy may be reasonable in the surgical treatment of hemorrhoids with concomitant anal fissure, neither the author nor editors recommend its use as the sole treatment for isolated hemorrhoidal disease [2]. In addition, most surgeons would be very hesitant to perform sphincterotomy in patients with lax sphincters or in elderly patients for hemorrhoidal symptoms.

Stapled Rectopexy or Procedure for Prolapse and Hemorrhoids (PPH)

Stapled rectopexy, also referred to as Procedure for Prolapse and Hemorrhoids (PPH), involves transanal, circular stapling of redundant anorectal mucosa with a modified circular stapling instrument (Proximate PPH 03, Ethicon Endosurgery, Cincinnati, OH or HEM 3348, Covidien, Minneapolis, MN). There is continued debate about the mechanisms by which this procedure relieves symptoms. As hemorrhoids are thought to be redundant fibrovascular cushions, most treatments reduce blood flow and remove redundant tissue. Stapled rectopexy is thought to work by similar mechanisms. Redundant mucosa is drawn into the instruction and excised within the "stapled doughnut." Additionally, mucosal and submucosal blood flow is interrupted by the circular staple line. No incisions are made in the somatically innervated, highly sensitive anoderm, which significantly reduces postoperative pain. The procedure involves techniques that are different from more common surgical procedures. Proper technique with meticulous attention to detail is required to get a successful result and avoid the serious complications that have been reported.

Patients are prepared as for a standard hemorrhoidectomy with partial or complete mechanical bowel preparation. General, spinal, and local anesthesia have all been described. Patients may be positioned in prone, lithotomy, or Sim's position depending upon the surgeon's preference.

After thorough examination of the anal canal and perianal tissues, a specially designed anoscope in inserted and a pursestring suture is placed. The pursestring should be 2–4 cm proximal to the dentate line and include only mucosa and submucosa. Suture "bites" should be close together as large gaps will allow redundant mucosa to evade

the stapler resulting in persistent hemorrhoids. Most surgeons place eight bites of the pursestring suture. The circular stapling instrument is then introduced (usually a 33 mm), fully opened, into the anal canal, and the suture tightened between the anvil and shaft of the instrument. Ends of the suture are drawn through slots of the stapler drawing distal redundant mucosal proximally into the jaws of the stapler. After tightening the stapler, a finger is placed transvaginally in females to assure that the anovaginal septum has not been included within the stapler. The stapler is then fired and removed (Fig. 17.8). Following this, the staple line is inspected for gaps and particularly for bleeding points, which can then be cauterized or oversewn. Some authors routinely place three figure of eight sutures at the location of the primary hemorrhoidal bundles to minimize the chances of postoperative bleeding.

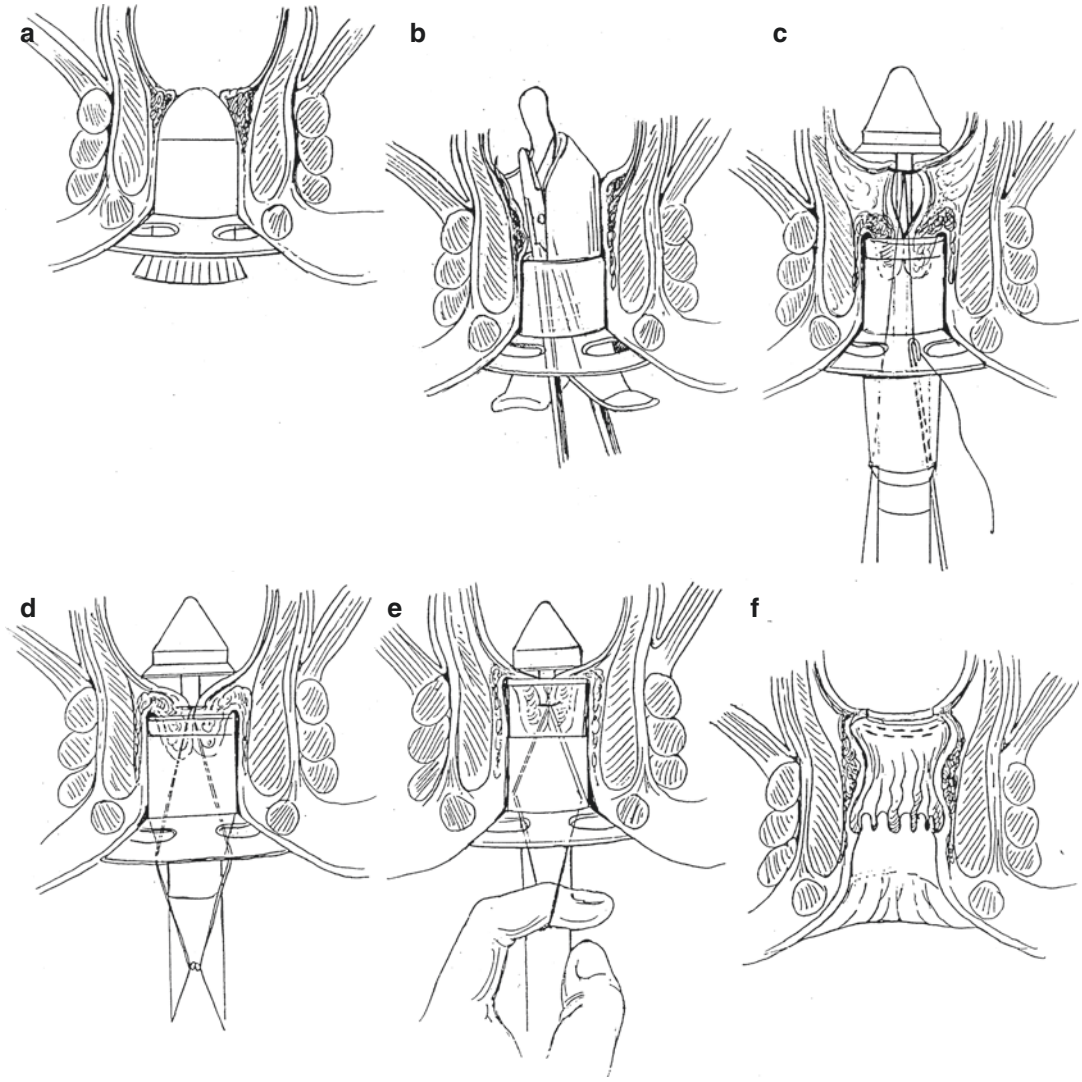


Fig. 17.8 Stapled rectoplasty (procedure for prolapse and hemorrhoids [PPH]). (**a**) Retracting anoscope and dilator inserted. (**b**) Monofilament pursestring suture (eight bites) placed using operating anoscope approximately 3–4 cm above anal verge. (**c**) Stapler inserted through pursestring. Pursestring suture tied and ends of suture manipulated through stapler. (**d**) Retracting on suture pulls anorectal mucosa into stapler. (**e**) Stapler closed and fired. (**f**) Completed procedure

A meta-analysis of randomized trials between 2000 and 2013 comparing Milligan-Morgan to PPH, identified 1343 patients. The PPH had shorter operative time, duration of hospitalization, and return to normal activity. PPH had better patient satisfaction, but higher rate of prolapsed and need for subsequent surgery [53]. A multicenter prospective controlled trial with long-term follow-up compared stapled rectopexy to a modified Ferguson technique [54]. The authors demonstrated that stapled rectopexy offered less postoperative pain, less requirement for analgesics, and less pain at first bowel movement, while providing similar control of symptoms and need for additional hemorrhoid treatment at 1-year follow-up from surgery.

In summary, stapled rectopexy is a technique available to patients otherwise requiring surgical hemorrhoidectomy. In published studies, stapled rectopexy it is associated with significantly less pain and similar complication rates when compared to conventional treatment. Considering the technique, however, the potential for disastrous complications may be higher (rectovaginal or rectourethral fistula due to including too much tissue within the purse-string). Bleeding also remains a problem and cases of perforation and leaks have been reported. It is also important to note that stapled rectopexy has not been compared to office treatments for grade I and II hemorrhoids and should not replace these techniques for minimally symptomatic hemorrhoid disease. The proven decreased pain of PPH as compared to excisional hemorrhoidectomy may justify its use despite a potentially increased incidence and spectrum of serious complications and recurrence. If the PPH approach is desired, meticulous surgical technique is mandatory.

Transanal Hemorrhoidal Dearterialization (THD)

A newer addition to surgical armamentarium is **Doppler-guided arterial ligation with hemorrhoidopexy** (Fig. 17.9) [56]. The technique has evolved and currently uses a Doppler-guided ligation of hemorrhoidal arterial inflow with a suture rectopexy. There are currently two commercial products available in the US [57]. Transanal hemorrhoidal dearterialization (THD, American Ankeny IA) and hemorrhoidal artery ligation and recto anal repair (HAL/RAR, A.M.I, Inc., Natck, MA). These non excisional techniques rely on detection and ligation of the branches of the superior hemorrhoidal artery in the mucosa that lacks sensation, well above the dentate line. The associated suture rectopexy reduces the redundant prolapsing mucosa and internal hemorrhoids.

The procedure is performed in the operating room and requires anesthesia similar to a traditional hemorrhoidectomy. A specially designed anoscope with a removable Doppler ultrasound probe and a slot for suture placement is used. After insertion, the anoscope is rotated until one of the arterial branches is located. Through the anoscope slot the vessel is suture ligated (2–3 cm above the dentate line). Loss of the Doppler signal confirms accurate placement of the ligating suture. After ligating the vessel, the suture is used to oversew the internal hemorrhoid with a running technique from proximal to distal direction. The suture is completed proximal to the dentate line to minimize pain. Usually four to six arteries are ligated and depending on the patient's anatomy and two to four hemorrhoids and fixated.

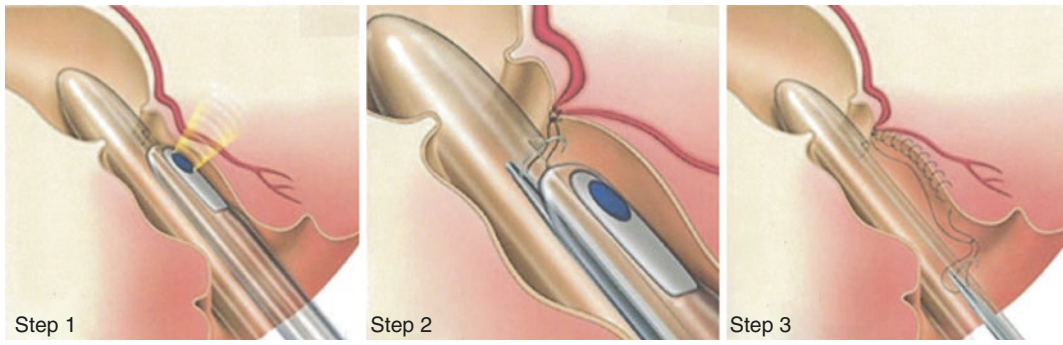


Fig. 17.9 Transanal hemorrhoidal dearterialization (THD) device

The operation has a short operating time and purports to accomplish the same goals as a stapled hemorrhoidopexy [56]. It is an operative procedure which includes anesthesia risks, operating room expense, and surgical risks of bleeding, infection, urinary retention, hematoma, and postoperative pain. The specialized anoscope and Doppler probe are disposable and add cost to the procedure which is somewhat less than a stapled hemorrhoidopexy. A variety of publications have documented safety, reduced pain and short recovery with the technique [58]. It appears effective for grades 2 and 3 hemorrhoids, but long-term results and cost-benefit analysis need additional study.

External Hemorrhoids

Acute Thrombosis

The management of **thrombosed external hemorrhoids** depends on when in the course of the disease the patient presents [5]. The natural course of this condition starts with thrombosis of an external hemorrhoid. This event is often associated with effort or straining (moving or lifting furniture, heavy exercise, etc.). The tissue around these clots swells causing moderate to severe pain. If not treated, in 2–4 weeks, the clot in the thrombosed vessels will either spontaneously drain through the thinned overlying skin or be gradually resorbed and the discomfort will gradually diminish. After resolution, redundant anal skin will remain which is usually asymptomatic and requires no treatment. If a tag causes irritation or difficulty in cleansing the anal area, a conservative excision under local anesthesia can be performed in the office.

If symptoms have stabilized or are improving, nonoperative care including stool bulking agents and pain medication are indicated. The patient should be reassured that the symptoms will resolve in 1–2 weeks. If the patient presents early, the procedure of choice is excision (Fig. 17.10). The remaining wound may be left open or closed. The goal with excision is to remove the clots and leave a cosmetically pleasing wound. The proce-

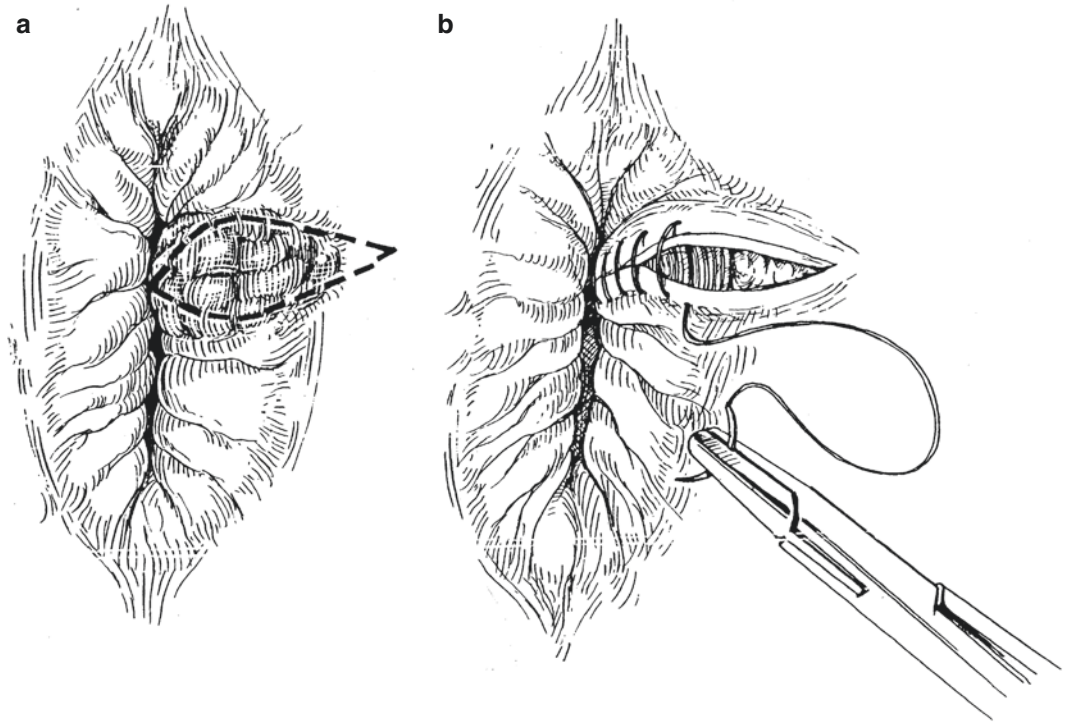


Fig. 17.10 Thrombosed external hemorrhoid. (**a**) Site of incision. (**b**) Running stitch for wound closure (From Beck DE. Hemorrhoids. In Beck DE. (ed) Handbook of Colorectal Surgery. 3rd ed. JP Medical, London, 2013. With permission)

dure can be performed with local anesthesia. Incision and drainage has no role as it removes only a portion of the clot, may not adequately relieve symptoms, and leaves excess skin when healing occurs.

Operative Hemorrhoidectomy

For symptomatic combined external and internal hemorrhoids, a hemorrhoidectomy is indicated [59, 60]. Several different **operative techniques** have been described [13]. Each of these procedures can be performed with general, spinal or local anesthesia. The choice must be individualized for each patient, but the national trend is toward local anesthesia. With a general anesthetic, the author prefers the Sims' (left lateral decubitus) (Fig. 2.1) position, although the editor (SDW) prefers the prone jack-knife position. With all other anesthetics, the prone jackknife position is used (Fig. 2.1). The anus is prepared with a povidone-iodine solution. If a local anesthetic (1% xylocaine with 1:100,000 epinephrine) is not being used, the anal submucosa is infiltrated with plain 1:100,000 epinephrine solution. The perineum is re-prepped and draped. An examination confirms the preoperative findings and determines the number of hemorrhoidal bundles to be excised.

The preferred procedure of both the author and editors is a **modified closed Ferguson technique** [13, 61]. A medium or large Hill-Ferguson or Fansler retractor placed in the anus exposes a hemorrhoidal bundle. A double elliptical incision is made in the mucosa (Fig. 17.11). For a pleasing cosmetic result, the incision should be at least three times as long as

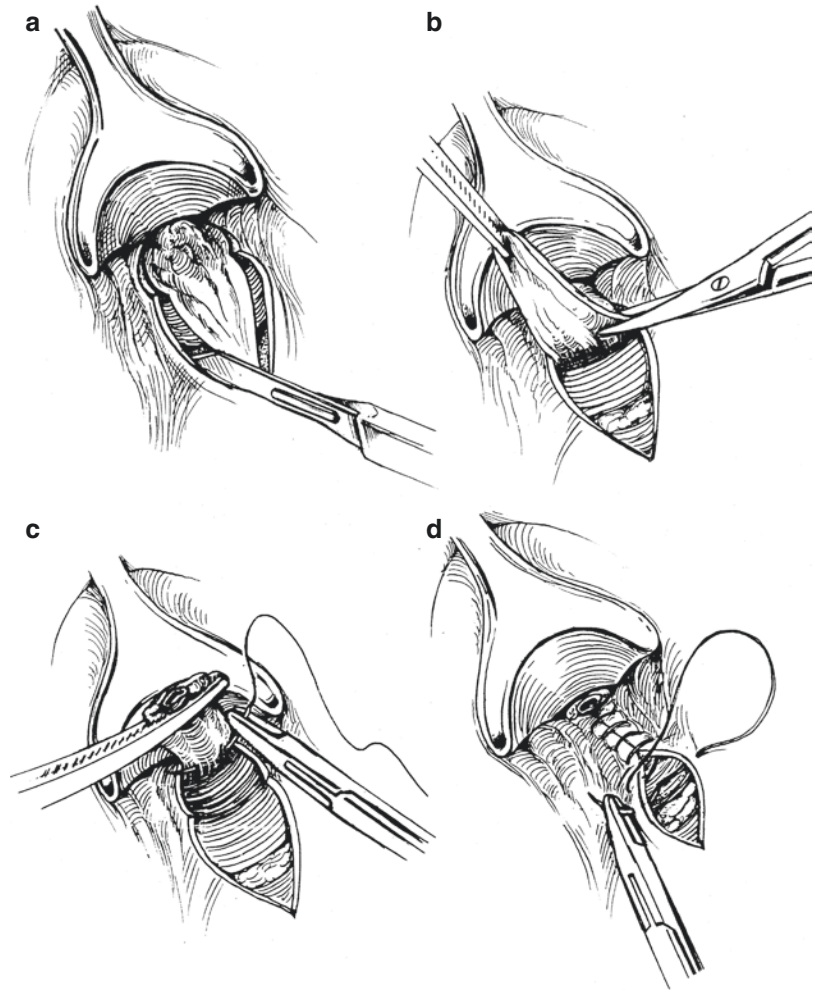


Fig. 17.11 Excisional hemorrhoidectomy. (**a**) Double elliptical incision made in mucosa and anoderm around hemorrhoid bundle with a scalpel. (**b**) The hemorrhoid dissection is carefully continued cephalad by dissecting the sphincter away from the hemorrhoid. (**c**) After dissection of the hemorrhoid to its pedicle, it is either clamped, secured, or excised. The pedicle is suture ligated. (**d**) The wound is closed with a running stitch. Excessive traction on the suture is avoided to prevent forming dog ears or displacing the anoderm caudally

it is wide. The distal edge is grasped with a fine-toothed pickup and the dissection is performed with scissors. Dissection in the proper plane results in elevation of all the varicosities with the specimen, while the sphincter muscles remain in their normal anatomic position. With the previously scored mucosa as a guide, the dissection is continued into the anal canal.

At the superior edge of the hemorrhoidal bundle, the remaining vascular pedicle is clamped and the hemorrhoid is detached. The editor (SDW) does not clamp the pedicle, but does ligate it. The hemorrhoid specimen should be sent for pathologic evaluation. In the absence of suspicion or some abnormality, it may be unnecessary to separately label each bundle (i.e. left lateral, right posterior) [13, 62]. Any bleeding vessels are cauterized with the electrocautery. An absorbable suture (e.g. 3-0 Vicryl) is utilized to suture ligate the pedicle beneath the clamp. This suture is then used to reapproximate the mucosal edges. It is important to take small bites at the edge of the mucosa and a small bite of the sphincter with each bite. This running suture is continued to close the wound and eliminate dead space. As sutures are placed, the mucosa is advanced in a cranial direction to reestablish the normal anal anatomy and result in a "plastic" closure. At the outer edge, the suture is loosely tied to itself to provide an escape for any hematoma developing after surgery. The other hemorrhoidal bundles are handled in a similar manner. The number of bundles that are excised will depend on the amount of excess tissue but usually should not involve more than three columns. The procedure preserves bridges of anoderm between the major bundles and maintains the dentate line in its anatomic position. Technique variations include the use of electrocautery instead of scissor excision and elimination of the pedicle stitch.

At St. Marks Hospital, Milligan et al. [63] popularized an **open technique** of hemorrhoidectomy, which was widely adopted. The procedure starts with gentle anal canal dilatation to two or three fingers. The hemorrhoidal complex is then everted by traction on a forceps placed just beyond the mucocutaneous junction. Additional forceps can then be placed toward the level of the anorectal ring. The hemorrhoid is excised from the subajacent sphincter and the proximal pedicle is ligated with strong suture material. Three quadrants are usually removed. Hemostasis is accomplished and an anal dressing is applied. Care must be taken to ensure that adequate islands of anoderm are retained to prevent anal stenosis with healing of the open hemorrhoid wounds [13].

Another operative technique, described by Whitehead [64], used a circumferential incision made at the level of the dentate line. Submucosal and subdermal hemorrhoidal tissue was dissected out and excised. After redundant rectal mucosa was removed, the proximal rectal mucosa was sutured circumferentially to the anoderm. While Whitehead described good results with his procedure, many surgeons who attempted the procedure encountered problems. When performed improperly, the procedure was associated with high rates of stricture, loss of normal sensation, and the development of ectropion commonly referred to as the "Whitehead deformity" (Fig. 17.12). These postoperative complications are often challenging to correct. Common mistakes in performing the Whitehead procedure include excising excess anoderm and fail to recreate the dentate line in the correct location. Despite its poor reputation, some surgeons have obtained good results after modifying and simplifying the procedure [65].

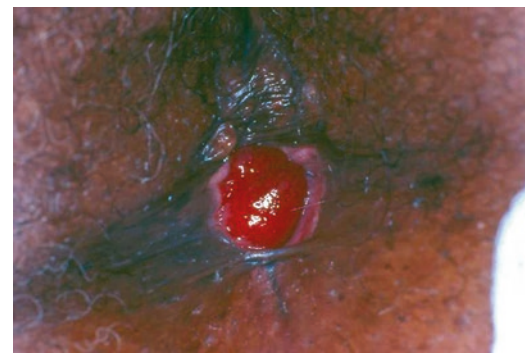


Fig. 17.12 Completely circumferential anal ectropion (classic "Whitehead" deformity). Courtesy of the American Society of Colon and Rectal Surgeons (ASCRS) Library

The type of hemorrhoidectomy a surgeon performs is based primarily on that surgeon's experience and training; few comparative trials are available. Seow-Choen and Low [66] compared a modified Whitehead hemorrhoidectomy to a modified Ferguson technique (four bundles excised with retention of anodermal bridges) in 28 patients. The four-bundle technique was found to be easier and required less operative time to perform. At 6 months there was no difference in patient perception of success. Recent experience has been directed toward performing hemorrhoidal surgery as outpatient surgery. With the proper support systems, patient preparation, and appropriate technique, hemorrhoidectomy can safely be performed as an outpatient procedure [67].

Acute, incapacitating hemorrhoids consisting of prolapse, thrombosis, and strangulation of hemorrhoidal tissue can involve one or all three primary complexes [13]. Although conservative therapy with bed rest, ice packs, and analgesics has been used with success, an **emergency (acute) hemorrhoidectomy** is preferred by most experienced surgeons. This provides rapid resolution of symptoms and prevents recurrence of hemorrhoidal symptoms. A closed hemorrhoidectomy as described previously is performed. Injection of an epinephrine solution (1:100,000) with 150 units of hyaluronidase (Wydase, Wyeth-Ayerst Laboratories, Philadelphia, PA) into the hemorrhoidal complex produces considerable shrinkage of the tissue and reduction of the edema. This simplifies the operation. Care must again be taken to preserve adequate anoderm. Recovery for these patients is similar to those with less acute disease.

Alternate Energy Sources

Laser hemorrhoidectomy (using a laser rather than a scalpel or scissors to remove the hemorrhoidal tissue) has received a lot of attention. Proponents have claimed that this technique involves less pain and has a better cosmetic result. Both the carbon dioxide (CO2) and the neodymium:yttrium-aluminum-garnet (Nd:YAG) have been used to surgically manage hemorrhoids [13]. Unfortunately, there are very few articles available in the English literature describing excisional hemorrhoidectomy with the laser, and the relatively small number of well-controlled prospective studies have demonstrated no advantage of a laser over traditional techniques [8, 22]. Senagore et al. [68] reported a prospective, randomized study comparing the Nd:YAG to a cold scalpel in 86 patients. Each method resulted in similar degrees of postoperative discomfort, requirements for postoperative analgesia, and time away from work.

Wang et al. [69] reported a randomized trial comparing Nd:YAG laser hemorrhoidectomy to a closed technique in 88 patients. Overall complications were similar, but prolonged wound healing was noted in the laser-treated group. Based on the available evidence, the Standards of Practice Task Force of the American Society of Colon and Rectal Surgeons produced the following statement [70]:

> No controlled trials have yet been completed to demonstrate superiority or even equivalence of the laser to more traditional treatment methods. Isolated reports suggest that the laser can be used with success, but there is as yet no reason to believe that results will be superior to current techniques.

The additional cost and safety requirements of the laser equipment along with the lack of significantly better results argue against its routine use.

Other energy devices (e.g. Ligasure, Covidien, Minneapolis, MN and harmonic scalpel, Ethicon, Cincinnati, OH) have been evaluated to reduce blood loss and pain in hemorrhoidectomy. A Cochrane Systemic Review in 2009 evaluated 12 studies with 1142 patients that had randomized hemorrhoidectomy patients to conventional diathermy to a Ligasure-technique [71]. The authors concluded that the Ligasure technique resulted in less postoperative pain without adverse effect on post-operative complications. A randomized study of 151 patients randomized to harmonic scalpel and Ferguson's with electrocautery found that the harmonic scalpel was safe and effective and resulted in less blood loss and postoperative pain than the Ferguson's with electrocautery [72]. However, none of these studies addressed the cost of the alternate energy devices (several hundred dollars) or their utilization with modern multi-modality pain management (described

below). In the authors experience, the cost of these devices far outweighs any potential advantages.

Postoperative care after hemorrhoidectomy focuses on two areas: prevention of potential complications and relief of pain. Preparing the patients mentally as well as physically aids in both areas. Truthful descriptions of the postoperative recovery allow the patient to develop a sense of relief as well as confidence. Patients are told that pain will occur, but depending on the type of anesthesia, it will not occur for several hours after the procedure and medication will be given to minimize their discomfort.

Several actions have been shown to reduce the incidence of postoperative urinary retention. Intravenous fluids are kept to a minimum during the intraoperative and postoperative period (<250 mL). The patient is asked to attempt to void soon after surgery. An adequate dose of the parasympathomimetic drug bethanecol (10 mg subcutaneously) has been shown to increase the likelihood of spontaneous voiding [73]. Patients who live close to the medical facility and are reliable may be discharged after surgery. They are instructed to return if bleeding or urinary retention occurs. An adequate amount of a strong, preferably non-constipating, oral narcotic is given for outpatient pain control. An alternative is patient controlled anesthesia using a subcutaneous morphine pump [74]. Bulking agents and thrice-daily Sitz baths are also prescribed. If constipation occurs, the patient may be administered a 500-mL warm tap water enema or gentle laxative. Most patients are seen 5–10 days after discharge.

Postoperative complications after hemorrhoid surgery are unusual (Table 17.4) [2, 75, 76]. Hemorrhage, usually at one of the pedicles, represents the most acute problem and occurred in 4% of 500 patients in a study by Buls and Goldberg [77] with a 1% incidence of bleeding severe enough to warrant a return trip to the operating room for suture ligation of a vessel. This agrees with a study from the Ferguson Clinic in which over 2000 hemorrhoidectomies were reviewed [78].

Major hemorrhage usually requires an adequate examination and suture ligation of the bleeding vessel. A 1–2 mL submucosal injection of 1/10,000 adrenaline at the bleeding point has also been successful [79].

Table 17.4 Post-hemorrhoidectomy complications[a]

	Incidence, %[2]
Acute (first 48 h)	
Bleeding	2–4
Bleeding requiring reoperation	0.8–1.3
Urinary retention	10–32
Early (first week)	
Fecal impaction	<1
Wound infection	<1
Thrombosed hemorrhoid	<1
Late	
Skin tags	6.00
Anal stenosis	1.00
Anal fissure	1–2.6
Incontinence	<0.4
Anal fistula	<0.5
"Recurrent" hemorrhoids	<1

[a]>2500 patients

Sepsis related to the wound itself is extremely rare. It is not unusual, however, to see erythemia and drainage from the wound edges. If there is suspicion of infection (fever, increased pain, difficulty voiding) and no obvious other source, the patient should be empirically started on antibiotics and watched carefully. Outpatient observation is acceptable if the patient manifests no signs of toxicity, but severe pain or worsening symptoms should prompt consideration for in-hospital management and careful examination, under anesthesia if necessary.

Postoperative pain is generally moderate in the first 24–48 h, and traditionally controllable by oral or parenteral narcotics. Patients were encouraged to take oral medications such as oxycodone or propoxyphene as soon as possible and informed that while bowel movements will be uncomfortable, they will not be as painful as they have heard from other patients. The use of multimodality pain management has significantly reduced the pain associated with hemorrhoidectomy. A multicenter randomized, double blind placebo-controlled trial of 186 patients undergoing hemorrhoidectomy found that patients receiving an extended-release bupivacaine (Exparel®, Pacira Parsippany, NJ) had significantly less pain through 72 h, decreased opioid requirements and improved patient satisfaction [80]. The addition of intravenous

acetaminophen and Ibuprofen further reduces the need for narcotics and improve the patient experience [81]. The use of warm soaks and stool normalizers (fiber bulking agents) as described in previous sections is also helpful.

Fecal impaction may occur in the first 7–10 days after hemorrhoidectomy and should be suspected if the patient reports watery feculent discharge, rectal pressure, and constipation during the early postoperative period. This problem is best avoided by giving the patient a high fiber diet with added psyllium or another bulking agent two or three times per day for the first several weeks after surgery [82]. An added mild laxative such as mineral oil or milk of magnesia can be offered to help stimulate the first evacuation. Treatment of an impaction should consist of two or three gentle, warm, 500-mL tap water enemas given through a soft latex catheter until the impaction is cleared. Anal pain or inability to clear the impaction by these methods may require manual disimpaction under anesthesia.

If external thrombosis or swelling of the external hemorrhoids occurs subsequent to hemorrhoidectomy, the usual cause is a subcutaneous bleeding vessel. Gentle compression should be applied to the wound for 10 min if it appears to be enlarging. Comfort measures such as Sitz baths, analgesics, and local application of a topical soothing cream may then be used. The area will generally resolve spontaneously, and only rarely require any additional therapy. Tense edema and swelling may require excision of the external hemorrhoid as described earlier, again erring on very conservative removal of the anoderm.

Edematous skin tags, often of concern to patients, should be left alone for 3–4 months since they usually shrink significantly over that time and usually require no treatment beyond reassurance. If tags that are bothersome to the patient remain after that time they can usually be excised in the office using local anesthesia.

Anal stenosis, although rare, may be the most troublesome long-term complication and should nearly always be preventable by conservative removal of anoderm at hemorrhoidectomy. Retention of adequate anoderm to prevent stenosis is confirmed by the ability to close all of the hemorrhoidectomy incisions without tension while a medium Hill-Ferguson retractor remains in the anal canal. Anal stenosis may be treated by simple anal sphincterotomy [83], leaving the longitudinally oriented wound open if scarring is so severe that a closed-type procedure is not possible. When stenosis is severe (will not allow insertion of a lubricated index finger or small Hill-Ferguson retractor at surgery), a plastic surgical correction of the stenosis may be required. Several of these techniques were described in detail in Chap. 14. The author's preference is one or two "House" advancement flaps along with a partial sphincterotomy as needed.

Ectropion may occur by inadvertent removal of anoderm and subsequent caudal displacement of rectal mucosa into the anal canal (Fig. 17.10). This can be avoided by remembering the rule that anoderm may always be safely advanced above the dentate line, but rectal mucosa should rarely be advanced below it. If ectropion does occur postoperatively, the patient may report wetness, itching, and irritation [84]. Most patients, unless entirely asymptomatic, require surgical correction. Treatment, if confined to only one half or less of the anal circumference, may be merely excising the ectopic rectal mucosa, but the author nearly always prefers performing an anoplasty. One or more "House" advancement flaps as described in Chap. 14 work well to close the defect created after the ectopic rectal mucosa is excised.

In cases of circumferential mucosa ectropion, the classic "Whitehead deformity", or in cases where more than 50% of the circumference is involved, the S-anoplasty remains the procedure of choice [85]. As described in Chap. 14, it may be performed on one or both sides of the anus.

Anal fissure may develop in the postoperative period, heralded by pain or burning bowel movements. Often, a degree of stenosis is an associated finding. If fissures occur in the first 3–4 weeks after surgery and are of mild to moderate severity, conservative measures such as Sitz baths, dietary fiber, and topical creams should be adopted. The patient is reassured and advised that soft, bulky stools are necessary to dilate the anal passage naturally and that watery, loose stools can contribute to narrowing of the area. If symptoms are severe, or if conservative measures are not helpful, a careful examination

under anesthesia with a planned sphincterotomy, possibly with an advancement flap anoplasty, may be needed.

Fecal incontinence is an unusual but potentially disastrous complication after hemorrhoidectomy and may occur more frequently than reported in the literature (<1%). Patients at higher risk include the elderly, especially women, and patients who have had prior anal surgery [2]. These patients required a detailed and carefully documented inquiry regarding anal continence. Digital rectal examination at rest and during maximum voluntary squeeze to ascertain sphincter tone, and anal manometry should be used to quantify anal pressures. Patients should be counseled about goals of the surgery, and nonoperative measures reconsidered if bowel control is impaired. At surgery it is acceptable to perform a one- or two-quadrant hemorrhoidectomy, conserving anoderm, and to rubber band ligate the other quadrants or leave them alone. The underlying sphincter should be carefully protected. While this conservative approach may lead to a slightly greater chance for recurrence, patients will understand the concern to protect continence.

Minor incontinence is rare unless an open sphincterotomy is performed concomitantly with hemorrhoidectomy as a "pain relieving" measure. Sphincterotomy should be avoided unless some degree of stenosis is present or when a concomitant fissure is present.

Recurrence of significant hemorrhoidal disease following a closed hemorrhoidectomy is unusual—only 1% in the 2038 patients surveyed by Ganchrow and colleagues [78]. Most symptoms that patients equate with recurrence are either skin tags or small external hemorrhoids, or are related to bleeding of small superficial veins near the hemorrhoidectomy wounds. Tags can be excised in the office under local anesthesia. Bleeding from the internal hemorrhoids is nearly always treatable with rubber band ligation, infrared coagulation, or sclerotherapy.

Special Considerations

Hemorrhoidal disease in **human immunodeficiency virus** (**HIV**) patients deserves additional comment. As discussed in Chap. 26, HIV infection can manifest initially with minimal alterations in health and physiology to complete immunologic failure. The major fear in these patients has been failure to heal and infection. Experience has demonstrated that early stage patients can be treated and expected to respond similar to uninfected patients. Late stage patients even with newer medical treatment for their HIV remain at significant risk of problems and should be managed as conservatively as possible [86, 87]. Most symptoms can be minimized with dietary manipulations or topical medications. If this fails, infrared coagulation has been used in selected patients with reasonable results.

There is no contraindication to hemorrhoid treatment during any stage of **pregnancy** [13]. However, an operative hemorrhoidectomy is usually avoided during pregnancy unless the patient is suffering from acute disease. With acute disease treatment, as described elsewhere, is accomplished along with special attention afforded the fetus. Saleeby et al. [88] reported on 12 of 12,455 pregnant women (0.2%) who had surgical hemorrhoidectomy. Most were in their third trimester of pregnancy and all did well.

Inflammatory bowel disease patients also develop hemorrhoidal disease. Symptoms of the two conditions must be differentiated. In known inflammatory bowel disease patients hemorrhoidal symptoms are usually related to their abnormal bowel movements. The presence of anorectal diseases increases concern about Crohn's disease. Crohn's disease patients should not have hemorrhoidectomies unless absolutely necessary, but in selected patients good results can be obtained [89]. In ulcerative colitic patients a safe hemorrhoidectomy can be performed if the colitis is under control [13].

Summary

Understanding of the pathophysiology of hemorrhoidal disease guides treatment selection. The author's preferred treatment plan is summarized in Table 17.5. A recent meta-analysis of hemorrhoidal treatment modalities supports this approach [90]. Appropriate treatments provide symptom resolution in a safe and cost effective manner.

Table 17.5 Author's treatment plan

Symptomatic internal hemorrhoids (bleeding)
1. Trial of supplemental fiber (i.e. Konsyl™, Citrucel ™, Fibercon ™);
2. If symptoms do not resolve, then perform rubber band ligation;
3. Repeat ligation in 1–6 months if symptoms improving and minimal discomfort with prior banding;
4. If discomfort with banding, consider infrared photocoagulation;
5. If symptoms persist, consider operative hemorrhoidectomy.
Symptomatic external or combined hemorrhoids
1. Operative hemorrhoidectomy (modified Ferguson technique) with local or regional anesthesia

References

1. Beck DE. Hemorrhoids. In: Beck DE, Welling DR, editors. Patient care in colorectal surgery. Boston: Little, Brown; 1991. p. 213–24.
2. Milsom JW. Hemorrhoidal disease. In: Beck DE, Wexner SD, editors. Fundamentals of anorectal surgery. New York: McGraw-Hill; 1992. p. 192–214.
3. Dirckx JH. The biblical plague of "hemorrhoids". Am J Dermatopathol. 1985;7:341–6.
4. Maimonides M. Treatise on hemorrhoids (Rosner F, Munter S, trans). Philadelphia: J.B. Lippincott; 1969.
5. Beck DE. Hemorrhoids. In: Beck DE, editor. Handbook of colorectal surgery. St. Louis: Quality Medical Publishing; 1997. p. 299–311.
6. Thompson WHF. The nature of hemorrhoids. Br J Surg. 1975;62:542–52.
7. Thulesius O, Gjores JE. Arterio-venous anastomoses in the anal region with reference to the pathogenesis and treatment of hemorrhoides. Acta Chir Scand. 1973;139:476–8.
8. Burkitt DP, Grahm-Stewart CW. Hemorrhoids-postulated pathogenesis and proposed prevention. Postgrad Med J. 1975;51:631–6.
9. Sonneberg A, Koch TR. Epidemiology of constipation in the United States. Dis Colon Rectum. 1989;32:1–8.
10. Haas PA, Fox TA, Haas GP. The pathogenesis of hemorrhoids. Dis Colon Rectum. 1984;27:442–50.
11. Johansson JF, Sonneberg A. The prevalence of hemorrhoids and chronic constipation: an epidemiologic study. Gastroenterology. 1990;98:380–6.
12. Hancock BD. Internal sphincter and the nature of haemorrhoids. Gut. 1977;18:651–5.
13. Mazier WP. Hemorrhoids. In: Maxier WP, Levin DH, Luchtefeld MA, Senagore AJ, editors. Surgery of the colon, rectum and anus. Philadelphia: W.B. Saunders; 1995. p. 229–54.
14. Nelson RL, Abcarian H, Davis FG, Persky V. Prevalence of benign anorectal disease in a randomly selected population. Dis Colon Rectum. 1995;38:341–244.
15. Corman ML. Colon and rectal surgery. 2nd ed. Philadelphia: J.B. Lippincott; 1989. p. 49–105.
16. Kluiber RM, Wolf BG. Evaluation of anemia caused by hemorrhoidal bleeding. Dis Colon Rectum. 1994;37:1006–7.
17. Larach S, Cataldo TE, Beck DE. Nonoperative treatment of hemorrhoidal disease. In: Hicks TC, Beck DE, Opelka FG, Timmcke AE, editors. Complications of colon and rectal surgery. Baltimore: Williams & Wilkins; 1997. p. 173–80.
18. Moesgaard F, Nielsen ML, Hansen JB, Knudsen JT. High fiber diet reduces bleeding and pain in patients with hemorrhoids. Dis Colon Rectum. 1982;25:454–6.
19. Alonso-Coello P, Zhou Q, Martinez-Zapata MJ, Mills E, Heels-Ansdell D, Johanson JF, Guyatt G. Meta-analysis of flavonoids for the treatment of haemorrhoids. Br J Surg. 2006;93(8):909–20.
20. Dodi G, Bogoni F, Infantino A, et al. Hot or cold in anal pain? A study of the changes in internal sphincter pressure profiles. Dis Colon Rectum. 1986;29:248–51.
21. Gorfine SR. Treatment of benign anal disease with topical nitroglycerin. Dis Colon Rectum. 1995;38:453–7.
22. Blaisdell PC. Prevention of massive hemorrhage secondary to hemorrhoidectomy. Surg Gynecol Obstet. 1958;106:485–8.
23. Barron J. Office ligation treatment of hemorrhoids. Dis Colon Rectum. 1963;6:109–13.
24. Lee HH, Spencer RJ, Beart RW. Multiple hemorrhoidal banding in single session. Dis Colon Rectum. 1994;37:37–41.
25. Lau WY, Chow HP, Dorn GP, Wong SH. Rubber band ligation of three primary hemorrhoids in a single session. Dis Colon Rectum. 1982;25:331–9.
26. Khubchandani IT. A randomized comparison of single and multiple rubber band ligations. Dis Colon Rectum. 1983;26:705–8.
27. Rothberg R, Rubin RJ, Eisenstat T, Salvati EP. Rubber band ligation hemorrhoidectomy, long-term results. Am Surg. 1983;49(3):167.
28. Corman ML, Veidenheimer MC. The new hemorrhoidectomy. Surg Clin North Am. 1973;53:417–22.
29. O'Hara VS. Fatal clostridial infection following hemorrhoidal banding. Dis Colon Rectum. 1980;23:570–1.
30. Russell TR, Donohue JH. Hemorrhoidal banding: a warning. Dis Colon Rectum. 1985;28:291–3.
31. Bartizol J, Slosberg P. An alternative to hemorrhoidectomy. Arch Surg. 1977;112:534–5.
32. Steinburg DM, Liegois H, Alexander-Williams J. Long term review of the results of rubber band ligation of haemorrhoids. Br J Surg. 1975;62:144–1146.
33. Wrobleski DE, Corman L, Veideheiner MC, Coller JA. Long-term evaluation of rubber ring ligation in hemorrhoidal disease. Dis Colon Rectum. 1980;23:478–82.

34. Neiger S. Hemorrhoids in everyday practice. Proctology. 1979;2:22–8.
35. O'Connor JJ. Infrared coagulation of hemorrhoids. Pract Gastroenterol. 1979;10:8–14.
36. Dennison A, Whiston J, Rooney S, et al. A randomized comparison of infrared photocoagulation with bipolar diathermy for the outpatient treatment of hemorrhoids. Dis Colon Rectum. 1990;33:32–4.
37. Gabriel WB. The principles and practice of rectal surgery. London: Lewis; 1963. p. 131.
38. Andrews E. The treatment of hemorrhoids by injection. Med Rec. 1879;15:451.
39. Alexander-Williams J, Crapp AR. Conservative management of haemorrhoids, I: injection, freezing, and ligation. Clin Gastroenterol. 1975;4:595–601.
40. Denckner H, Hjorth N, Norryd C, et al. Comparison of results with different methods of treatment of internal haemorrhoids. Acta Chir Scand. 1973;139:742–5.
41. Wilson MC, Schoefeld P. Cryosurgical haemorrhoidectomy. Br J Surg. 1976;63:497–8.
42. Savin S. Hemorrhoidectomy-how I do it: results of 444 cryorectal surgical operations. Dis Colon Rectum. 1977;20:189–96.
43. Goligher JC. Cryosurgery of hemorrhoids. Dis Colon Rectum. 1976;19:213–8.
44. Smith LE, Goudreau JJ, Fonty J. Management of hemorrhoids: operative hemorrhoidectomy versus cryosurgery. Dis Colon Rectum. 1979;22:10–6.
45. Yang R, Migikovsky B, Peicher J, Laine L. Randomized, prospective trial of direct current versus bipolar electrocoagulation for bleeding internal hemorrhoids. Gastrointest Endosc. 1993;39:766–9.
46. Lord PH. A new regime for the treatment of hemorrhoids. Proc R Soc Med. 1968;61:935–6.
47. Lord PH. Diverse methods of managing hemorrhoids: dilatation. Dis Colon Rectum. 1973;16:180–3.
48. McCaffrey J. Lord treatment of hemorrhoids: four year follow-up of fifty patients. Lancet. 1975;1:133–4.
49. Allgower M. Conservative management of haemorrhoids, III: partial internal sphincterotomy. Clin Gastroenterol. 1975;4:608–18.
50. Arabi Y, Gathouse D, alexander-Willimas J, et al. Rubber band ligation of lateral subcutaneous sphincterotomy for treatment of haemorrhoids. Br J Surg. 1977;64:737–40.
51. Shouten WR, van Vroonhoven TJ. Lateral internal sphincterotomy in the management of hemorrhoids—a clinical and manometric study. Dis Colon Rectum. 1986;29:869–72.
52. Leong AFP, Husain MJ, Seow-Choen F, Goh HS. Performing internal sphincterotomy with other anorectal procedures. Dis Colon Rectum. 1994;37:1130–2.
53. Wang GQ, Liu Y, Liu Q, Yang RQ, Hong W, Fan K, Lu M. A meta-analysis on short and long term efficacy and safety of procedure for prolapse and hemorrhoids. Chin J Surg. 2013;51(11):1034–8.
54. Senagore AJ, Singer M, Abcarian H, et al. A prospective, randomized, controlled multicenter trial comparing stapled hemorrhoidopexy and Ferguson hemorrhoidectomy: perioperative and one-year results. Dis Colon Rectum. 2004;47(11):1824–36.
55. Yang HK. Nonsurgical treatment of hemorrhoids. In: Yang HK, editor. Hemorrhoids. New York: Springer; 2014. p. 47–63.
56. Morianga K, Hasuda K, Ikeda T. A novel therapy for internal hemorrhoids: ligation of the hemorrhoidal artery with a newly devised instrument (Moricorn) in conjunction with a Doppler flowmeter. Am J Gastroenterol. 1995;90:610–3.
57. Singer M. Hemorrhoids. In: Beck DE, Wexner SD, Roberts PL, Sacclarides TJ, Senagore A, Stamos M, editors. ASCRS textbook of colorectal surgery. 2nd ed. New York: Springer; 2007.
58. Giordano P, Overton J, Madeddu F, Zaman S, Gravante G. Transanal hemorrhoidal de-arterialization: a systemic review. Dis Colon Rectum. 2009;52:16665–71.
59. Ferguson JA, Mazier WP, Ganchow MI, Friend WG. The closed technique of hemorrhoidectomy. Surgery. 1971;70:480–4.
60. Mazier WP, Halleran DR. Excisional hemorrhoidectomy. In: Kodner IJ, Fry RD, Roe JP, editors. Colon, rectal, and anal surgery. St. Louis: C.V. Mosby; 1985. p. 3–14.
61. Ferguson JA, Heaton JR. Closed hemorrhoidectomy. Dis Colon Rectum. 1959;2:1176–9.
62. Cataldo PA, MacKeigam JM. The necessity of routine pathologic evaluation of hemorrhoidectomy specimens. Surg Gynecol Obstet. 1992;174:302–4.
63. Milligan ETC, Morgan CN, Nanton LE, Officier R. Surgical anatomy of the anal canal and the operative treatment of hemorrhoids. Lancet. 1937;2:1119–24.
64. Whitehead W. The surgical treatment of hemorrhoids. Br Med J. 1882;1:148–50.
65. Bonello JC. Who's afraid of the dentate line? The Whitehead hemorrhoidectomy. Am J Surg. 1988;156:182–6.
66. Seow-Choen F, Low HC. Prospective randomized study of radial versus four piles haemorrhoidectomy for symptomatic large circumferential prolapsed piles. Br J Surg. 1995;82:188–9.
67. Patel N, O'Connor T. Suture haemorrhoidectomy: a day-only alternative. Aust N Z J Surg. 1996;66:830–1.
68. Senagore A, Mazier WP, Luchtefeld MA, MacKeigan JM, Wengert T. The treatment of advanced hemorrhoidal disease: a prospective randomized comparison of cold scalpel vs. contact Nd:YAG laser. Dis Colon Rectum. 1993;36:1042–9.
69. Wang JY, Chang-Chein CR, Chen JS, Lai CR, Tang R. The role of lasers in hemorrhoidectomy. Dis Colon Rectum. 1991;34:78–82.
70. Standards Task Force American Society of Colon and Rectal Surgeons. Practice parameters for the treatment of hemorrhoids. Dis Colon Rectum. 1990;33:7A–8A.
71. Niehuis S, de Hingh I. Conventional versus LigaSure hemorrhoidectomy for patients with symptomatic hemorrhoids. Cochrane Database Syst Rev. 2009;1:CD006761.

72. Bulus H, Tas A, Coskun A, Kucukazman M. Evaluation of two hemorrhoidectomy techniques: harmonic scalpel and Ferguson's with electrocautery. Asian J Surg. 2014;37:20–3.
73. Gottesman L, Milsom JW, Mazier WP. Postoperative urinary retention treated with Urecholine: a prospective, randomized, blinded study. Dis Colon Rectum. 1989;32:867–80.
74. Goldstein ET, Williamson PK, Larach SW. Subcutaneous morphine pump for postop hemorrhoidectomy pain management. Dis Colon Rectum. 1993;36:439–46.
75. Smith LE. Current therapy on colon and rectal surgery. In: Fazio VW, editor. Current therapy in colon and rectal surgery. Philadelphia: B.C. Decker; 1990. p. 9–14.
76. Dean KI, Wong WD. Hemorrhoidal surgery. In: Hicks TC, Beck DE, Opelka FG, Timmcke AE, editors. Complications of colon and rectal surgery. Baltimore: Williams & Wilkins; 1997. p. 163–72.
77. Buls JG, Goldberg SM. Modern management of hemorrhoids. Surg Clin North Am. 1978;58:469–78.
78. Ganchrow MI, Mazier WP, Friend WG, et al. Hemorrhoidectomy revisited—a computer analysis of 2038 cases. Dis Colon Rectum. 1971;14:128–33.
79. Nyam DCNK, Seow-Choen F, Ho YH. Submucosal adrenaline injection for posthemorrhoidectomy hemorrhage. Dis Colon Rectum. 1995;38:776–7.
80. Gorfine SR, Onel E, Patou G, Krivokapic ZV. Bupivacaine extended-release liposome injection for prolonged postsurgical analgesia in patients undergoing hemorrhoidectomy: a multicenter, randomized, double-blind, placebo-controlled trial. Dis Colon Rectum. 2011;54:1552–9.
81. Beck DE, Margolin DA, Babin S, Russo CT. Benefits of a multimodal regimen for postsurgical pain management in colorectal surgery. Ochsner J. 2015;15(4):408–12.
82. Corman ML. Management of postoperative constipation in anorectal surgery. Dis Colon Rectum. 1979;22:149–51.
83. Milsom JW, Mazier WP. Classification and management of postsurgical anal stenosis. Surg Gynecol Obstet. 1986;163:60–4.
84. Granet E. Hemorrhoidectomy failures: causes, prevention, and management. Dis Colon Rectum. 1968;11:45–8.
85. Ferguson JA. Repair of "Whitehead deformity" of the anus. Surg Gynecol Obstet. 1959;108:115–6.
86. Wexner SD. AIDS: what the colorectal surgeon needs to know. Perspect Colon Rectal Surg. 1989;2:19–54.
87. Morandi E, Merlini D, Salvaggio A, Foschi D, Trabucchi E. Prospective study of healing time after hemorrhoidectomy: influence of HIV infection, acquired immunodeficiency syndrome, and anal wound infection. Dis Colon Rectum. 1999 Sep;42(9):1140–4.
88. Saleeby RG, Rosen L, Stasik JJ, et al. Hemorrhoidectomy during pregnancy: risk or relief? Dis Colon Rectum. 1991;34:260–1.
89. Wolkomir AF, Luchtefeld MA. Surgery for symptomatic hemorrhoids and anal fissures in Crohn's disease. Dis Colon Rectum. 1993;36:545–7.
90. MacRae HM, McLeod RS. Comparison of hemorrhoidal treatment modalities. Dis Colon Rectum. 1995;38:685–94.

18

Proctalgia Fugax, Levator Spasm, and Pelvic Pain: Evaluation and Differential Diagnosis

Amir L. Bastawrous and Jennifer K. Lee

Introduction

Pelvic pain is a common complaint with a wide range of causes involving multiple organ systems, making the diagnosis particularly complicated. The expansive differential can be divided into acute and chronic etiologies. The most common causes of acute pain include thrombosed external hemorrhoids, perianal abscesses, fistulas and anal fissures. Chronic pelvic pain also has a broad differential that includes several pelvic floor syndromes. The differential can be divided into organic or functional etiologies, the later of which relates to diagnoses that do not have a structural or anatomical cause.

Patients may present shortly after the acute pain starts or delay seeing a provider due to anxiety and embarrassment. Many may also ignore the pain altogether. Pelvic pain is especially distressing as it affects a sensitive area of the body that is difficult for patients to examine themselves. Nevertheless, with a systematic approach to the history and physical, the physician can identify most diagnoses and treat them successfully.

A. L. Bastawrous (✉) · J. K. Lee
Swedish Colon and Rectal Clinic, Swedish Cancer Institute, Seattle, WA, USA
e-mail: amir.bastawrous@swedish.org; Jennifer.lee@swedish.org

General Approach to the Patient with Pelvic Pain

History

Many patients come with a predetermined diagnosis, such as hemorrhoids or anal fissure, which can be a distractor. It is essential to listen to key descriptions provided by the patient, focusing on pain characteristics such as character, duration, location, causative factors and associated signs and symptoms.

Evaluate the past medical, surgical and gynecological history. A family history may point towards a malignant etiology. A history of inflammatory bowel disease may raise suspicion of anal fistulas or fissure and a history of diabetes or HIV may point to an infectious cause. Sexual history may raise suspicions for sexually transmitted disease, anal dysplasia or cancer. A history of physical, emotional or sexual abuse may underlie certain chronic pelvic pain symptoms.

Physical Examination

While a complete examination is important, high-yield portions include the examination of the abdomen, inguinal region, perianal skin and soft tissue, buttocks and gluteal cleft, anal canal and rectum. The abdominal exam starts with inspection. Scars may reveal a history of

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_18

operations or trauma. Palpation helps appreciate distention and tympani in the setting of constipation. The point of maximum tenderness in the left lower quadrant can reveal diverticulitis. Metastases may present with hepatomegaly. The inguinal exam may identify lymphadenopathy, which may raise suspicions of an infectious and neoplastic process. Anal and low rectal cancers can present with palpable lymphadenopathy in metastatic disease [1].

The external and internal anal exams are crucial. This part of the evaluation requires extreme sensitivity on the part of the examiner, as it is both a physically and psychologically sensitive examination event for the examinee. Warn the patient before initiating any portion of the perianal and internal anorectal exam. By putting the patient at ease and earning trust, one can obtain helpful information in a more efficient manner and with minimal discomfort.

Starting with the external exam, visualization of the gluteal, intergluteal and perianal skin can reveal discoloration of the skin, thickened folds or scaling, masses, secondary openings of fistulae, swelling from abscesses, pilonidal pits, skin tags or thrombosis of external hemorrhoids. Gentle distraction of the buttocks may reveal anal fissures. Palpation of the perianal skin can identify abscesses or a mass concerning for a neoplastic process. Assess the size, firmness, fixation and tenderness of any lesions.

The digital rectal exam is best tolerated with adequate lubrication and in the case of pelvic pain, topical anesthetic should be considered to maximize patient tolerance. In the case of a visualized fissure on external exam, it is helpful to gently insert the examining finger to place initial pressure on the contralateral side. Palpate for masses and define the location in regards to anterior, posterior, right or left lateral quadrants. Define the distance of the lesion from the anal verge and anorectal ring. The firmness and fixation of the lesion are also discernable on digital exam and should be recorded.

Assess anal sphincter tone, which is usually hypertonic in most cases of anal fissures, but can also be found to be normal in some patients, which alters the treatment options for fissures. Starting at the coccyx, rotate the finger to each lateral quadrant, feeling for muscle spasm of the levator complex. This should also reproduce pain in the setting of levator syndrome.

Palpate for fluctuance with concomitant pain in the setting of perirectal abscesses. Posteriorly, fullness on palpation can identify presacral masses. Palpation of the coccyx can diagnose coccygodynia. For completion, rotate the finger anteriorly in men to identify point tenderness of the prostate in cases of prostatitis and for rectocele in women with a history of constipation.

If the patient is unable to tolerate the process, an exam under anesthesia should be performed. Repeated and aggressive pain-inducing examinations will not yield helpful information, especially in setting of investigating pelvic pain.

Anoscopy/Rigid Proctoscopy

Anoscopy and sigmoidoscopy allow for visualization of intraanal and rectal lesions. These findings can range from enlarged hemorrhoids to distinct neoplastic lesions to mucosal changes from sexually transmitted infections or inflammatory bowel disease.

Imaging/Testing

There are certain circumstances when diagnostic or confirmatory studies are required after a history and physical exam. This especially occurs when the history is concerning for an anorectal abscess but there are limited physical exam findings. A pelvis computed tomography (CT) may be helpful in this case and may have already been ordered by inexperienced practitioners. Diagnosis of pelvic floor disorders can be visualized with a defecogram or dynamic pelvic magnetic resonance imaging (MRI). Patients with a history concerning for outlet obstruction can be diagnosed with high-resolution anorectal manometry and a balloon expulsion study. A history of a retained foreign body should prompt an abdominal and pelvic radiograph in order to identify some objects, as well as evaluate for free air. Finally, the standard workup for an anal or rectal cancer includes staging with ultrasound or MRI

and CT.Colonoscopy should be added for routine screening or for suspicion of inflammatory or neoplastic processes.

Acute Pelvic Pain

Three of the most common causes of acute pelvic pain include thrombosed external hemorrhoids, anal fissures and anorectal abscesses (Table 18.1). Key components of the history and physical include asking when the pain first occurred and if an inciting event could be identified, such as a bowel movement or certain physical activities. If there is a history of bleeding or drainage, the amount and frequency should be quantified. Oftentimes, the history and physical are sufficient to confirming a diagnosis of most causes of acute pelvic pain.

Thrombosed External Hemorrhoid

Most patients will be able to pinpoint the exact time they developed a thrombosed external hemorrhoid (Fig. 18.1). It often occurs after straining, either with a bowel movement or with lifting heavy objects. It can also occur with diarrhea. The pain is sharp, constant and worse when they touch the area or sit. They may feel a "bulge" near the anus. The pain tends to increase over the first few days then gradually decrease after about one week as the thrombosis naturally resolves. They deny any fever [2, 3]. The exam will reveal a blue or purplish lesion that may be firm and tender or soft and nontender to palpation depending on when the patient presents.

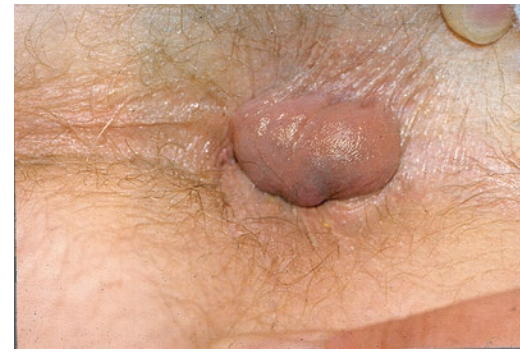


Fig. 18.1 Thrombosed external hemorrhoid. With permission from [57] © 2014 Springer

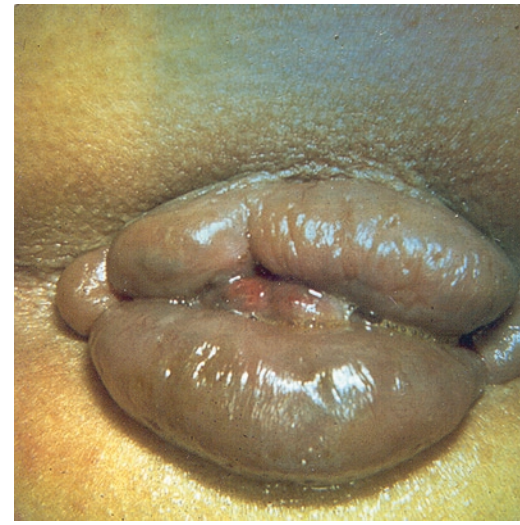


Fig. 18.2 Circumferential thrombosis of internal and external hemorrhoids. With permission from [57] © 2014 Springer

Table 18.1 Three most common causes of acute pelvic pain

	Pain quality	Findings
Thrombosed external hemorrhoid	Sharp and constant	Enlarged purplish lesion on anal verge, firmness depending on chronicity
Fissure	Sharp, cutting and worse during bowel movements	Visible cut tear in anoderm
Abscess	Throbbing, worse with pressure, fevers/chills	Erythema, fluctuance, induration, active purulent drainage

If the hemorrhoid is symptomatic and firm, office excision and drainage of the clot can provide instant relief. Compared to a simple incision through the skin with enucleation of the clot, excision prevents recurrence at that particular hemorrhoid. When all external hemorrhoids are thrombosed (also known as hemorrhoidal crisis), an exam under anesthesia with excisional hemorrhoidectomy should be performed (see Chap. 17) (Fig. 18.2) [4].

Anal Fissure

Patients typically describe a sharp cutting pain that occurs during and right after passage of a bowel movement [5, 6]. The inciting event may be passage of a hard and constipated stool. The pain can last for minutes to hours after a bowel movement and the quality can change from sharp to a burning sensation. If the pain is very severe, patients may even describe being afraid of having a bowel movement. There may be spotting of blood on the toilet paper after wiping or drops of blood in the toilet water. Some may have tried warm soaks with some relief.

The exam can be especially challenging due to the acuity of pain. Distraction of the buttocks may reveal the fissure (Fig. 18.3). Typical locations include the posterior and anterior midline. Ectopic locations should raise suspicion of underlying infectious or inflammatory etiologies. Acute fissures often appear as a superficial tear of the anoderm. Chronic fissures may reveal exposed internal sphincter muscle fibers at the base with an associated sentinel pile and hypertrophic anal papilla.

If the patient tolerates the digital rectal exam, pain is reproduced with gentle palpation of the fissure and hypertonicity of the sphincter is often appreciated. Normal tone can also be present in some cases, which will alter treatment options for these patients.

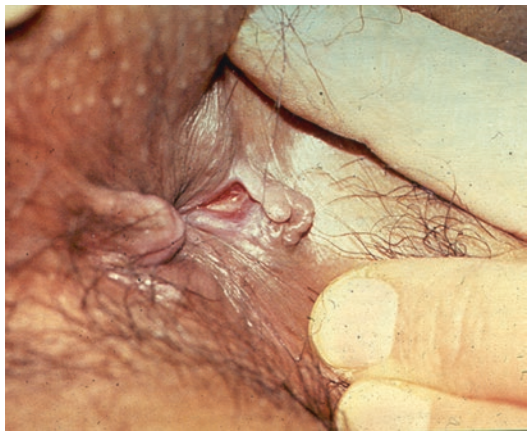


Fig. 18.3 Anal fissure with skin tag. With permission from [57] © 2014 Springer

Treatment for typical fissures is initially medical and focuses on relieving the sphincter spasm. Bulking agents and sitz baths provide relaxation of the muscles but in many cases, the addition of a calcium channel blocker (nifedipine or diltiazem) or nitroglycerin-based creams may be required. This has high success but patients should be educated on potential side effects, including hypotension and headache.

The gold standard for treatment of chronic anal fissures is lateral internal sphincterotomy (LIS). The sphincterotomy is performed to the length of the fissure itself. This is performed on the lateral quadrant position and not through the fissure itself in order to prevent limit creation of a keyhole deformity.

Another surgical option is chemical sphincterotomy with botulinum A toxin (Botox). Botox functions by preventing acetylcholine release, which causes relaxation of the muscle. The effects last 3–6 months. There is risk of incontinence that is time-limited by the duration of the effects of the neurotoxin. A meta-analysis of randomized controlled trials was performed comparing Botox to LIS and showed higher recurrence rates with Botox and higher rate of minor anal incontinence for LIS [7]. Persistent fissures may be amenable to botulinum injections, contralateral internal sphincterotomy or anal advancement flap into the anal canal. Additional information on anal fissure is covered in Chap. 14.

Anorectal Abscess

Patients with acute abscesses will often present with the most discomfort that is described as worsening pressure and pain. The pain is often worse before and during a bowel movement with some improvement afterwards. It can also be worse with direct pressure, as some patients will be seen laying or sitting while shifting away from the affected side. Patients may describe associated fevers, chills or even difficulty urinating [8–11].

The exam may reveal erythema and induration of the perianal skin, with an area of fluctu-

ance or even a point of active drainage (Fig. 18.4). In these cases, an incision and drainage is indicated after injection of local anesthesia. This can be done with a catheter or an ellipse of skin should be removed to ensure adequate drainage while delaying skin closure (see Chap. 10). Packing is usually unnecessary unless there are concerns for hemostasis—any packing should be removed in a timely fashion (24 h or less). Blind and aggressive spreading within the abscess cavity in hopes to "break up loculations" has the risk of pudendal nerve injury and should not be performed.

When there is no identifiable abscess on external exam, the digital rectal exam can reveal an area of induration or fluctuance within the anal canal or rectum. It is common to have a deep postanal abscess with no external evidence. If the internal exam is also unrevealing but the suspicion remains high and a parasacrococcygeal approach does not drain a collection, an imaging study such as a pelvic CT can help localize the abscess. Larger abscesses, such as horseshoe abscesses, are best treated in the operating room. Overall, the location of the abscess will determine the approach of drainage.

Recurrent abscesses after incision and drainage usually indicate formation of a fistula-in-ano. Persistent drainage through the fistula may cause pruritus, which may in turn lead to chronic perianal pain.

Other Causes of Acute Pelvic Pain

While the previously mentioned etiologies are the most commonly encountered, the differential for anorectal and pelvic pain is broad and includes anything from idiopathic pruritus to inflammatory disease to neoplasm.

Pruritus Ani

Although it is a particularly sensitive organ, the perianal skin can have poor discrimination of sensation. Patients with pruritus ani will complain of burning or itching pain. They may endorse a feeling of being unable to get clean enough, prompting them to use medicated wipes or scrubbing of the area. Unfortunately, scratching the area starts a cycle of itching and augments irritation.

The exam will reveal skin changes such as excoriation, cracked skin, discoloration (white or red) thickened folds and moisture (Fig. 18.5). A digital rectal exam may reveal poor tone, which would allow for seepage. One should distinguish the presenting symptoms from cancers, anal fissures or infectious ulcers.

Treatment is nonsurgical and targets altering bowel habits. Patients should discontinue use of topical salves, soaps, hemorrhoid creams, and medicated wipes, as well as avoid excessive scrubbing and scratching. We recommend gentle

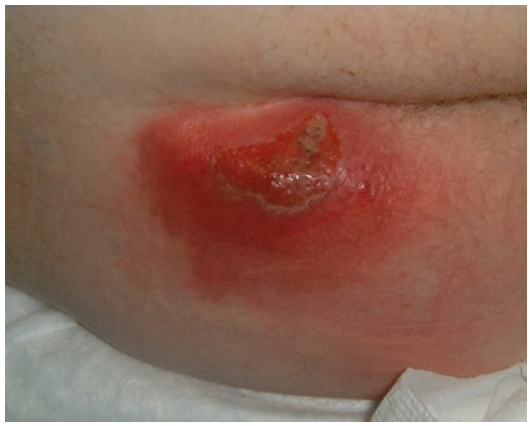


Fig. 18.4 Perianal abscess. With permission from [57] © 2014 Springer

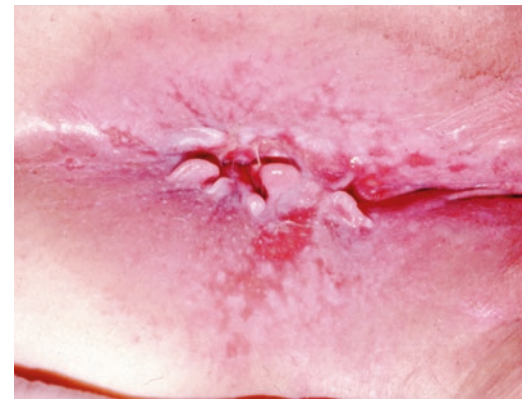


Fig. 18.5 Pruritus ani. With permission from [57] © 2014 Springer

blotting of the area after bowel movements with a cotton ball. Leaving a fluffed cotton ball at the anus helps absorb moisture and protect the surrounding skin. The use of desiccants like cornstarch can help in a similar way but can often act as abrasive if too much is used.

The quality of stools also needs to be addressed by normalizing or "drying" the stools with increasing dry soluble fiber intake and decreasing excess water intake to limit irritation. Fiber wafers are particularly useful in this situation.

Finally, for patients who have persistent symptoms despite adhering to these recommendations, consider a biopsy of the perianal skin to rule out other conditions such as lichen sclerosis et atrophicus, Bowen's disease, Paget's disease, and other conditions that may benefit from dermatologic referral or appropriate treatment based on biopsy results (see Chap. 13).

Hidradenitis Suppuritiva

Hidradenitis is a cutaneous condition believed to originate from a disorder of sebaceous apocrine gland metabolism and can often be misdiagnosed as perirectal abscesses. These patients will often have similar lesions in the axillae and groin. The exam may reveal multiple superficial abscesses in the perineal, axillary and inguinal regions. Careful examination will show sparing of the perianal verge skin from the disease process, as this area is devoid of hair and skin accessory glands.

Treatment depends on the extent of disease but always starts with antibiotics. Extensive lesions that persist despite medical treatment may require excision. As with typical perirectal abscesses, incision and drainage is indicated and extensive disease may require operative drainage (see Chap. 16).

Infectious

Infectious causes should always be considered in the differential of a patient presenting with anal or rectal pain in the setting of fever, perirectal drainage, or history of sexually transmitted disease (STD). One should inquire about HIV status, as proctitis from herpes simplex in an HIV positive patient can be particularly severe (see Chap. 27).

Gonorrhea

Many patients with gonorrhea will be asymptomatic. Those who have symptoms often endorse tenesmus and even severe anal pain. If the suspicion is high for gonorrhea, one should avoid the use of lubricants due to their antibacterial properties, which may provide a false negative culture. Swabs are placed on a Thayer-Martin agar, although newer tests include nucleic acid amplification tests (NAATs), which have higher sensitivity with similar specificity of cultures [12]. Treatment includes oral cephalosporins such as ceftriaxone 250 mg IV in a single dose. Concomitant treatment for chlamydia and evaluation for other STDs should be initiated.

Chlamydia

Chlamydia is the most prevalent infection among sexually active patients between ages 14 and 24. Although the infection starts in the anal canal, proctocolitis can develop with ulcer formation in the rectum. There are multiple variations of the species *C. trachomatis*. Serovars D through K are responsible for urethritis, pelvic inflammatory disease and proctitis. It is often asymptomatic but can present similarly to gonorrhea with proctitis and discharge. Anoscopy may show friable mucosa and discharge.

Gottesman et al point out that if a gram stain shows polymorphonuclear leukocytes in the absence of gonococci, the presumptive diagnosis is chlamydia [13]. Swabbing for NAAT testing is the test of choice. Treatment includes either azithromycin 1g orally once or doxycycline 100 mg orally twice daily for 7 days. These patients should also abstain from sex for 1 week after starting treatment to decreases transmission rates [14].

Lymphogranuloma venereum (LGV) is another subset caused by *C. trachomatis,* with the most common serovars being L1, L2 or L3. LGV presents with unilateral tender lymphadenopathy

in the inguinal and femoral region. Anoscopy may reveal ulcers and bloody mucous discharge from the rectum with fever and pain. The disease can lead to the formation of fistulae and strictures, if not treated. The diagnosis is made by clinical suspicion and confirmed with NAAT. Treatment involves doxycycline 100 mg orally BID for 21 days, or alternatively erythromycin base 500 mg orally 4 times daily.

Herpes Simplex/Zoster

The two types of herpes simplex virus are HSV 1 and HSV 2. Once infected, patients have a lifelong viral infection. HSV 2 is most commonly associated with genital herpes although HSV 1 can also present similarly. Patients have significant pain with associated perianal ulcers.The first outbreak may be with fever, lymphadenopathy on exam, and last longer than subsequent recurrences. The exam may reveal vesicles that rupture and form shallow ulcers that heal in about 3 weeks. The disease can extend into the anal canal and rectal mucosa, confirmed by visualizing ulcers or friable mucosa on anoscopy or proctoscopy. The pain can be quite severe, even causing difficulty with voiding.

Diagnostic tests include a viral culture and serologic testing. Because the virus persists in the ganglia of sensory nerves, there is no cure and recurrence is common. In some cases, associated radiculopathy in the lumbosacral distribution can cause bladder and sexual dysfunction, along with pain along the buttocks and thighs. For this reason, herpes zoster can be included in the differential for chronic pelvic pain as well. Treatment is acyclovir 400 mg orally 3 times daily for 10 days and should be supplemented with pain medication and warm soaks.

Syphilis (Treponema Pallidum)

Known as the "Great Impersonator", perianal syphilis can be misdiagnosed as anal fissures. The severe pain generally resolves on its own over 3–6 weeks, and is similar to that of a typical fissure [15]. Lesions are atypical in their location and may also be multiple. Early lesions are infectious but it may take a week for symptoms to present. Inguinal lymphadenopathy can often be appreciated.

Diagnosis is made by screening for rapid plasma reagin (RPR) followed by a treponemal test to confirm the diagnosis. Treatment is a single muscular injection of benzathine penicillin G, which generally cures the patient with early diagnosis.Doxycycline 100 mg orally twice daily for 2 weeks is acceptable for those with a penicillin allergy.

Chancroid (Haemophilus Ducreyi)

Overall, chancroid is less and less common in the US. The lesions start as a tender erythematous papule that becomes a pustule and then a painful genital or perianal ulcer. These may also have associated abscesses.

The diagnosis is confirmed with a gram stain and culture on chocolate agar. The gram stain may show gram-negative rods in small groups. This should be followed with a special culture media. The suspicion should be high if there are one or more painful genital ulcers with lymphadenopathy, with syphilis and HSV having been ruled out. The treatment is azithromycin 1 g orally once, ciprofloxacin 100 mg orally twice daily for 3 days or erythromycin base 500 mg orally twice daily for 3 days.

Granuloma Inguinale (Calymmatobacterium Granulomatis)

The exam for granuloma inguinale will reveal extensive ulcers of the genitalia and anus with granulation-like tissue and rolled edges. The lesions bleed easily and may have associated lymphadenopathy. Diagnosis requires visualizing the dark-staining Donovan bodies on biopsy. Treatment is doxycycline 100 mg orally twice daily for 3 weeks or until lesions are healed.

Overall, the sexually transmitted anorectal infections described can present with severe proctitis or ulcerations, as shown in Table 18.2. Once identified, antibiotics are the first line of treatment. Along with treating the acute infection, counsel patients on HIV as well as on the prevention of further infection and spread of disease.

Table 18.2 Sexually transmitted diseases associated with anorectal pain

Disease	Organism	Histology	Symptoms/signs	Treatment
Gonorrhea	Neisseria gonorrhea	Gram negative diplococcus in pairs/clusters on Thayer-Martin agar/NAATs	Pruritus, thick bloody mucopurulent discharge from anal crypts	Ceftriaxone 250 mg IM ×1
Chlamydia	Chlamydia trachomatis Serovars D-K	NAAT	Tenesmus, mild proctitis	Azithromycin 1 g PO ×1 or doxycycline 100 mg PO BID ×7 days
Lymphogranuloma venereum	Chlamydia trachomatis Serovars L1, L2, L3	NAAT	Small shallow ulcers with rapid healing, bloody mucoid discharge	Doxycycline 100 mg PO BID ×21 days
Herpes simplex	HSV 2, HSV 1 (less common)	–	Vesicles which form shallow ulcers, coalesce into groups with erythematous base	Acyclovir 400 mg PO TID ×10 days (less frequent dosing for recurrence)
Syphilis	Treponema pallidum	–	Chancre, clean based eccentric ulcer, rolled edges	Benzathine penicillin G 2.4 million units IM
Chancroid	Haemophilus ducreyi	Gram negative rods in small groups on chocolate agar	Indurated, tender papule, gray/yellow exudates at base	Azithromycin 1 g PO ×1, ceftriaxone 250 mg IM ×1, ciprofloxacin 100 mg PO BID ×3 days
Granuloma inguinale	Klebsiella (calymmatobacterium) granulomatis	Intracellular bacterium, dark staining Donovan bodies	Extensive and progressive ulcers with rolled edges, granulation-like tissue, bleed easily	Doxycycline 100 mg PO BID ×3 weeks or until all lesions healed

Perianal Crohn's Disease

Patients with Crohn's disease may present with pain from fistulae with associated proctitis. There may also be pain from sphincter spasm. Because the discomfort can limit an office exam, evaluation is typically best under anesthesia in order to identify and treat fistulae and undrained abscesses (Fig. 18.6). One should avoid fistulotomy in most cases and place draining setons instead. Fissures should be approached medically as with non-Crohn's patients, but sphincterotomy should be avoided due to poor healing (see Chap. 29).

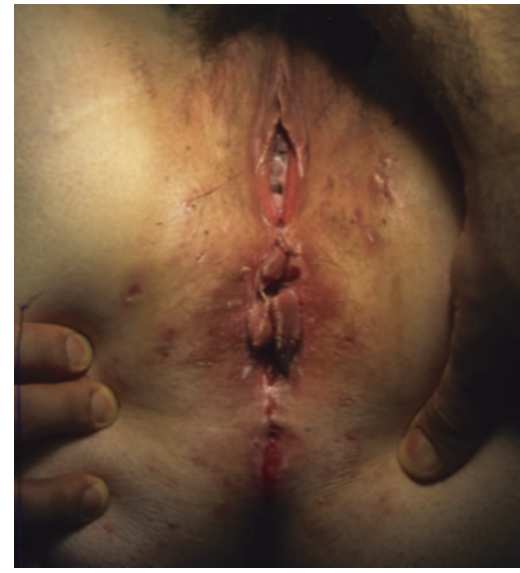


Fig. 18.6 Perianal Crohn's disease. With permission from [57] © 2014 Springer

Proctitis/Pouchitis

Inflammation of the rectum typically presents as pain in the setting of an increased number of bowel movements per day, as well as associated mucoid

and bloody discharge. A thorough history is key as proctitis can arise from a history of radiation treatment, diversion, infections, chemical irritation and inflammatory bowel disease.

Pouchitis presents similarly and occurs in up to 50% of patients who undergo a restorative ileal pouch-anal anastomosis for conditions like ulcerative colitis. This condition develops due to bacterial overgrowth imbalance in the pouch. Similarly, there can be "cuffitis", or inflammation of any remnant anorectal mucosa [16].

The diagnosis is confirmed with proctoscopy, evidenced by inflammation of the rectal mucosa. Treatment depends on the cause of the inflammation. Proctitis treatment may involve the use of antibiotics as well as anti-inflammatory agents. Pouchitis treatment also involves antibiotics but recalcitrant cases may require steroids or even immunosuppressants. Extreme cases may require diversion or excision of the pouch.

Radiation

Radiation to the perineal and pelvic area can cause anodermal thinning, sphincter injury, stenosis and proctitis. These patients endorse a history of anal, distal rectal, vulvar or prostatic cancers. For this reason, the evaluation should involve a search for recurrent malignancy.

Symptomatic treatment includes the use of sucralfate suppositories, which requires a compounding pharmacy in most cases. If bleeding persists, a dilute 10% formalin solution can be instilled into the rectum [17]. More recalcitrant bleeding can be addressed with argon beam coagulation to achieve hemostasis by destroying damaged tissue.

Anal Stricture

Anal strictures can be iatrogenic or related to radiation or a history of malignancy. The patient will describe pain during defecation and a change in stool caliber. Difficulty introducing the finger or anoscope due to the stenosis confirms the diagnosis and a tearing of the anoderm can sometimes be appreciated.

Workup should include the ruling out of any associated or recurrent malignancy. Benign strictures can be addressed with dilation or anoplasty (see Chap. 14).

Anal/Rectal Cancer

The fear of malignancy is one of the major reasons patients seek evaluation for pelvic pain. Fortunately, most causes of pain are benign. Nevertheless, malignancy should always be considered in the differential, as anal and rectal cancers can present with pain. These patients may endorse unexpected weight loss or a family history of malignancy [18–20]. Low rectal cancers can present with a change in bowel habits, whether as thinner caliber stools or watery stools, as well as bleeding (see Chaps. 21, 22, and 23).

The abdominal exam may show distention in the case of near-obstructing tumors. There may be lymphadenopathy in low rectal or anal canal and margin squamous cell cancers. The digital rectal exam and rigid proctoscopy are essential in identifying the location of these tumors in reference to the anal verge, anorectal ring, prostate and vagina.

Anal cancers can present like fissures, with pain during and after bowel movements and spotting of blood. Despite appearing like typical fissures, anal cancer lesions will not heal despite appropriate medical treatment. A biopsy should be performed to confirm suspicions.

Conditions like Paget's (intraepithelial adenocarcinoma) or Bowen's (intraepithelial squamous cell carcinoma) disease will typically present with more chronic itching and irritation than pain. Like anal cancer, the pain can be associated with ulceration and sphincter spasm. Once confirmed histologically, treatment of these conditions is wide local excision.

Rectal Prolapse

The degree of pain with rectal prolapse often relates to the degree of prolapse. The pain is usually notable during and after defecation with associated prolapsing of tissue (Fig. 18.7).

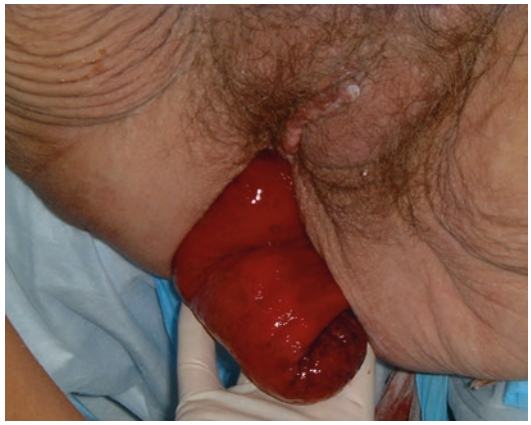


Fig. 18.7 Rectal prolapse. With permission from [57] © 2014 Springer

Incarceration of a prolapsed rectum can present with acute pain.

The exam is confirmatory but may require a "toilet test" in order to demonstrate the prolapse, whether by having the patient valsalva on the toilet or by identifying the pathology on defecography. Defecography may also identify other prolapsing organs in the form of cystocele, uterine prolapse, and enterocele.

Chronic non-ischemic prolapse can often be reduced and definite surgical treatment can be planned electively. Acute incarceration may require more urgent surgical intervention and a resection proctosigmoidectomy should be performed in these cases. Additional information on rectal prolapse is presented in Chap. 8.

Retrorectal Tumors

In addition to being a rare diagnosis in general, retrorectal tumors will rarely present solely as chronic pelvic pain. Patients may have changes in stool caliber or constipation, as these extrarectal tumors cause external compression of the bowel lumen. The rectal exam may reveal a palpable mass posteriorly or laterally. Workup includes imaging with CT or MRI to characterize these lesions as cystic or solid and to identify their location and association with other pelvic structures (Fig. 18.8). A biopsy is not routinely required and essentially all lesions should be resected due to malignant potential (see Chap. 26).

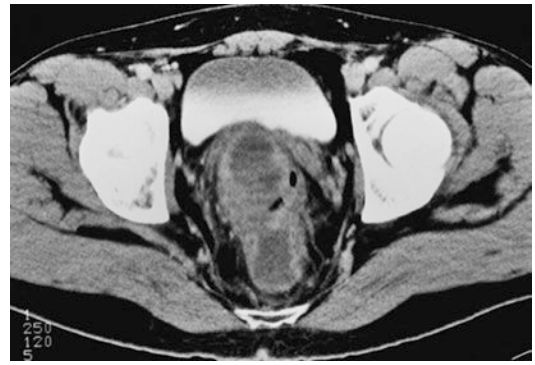


Fig. 18.8 Retrorectal tumor. With permission from [57] © 2014 Springer

Prostatitis

Anterior rectal pain may originate from the prostate. Patients describe the pain as a dull ache. The causes of prostatitis can range from infectious to neurologic and these patients may endorse urinary or sexual dysfunction. The exam is often confirmatory with point tenderness upon palpation of the prostate with a lack of findings in the remainder of the exam [21]. A urological referral is indicated. Bacterial causes, including those of STDs, will require antibiotic treatment.

Gynecological Causes

Gynecological causes of pelvic pain vary widely but rarely present as anal pain specifically. Instead, patients describe a deep lower abdominal or pelvic pain with symptoms akin to constipation or outlet dysfunction. Causes can include rectocele, endometriosis, ectopic pregnancies or adnexal abnormalities and diseases. These should always be considered in the differential of pelvic pain in the female patient and may prompt a gynecological referral, given the broad range of possibilities beyond the scope of this chapter.

Neurogenic Pain

Disorders affecting the distal lumbar and sacral sensory nerves can cause pelvic pain. The etiologies of neurogenic pain are beyond the scope of this chapter but can include spinal anatomical abnormalities like ruptured discs, malignancies or bony abnormalities. The perianal and rectal exam may reveal weak sphincter tone and the neurological exam should also assess for lower extremity weakness and sensory changes. Workup involves imaging such as MRI and appropriate referral as indicated.

Chronic Pelvic Pain

Frequently recurring pain of the anal canal, rectum and pelvis is a complex issue that can stem from a variety of causes. This already sensitive issue is made more challenging as patients may see multiple specialists before the cause of their pain is correctly identified. Despite the considerable effect this pain may have on quality of life, only about 1/3 of patients will consult a physician. In addition, there remains a dearth of reliable research regarding these conditions overall [22]. Although 15% of women in the United States report chronic pelvic pain, the condition also affects men [23].

Similar to identifying the cause of acute pelvic pain, the history and physical exam are crucial to identifying the diagnosis. Chronic pain is distinguished from acute pain by the duration of symptoms, with patients experiencing pain for more than 6 months [24]. The pain can be constant or intermittent with variability of improvement with warm baths or bowel movements. The quality can be described in a number of ways, from sharp to dull and from burning to aching and cramping. A key aspect to elicit from a history of chronic pain is the tempo and variation during the course of a day.

Patients usually do not complain of fever, chills or bleeding. Other associated symptoms such as dyspareunia, vaginal bleeding, or dysuria should prompt appropriate subspecialty referrals. If there is a history of constipation, it may be specifically defined as difficulty with stool evacuation. Patients may also have a history of irritable bowel syndrome and anxiety or depression. Inquire about gynecological and obstetric history, as well as any history of psychosocial trauma or abuse. Obtain records of previous anorectal, urological and gynecological operations as well as reports from colonoscopies and pathology.

Key aspects of the physical exam for chronic pelvic pain should focus on the perineal exam and anorectal exam as described previously. A vaginal exam may reveal other pathologies such as discharge or cervical motion tenderness, which may suggest STDs. The pelvic floor musculature is another source of chronic pelvic pain that can be assessed with the digital rectal exam. Have the patient squeeze and valsalva. One will feel the finger pull up during a normal squeeze as the pelvic floor contracts and the descent of the perineum and the degree of prolapse can be appreciated on Valsalva maneuver. Evaluate spasm of the levator muscles or attempt to reproduce the pain described by patients by palpating these muscles. Finally, palpation of the coccyx may reproduce pain in coccygodynia.

Despite a comprehensive workup, one study found that an organic cause was found in only 15% of patients with chronic pelvic pain. These patients are placed under the subset of "functional" chronic anorectal and pelvic pain [25]. The goal of this section is to focus on the most common syndromes associated with chronic pelvic pain, including levator syndrome, proctalgia fugax, coccygodynia and pudendal neuropathy (Table 18.3). There is also a brief mention of urogynecological causes of chronic pain that one should be familiar with the workup.

Urogynecological Causes

The most common cause of pelvic pain in women is endometriosis. The degree and quality of symptoms depends on the location and depth of involvement of the extrauterine tissue deposits. When the gastrointestinal tract is

Table 18.3 Pelvic pain syndromes

	Pain duration	Exam
Proctalgia fugax	<20 min, usually seconds, can awaken from sleep	Episodic
Levator ani syndrome	>20 min	Tenderness with palpation of the puborectalis
Coccygodynia	Variable	Tenderness with palpation of coccyx
Pudendal neuralgia	Variable	Distribution along the pudendal nerve

involved, patients may describe cramping and changes in bowel habits, oftentimes coinciding with the menstrual cycle. While some patients are diagnosed by symptoms alone, many require a diagnostic laparoscopy for identification of the characteristic lesions. Treatment options range from hormone therapy to surgical excision of implants with concomitant hysterectomy and salpingo-oophorectomy in refractory cases. Other gynecological causes of pelvic pain include pelvic congestion, vulvodynia and vaginitis.

Urological causes of chronic pain include cystitis and urethral syndrome. These patients endorse may complain of dysuria along with changes in urgency and frequency. The workup should include urinalysis and may require cystoscopy. Both gynecological and urological causes go beyond the scope of this chapter and should prompt a referral to the appropriate specialist.

Pelvic Floor Pain Syndrome

Improper function of the pelvic floor musculature can cause significant chronic pelvic pain. The pathophysiology of these conditions is unclear but is likely related to spasm or tension of the striated muscles of the pelvic floor. Precipitating factors can vary from anxiety to childbirth to pelvic, anorectal and spinal operations [26, 27].

Levator Ani Syndrome

The levator ani syndrome is also referred to as puborectalis syndrome, chronic idiopathic perineal pain, pyriformis syndrome and chronic proctalgia. Patients describe a dull pressure or ache that distinctly worsens when sitting or lying down and improves with standing. This pain usually begins in the morning and worsens through the day, but rarely occurs at night. The pain can be associated with the rectum and extend to the sacrum, coccyx or even gluteal region and thighs. Although difficult to localize in some cases, some patients may complain of more pain on the left side of the rectum where the levator ani muscles insert into the pubic ramus [26, 28]. A bowel movement may provide relief, which distinguishes this diagnosis from other causes of pelvic pain.

There may also be overlap with other levator functional pathology. Specifically, some patients may also have obstructed defecation constipation due to non-relaxation of the puborectalis portion of the levator ani muscles. This may need cine video defecography to confirm the diagnosis. Treatment of the one set of symptoms may relieve the other set.

Patients may also have a history of anxiety or depression, recent stress or trauma or recent prolonged sitting. Although diagnosed more frequently in women and in those between 30 and 60 years of age, the actual prevalence is unclear [29].

In order to provide consistency in the diagnosis of this syndrome, the Rome III criteria were developed for levator ani syndrome and include the following: (1) chronic or recurrent episodes of rectal-area pain or aching, (2) lasting 20 min or longer, (3) occurring for at least 12 weeks in the past 12 months, and (4) in the absence of other causes [28]. This longer duration of pain distinguishes levator syndrome from proctalgia fugax.

During the exam, applying posterior traction to the levator muscle near its coccygeal attachment can often reproduce the pain. The experienced examiner may appreciate spasms of this muscle. Digital massage can improve symptoms in many

cases [30]. Even if these exam findings are not identified, the diagnosis of levator syndrome is still possible. Nevertheless, one should exclude other causes with additional tests such as colonoscopy, GI contrast studies, CT scan and in some cases diagnostic laparoscopy. The use of anorectal manometry has been reported but results are inconsistent [25].

Management is multifactorial and involves patient reassurance, pharmacological therapy and physical therapy. Reassurance is key as anxiety may augment symptoms for these patients. Reported use of anxiolytics in both oral and suppository form have been reported but side effects should be considered. Warm baths are thought to alleviate symptoms by relaxing the muscles and have no harmful side effects, although a review of the literature revealed a lack of scientific data to support its use [31].

Digital massage of the puborectalis sling on the affected side has been described. This is limited by the patient's discomfort. This is rarely the only therapy, as massage is often done in conjunction with sitz baths or a short course of oral benzodiazepines. Long-term effects are not clear [27, 28, 30].

Physical therapy of the pelvic floor is helpful in the treatment of these patients. This requires a dedicated physical therapist that is sensitive to the patient's needs and, often, initial resistance to this mode of therapy. Various techniques utilized by pelvic floor physical therapists include biofeedback, electrogalvanic stimulation and internal massage. The research behind these techniques show varied success and is based mainly on small studies with a wide range of follow-up.

Biofeedback was first described in 1991 and studies have been small with varied success rates [32–34]. By retraining the coordination and relaxation of the levator muscles, patients may be able to break the cycle of spasms. Case reports vary in success and none are controlled studies. [35].

Electrogalvanic stimulation (EGS), a technique first described in 1982, involves stimulation of the pelvic floor muscles with a transrectal probe [27, 36, 37]. The stimulation is administered for 20–30 min per session for 3 sessions a week, with the goal of fatiguing the muscles. Sohn et al. describe starting at a pulse frequency of 80 cycles per second with a gradual increase in voltage to the point of discomfort [38]. While there are reports of up to 70% of patients finding relief, the long-term response is less sustainable.

Botox injection has also provided a varied degree of relief in case reports [39]. Unfortunately, the literature also reports a variety of dosages and techniques for administering Botox [40, 41]. We percutaneously inject 100 units of Botox mixed with injectable saline at insertion points of the levator muscle and into the muscle belly.

Sacral nerve stimulation (SNS) has been reported in the treatment of functional anal pain but results are varied. Falletto et al. showed improvements in pain scores at a mean follow up of 15 months and recommended SNS as an option for pain refractory to biofeedback or medications [42]. However in one small study, Dudding et al. showed that SNS was not an effective treatment modality with a 5-year follow-up [43].

Other reported therapies include use of acupuncture, injection of local anesthetics or steroids into the arcus tendon of the levator muscle, or even surgical division of the puborectalis muscle. The later option resulted in a high incidence of incontinence to both stool and gas in case studies, making this therapy undesirable [44].

For all therapies described above, the literature remains highly variable in terms of the inclusion criteria, follow-up intervals, and sample size. Even among randomized studies, there remains variability regarding the number of treatments of one kind and consideration of the effect of previously attempted therapies. Finally, along with pelvic floor musculature dysfunction, there remains the variable of brain processing of pain that may be altered in these patients. For these reasons, patients with levator syndrome may have different therapies to choose from, but outcomes cannot be defined at this time.

Proctalgia Fugax

Patients with proctalgia fugax present with a distinct description of severe sharp pain that lasts for a few seconds to minutes, then resolves completely. The average duration is around 5 min and

patients are asymptomatic between episodes [45]. This severe pain can awaken them from sleep and is localized to the anus or rectum. Because symptoms are fleeting and generally infrequent, proctalgia fugax is difficult to evaluate. While there have been suggestions that stress, defecation, long periods of sitting or menstruation may trigger pain, there may be no obvious trigger identified [46].

The estimated prevalence is up to 18% of the general population but with less than a quarter of those patients reporting symptoms to a physician. The age range is wide but typically affects those around 50 years of age with higher prevalence in women [46, 47]. Spasm of the pelvic floor muscles as well as neuropathy has been implicated as causes. Anal manometry revealed increased resting anal pressures but no differences in squeeze pressure or sphincter relaxation of sphincter complex thickness in those with proctalgia fugax [47].

Although the history of this pain is distinct from other chronic pelvic pain syndromes with short episodes of severe pain, proctalgia fugax is a diagnosis of exclusion. The physical exam and workup can be extensive before this diagnosis is identified.

There are limited data regarding management, but include patient reassurance and treatment of muscle spasm. There are reports of use of topical antispasmodics or muscle relaxants (e.g. Beladona and opium suppositories) [48]. Biofeedback is a noninvasive method used to treat other causes of pain and may be helpful [45]. The use of Botox is more invasive and has been reported with injection of 50 units of the toxin into the anal sphincter with pain relief and no incontinence at 2 months [49]. Other reported modalities of treatment in small studies include the use of inhaled albuterol, intravenous Lidocaine and internal anal sphincterotomy.

Coccygodynia

Coccygodynia is described as pain localized at or around the coccyx. The pain is triggered with prolong sitting and patients often describe repetitive trauma or childbirth as the inciting event [50]. This diagnosis can be confirmed on exam by reproducing pain with palpation of the coccyx on digital exam and external palpation.Plain films of the pelvis are obtained to rule out fractures and more than 50% of patients show features of coccyx instability on imaging [51]. Relief of pain with local anesthetic injection into the coccyx also confirms the diagnosis. The cause of pain may also be related to associated levator spasm with traction on the coccyx.

Treatment begins by avoiding aggravating factors, with Sitz baths and sitting on a cushion in order to reduce pressure [52]. Other reported therapies include levator massage, physical therapy and injection with steroids into the joints and tissues around the coccyx. Coccygectomy is less commonly utilized as a first step in treatment but has been reported for refractory cases [53]. Outcomes have not been evaluated in controlled trials but one study showed that wound infection is the most common complication and outcomes are likely related to surgeon expertise [54].

Pudendal Neuralgia

The pudendal nerve, which runs through Alcock's canal, includes a mix of sensory and motor nerves originating from S2 to S4. Compression of the pudendal nerve at the ischium and obturator internus muscle causes burning, pinching or a twisting sensation that may be located in the perineum, vulvar or anorectal regions. The second common site of compression is at the ischial spine in the gluteal region. Sitting will often aggravate symptoms whereas standing will relieve them. The pain may be unilateral or bilateral. While entrapment is the most common etiology, other reported causes include herpetic and post radiation neuropathy [55].

As with the previous conditions, other causes of anal pain should be excluded. Confirmatory tests can include pudendal nerve terminal motor latency measurements, which will be prolonged. A CT scan may identify the point of nerve compression and a diagnostic CT-guided nerve block

by anesthesia can attempt to relieve the pain. This is usually done first with local anesthetic and if successful in relieving pain, additional injections are provided by peridural route. Long-term results are not available. A surgical decompression may also need to be considered [56].

Summary

Pelvic pain, whether acute or chronic, is one of the most common complaints bringing patients to the colorectal surgeon's office. Quality of life is significantly affected and made worse by a delay in diagnosis, prompted by patient embarrassment and referrals to several specialties. A thorough history and detailed anorectal exam can provide the diagnosis in most cases. The most common causes of acute pain are treatable and non-surgical treatments are effective in a majority of cases. Chronic causes of anorectal and pelvic pain are less well defined but are closely related to dysfunction of the pelvic floor musculature. While a multidisciplinary approach is helpful, it is important to be sensitive to the patient's embarrassment and frustration over this delicate problem. Diagnosing a patient with a pelvic pain syndrome requires a diligent and systematic approach, as well as a careful ear for revealing components of the patient's history.

References

1. Gerard JP, Chapet O, Samiei F, Morignat E, Issac S, Paulin C, et al. Management of inguinal lymph node metastases in patients with carcinoma of the anal canal: experience in a series of 270 patients treated in Lyon and review of the literature. Cancer. 2001;92(1):77–84.
2. Rivadeneira DE, Steele SR, Ternent C, Chalasani S, Buie WD, Rafferty JL, et al. Practice parameters for the management of hemorrhoids. Dis Colon Rectum. 2011;54(9):1059–64.
3. Loder PB, Kamm MA, Nicholls RJ, Phillips RK. Haemorrhoids: pathology, pathophysiology and aetiology. Br J Surg. 1994;81(7):946–54.
4. MacRae HM, Temple LK, McLeod RS. A meta-analysis of hemorrhoidal treatments. Semin Colon Rectal Surg. 2002;13:77–83.
5. Lund JN, Nystrom PO, Coremans G, Herold A, Karaitianos I, Spyrou M, et al. An evidence-based treatment algorithm for anal fissure. Tech Coloproctol. 2006;10(3):177–80.
6. Perry WB, Dykes SL, Buie WD, Rafferty JF, Standards Practice Task Force of the American Society of Colon and Rectal Surgeons. Practice parameters for the management of anal fissures (3rd revision). Dis Colon Rectum. 2010;53(8):1110–5.
7. Shao WJ, Li GC, Zhang ZK. Systematic review and meta-analysis of randomized controlled trials comparing botulinum toxin injection with lateral internal sphincterotomy for chronic anal fissure. Int J Color Dis. 2009;24(9):995–1000.
8. Ramanujam PS, Prasad ML, Abcarian H, Tan AB. Perianal abscesses and fistulas. A study of 1023 patients. Dis Colon Rectum. 1984;27(9):593–7.
9. Gilliland R, Wexner SD. Complicated anorectal sepsis. Surg Clin North Am. 1997;77(1):115–53.
10. Steele SR, Kumar R, Feingold DL, Rafferty JL, Buie WD, Standards Practice Task Force of the American Society of Colon and Rectal Surgeons. Practice parameters for the management of perianal abscess and fistula-in-ano. Dis Colon Rectum. 2011;54(12):1465–74.
11. Bastawrous A, Cintron J. Anorectal abscess and fistula. In: Cameron J, editor. Current surgical therapy. 8th ed. Philadelphia: Elsevier Mosby; 2004. p. 256.
12. Bachmann LH, Johnson RE, Cheng H, Markowitz L, Papp JR, Palella FJ Jr, et al. Nucleic acid amplification tests for diagnosis of *Neisseria gonorrhoeae* and *Chlamydia trachomatis* rectal infections. J Clin Microbiol. 2010;48(5):1827–32.
13. Gottesman L, Gandhi N. Anogenital condyloma and other sexually transmitted diseases. In: Bailey HR, Bilingham RP, Stamos MJ, Snyder MJ, editors. Colorectal surgery. Philadelphia: Elsevier Mosby; 2012. p. 186–204.
14. Whitlow C. Sexually transmitted diseases. In: Beck DE, editor. The ASCRS textbook of colon and rectal surgery. New York: Springer; 2011. p. 295–307.
15. Hook EW, Marra CM. Acquired syphilis in adults. N Engl J Med. 1992;326(16):1060–9.
16. Sagar PM, Pemberton JH. Intraoperative, postoperative and reoperative problems with ileoanal pouches. Br J Surg. 2012;99(4):454–68.
17. Haas EM, Bailey HR, Farragher I. Application of 10 percent formalin for the treatment of radiation-induced hemorrhagic proctitis. Dis Colon Rectum. 2007;50(2):213–7.
18. Monson JR, Weiser MR, Buie WD, Chang GJ, Rafferty JF, Buie WD, et al. Practice Parameters for the Management of Rectal Cancer. Dis Colon Rectum. 2013;56(5):535–50.
19. Blumetti J, Bastawrous AL. Epidermoid cancers of the anal canal: current treatment. Clin Colon Rectal Surg. 2009;22(2):77–83.
20. Steele SR, Varma MG, Melton GB, Ross HM, Rafferty JF, Buie WD, Standards Practice Task Force of the American Society of Colon and Rectal Surgeons.

Practice parameters for anal squamous neoplasms. Dis Colon Rectum. 2012;55(7):735–49.
21. Anothaisintawee T, Attia J, Nickel JC, Thammakraisorn S, Numthavaj P, McEvoy M, et al. Management of chronic prostatitis/chronic pelvic pain syndrome: a systematic review and network meta-analysis. JAMA. 2011;305(1):78–86.
22. Drossman DA, Li Z, Andruzzi E, Temple RD, Talley NJ, Thompson WG, et al. U.S. householder survey of functional gastrointestinal disorders. Prevalence, sociodemography, and health impact. Dig Dis Sci. 1993;38(9):1569–80.
23. Mathias SD, Kuppermann M, Liberman RF, Lipschutz RC, Steege JF. Chronic pelvic pain: prevalence, health-related quality of life, and economic correlates. Obstet Gynecol. 1996;87(3):321–7.
24. Apte G, Nelson P, Brismée JM, Dedrick G, Justiz R, Sizer PS Jr. Chronic female pelvic pain–part: clinical pathoanatomy and examination of the pelvic region. Pain Pract. 2012;12(2):88–110.
25. Chiarioni G, Asteria C, Whitehead WE. Chronic proctaglia and chronic pelvic pain syndromes: new etiologic insights and treatment options. World J Gastroenterol. 2011;17(40):4447–55.
26. Park DH, Yoon SG, Kim KU, Hwang DY, Kim HS, Lee JK, et al. Comparison study between electrogalvanic stimulation and local injection therapy in levator ani syndrome. Int J Color Dis. 2005;20(3):272–6.
27. Salvati EP. The levator syndrome and its variant. Gastroenterol Clin N Am. 1987;16(1):71–8.
28. Wald A, Bharucha AE, Enck P, Rao SS. Functional anorectal disorders. In: Drossman DA, Corazzairi E, Delvaux M, Spiller RC, Talley NJ, Thompson WG, Whitehead WE, editors. Rome III: the functional gastrointestinal disorders. 3rd ed. McLean: Degnon Associates; 2006. p. 639–85.
29. Whitehead WE, Wald A, Diamant NE, Enck P, Pemberton JH, Rao SS. Functional disorders of the anus and rectum. Gut. 1999;45(Suppl 2):55–9.
30. Grant SR, Salvati EP, Rubin RJ. Levator syndrome: an analysis of 316 cases. Dis Colon Rectum. 1975;18(2):161–3.
31. Tejirian T, Abbas MA. Sitz bath: where is the evidence? Scientific basis of a common practice. Dis Colon Rectum. 2005;48(12):2336–40.
32. Wald A. Functional anorectal and pelvic pain. Gastroenterol Clin N Am. 2001;30(1):243–51. viii-ix
33. Gilliland R, Heymen JS, Altomare DF, Vickers D, Wexner SD. Biofeedback for intractable rectal pain: outcome and predictors of success. Dis Colon Rectum. 1997;40(2):190–6.
34. Grimaud JC, Bouvier M, Naudy B, Guien C, Salducci J. Manometric and radiologic investigations and biofeedback treatment of chronic idiopathic anal pain. Dis Colon Rectum. 1991;34(8):690–5.
35. Heah SM, Ho YH, Tan M, Leong AF. Biofeedback is effective treatment for levator ani syndrome. Dis Colon Rectum. 1997;40(2):187–9.
36. Billingham RP, Isler JT, Friend WG, Hostetler J. Treatment of levator syndrome using high-voltage electrogalvanic stimulation. Dis Colon Rectum. 1987;30(8):584–7.
37. Hull TL, Milsom JW, Church J, Oakley J, Lavery I, Fazio V. Electrogalvanic stimulation for levator syndrome: how effective is it in the long-term? Dis Colon Rectum. 1993;36(8):731–3.
38. Sohn N, Weinstein MA, Robbins RD. The levator syndrome and its treatment with high-voltage electrogalvanic stimulation. Am J Surg. 1982;144(5):580–2.
39. Thomson AJ, Jarvis SK, Lenart M, Abbott JA, Vancaille TG. The use of botulinum toxin type A (BOTOX) as treatment for intractable chronic pelvic pain associated with spasm of the levator ani muscles. BJOG. 2005;112(2):247–9.
40. Rao SS, Paulson J, Mata M, Zimmerman B. Clinical trial: effects of botulinum toxin on Levator ani syndrome—a double-blind, placebo-controlled study. Aliment Pharmacol Ther. 2009;29(9):985–91.
41. Bhide AA, Puccini F, Khullar V, Elneil S, Digesu GA. Botulinum neurotoxin type A injection of the pelvic floor muscle in pain due to spasticity: a review of the current literature. Int Urogyencol J. 2013;24(9):1429–34.
42. Falletto F, Masin A, Lolli P, Villani R, Ganio E, Ripetti V, et al. Is sacral nerve stimulation an effective treatment for chronic idiopathic anal pain? Dis Colon Rectum. 2009;52(3):456–62.
43. Dudding TC, Thomas GP, Hollingshead JR, George AT, Stern J, Vaizey CJ. Sacral nerve stimulation: an effective treatment for chronic functional anal pain? Color Dis. 2013;15(9):1140–4.
44. Barnes PR, Hawley PR, Preston DM, Lennard-Jones JE. Experience of posterior division of the puborectalis muscle in the management of chronic constipation. Br J Surg. 1985;72(6):475–7.
45. Atkin GK, Suliman A, Vaizey CJ. Patient characteristics and treatment outcome in functional anorectal pain. Dis Colon Rectum. 2011;54(7):870–5.
46. de Parades V, Etienney I, Bauer P, Taouk M, Atienza P. Proctalgia fugax: demographic and clinical characteristics. What every doctor should know from a prospective study of 54 patients. Dis Colon Rectum. 2007;50(6):893–8.
47. Eckardt VF, Dodt O, Kanzler G, Bernhard G. Anorectal function and morphology in patients with sporadic proctalgia fugax. Dis Colon Rectum. 1996;39(7):755–62.
48. Lacy BE, Weiser K. Common anorectal disorders: diagnosis and treatment. Curr Gastroenterol Rep. 2009;11(5):413–9.
49. Katsinelos P, Kalomenopoulou M, Christodoulou K, Katsiba D, Tsolkas P, Pilpilidis I, et al. Treatment of proctalgia fugax with botulinum A toxin. Eur J Gastroenterol Hepatol. 2001;13(11):1371–3.
50. Thiele GH. Tonic spasm of the levator ani, coccygeus and piriformis muscle: relationship to coccygodynia and pain in the region of the hip and down the leg. Trans Am Proctol Soc. 1936;37:145–55.

51. Maigne JY, Lagauche D, Doursounian L. Instability of the coccyx in coccydynia. J Bone Joint Surg Br. 2000;82(7):1038–41.
52. Mazza L, Formento E, Fonda G. Anorectal and perineal pain: new pathophysiological hypothesis. Tech Coloproctol. 2004;8(2):77–83.
53. Cebesoy O, Guclu B, Kose KC, Basarir K, Guner D, Us AK. Coccygectomy for coccygodynia: do we really have to wait? Injury. 2007;38(10):1183–8.
54. Karadimas EJ, Trypsiannis G, Giannoudis PV. Surgical treatment of coccygodynia: an analytic review of the literature. Eur Spine J. 2011;20(5):698–705.
55. Benson JT, Griffis K. Pudendal neuralgia, a severe pain syndrome. Am J Obstet Gynecol. 2005;192(5):1663–8.
56. Labat JJ, Riant T, Robert R, Amarenco G, Lefaucher JP, Rigaud J. Diagnostic criteria for pudendal neuralgia by pudendal nerve entrapment (Nantes criteria). Neurourol Urodyn. 2008;27(4):306–10.
57. Billingham RP, Bastawrous AL. Chronic anal pain. In: Steele SR, Maykel JA, Champagne BJ, Orangio GR, editors. Complexities in colorectal surgery. New York: Springer; 2014. p. 363–75.

Anal Neoplasms

19

Brian R. Kann

Introduction

While anal neoplasms account for less than 5% of lower gastrointestinaltract malignancies and less than 1% of new malignancies overall in the United States [1], knowledge regarding the diagnosis and management of these lesions is critical to the practice of colon and rectal surgery. It is estimated that there will be 8200 new cases of anal cancer diagnosed in 2017, and an estimated 1100 deaths; both of these represent a continued slow upward trend in recent years [2]. This chapter will outline the diagnosis and management of anal neoplasms, both malignant and pre-malignant.

Anatomy

A clear understanding of anorectal anatomy and histology is of paramount importance in understanding the origin, diagnosis, and management of the different types of anorectal neoplasms encountered (Fig. 19.1).

B. R. Kann (✉)
Department of Colon and Rectal Surgery,
Ochsner Medical Center, New Orleans, LA, USA
e-mail: brian.kann@ochsner.org

The surgical anal canal extends from the puborectal sling at the top of the anal sphincter complex proximally to the intersphincteric groove distally. The upper two-thirds and lower third of the anal canal are separated by the dentate (or pectinate) line, which is the point of fusion between tissues of endodermal and ectodermal origin. The upper two-thirds is lined by endodermal columnar epithelium, which transitions to transitional epithelium just proximal to the dentate line, then ectodermal squamous epithelium distal to the dentate line. The anal transition zone is the 1–2 cm region just proximal to the dentate line, which is lined by transitional epithelium. The squamous epithelium in the distal anal canal is non-keratinized and lacks hair follicles and other accessory organs typically seen in cutaneous squamous epithelium. At the anal verge, this modified squamous epithelium transitions to a more typical, keratinized, hair-bearing skin. The arterial supply of the upper two-thirds of the anal canal is via the superior rectal artery, a branch of the inferior mesenteric artery. The lower third of the anal canal is supplied by the inferior rectal artery, a branch of the internal pudendal artery. Lymphatic drainage of the anal canal is multi–directional, draining superiorly to the pararectal and superior hemorrhoidal nodes, laterally to the internal iliac nodes, and inferiorly to the inguinal and external iliac nodes.

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_19

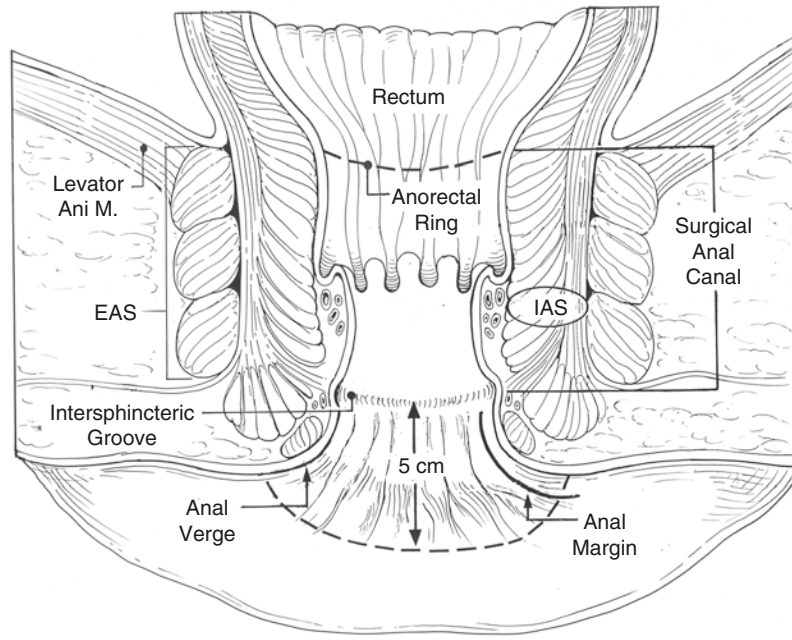


Fig. 19.1 Anatomy of anal canal and anal margin. *EAS* External anal sphincter; *IAS* Internal anal sphincter

The anal margin extends from the intersphincteric groove to a distance of approximately 5-cm circumferentially around the anal verge. Metastatic anal margin tumors typically metastasize to inguinal lymph nodes, though they may also metastasize proximally to pelvic lymph nodes if distal lymphatic drainage is obstructed by tumor.

Varying epithelial types in different locations of the anus may give rise to various types of tumors (Tables 19.1 and 19.2), the management of which will be discussed in this chapter. Squamous cell cancer of the anal canal arises from either the keratinized or non-keratinized squamous epithelium of the anal canal. Histologic variants of squamous cell cancer, such as transitional and basaloid cancer, typically arise from the anal transition zone. Adenocarcinoma of the anal canal arises from the columnar epithelium in the proximal anal canal or glandular cells of the anal transition zone. A classification system has been suggested whereby the location of anal neoplasms is described as being intra-anal (either only partially visible or not visible at all when gentle traction is placed on the buttocks), perianal (visualized in their entirety and within a 5-cm

Table 19.1 WHO histological classification of malignant tumours of the anal canal [104]

• Carcinoma
– Squamous cell carcinoma (“Epidermoid carcinoma”)
– Adenocarcinoma
Rectal type
Of anal glands
Within anorectal fistula
– Mucinous adenocarcinoma
– Small-cell carcinoma
– Undifferentiated carcinoma
• Carcinoid tumors
• Malignant melanoma
• Non-epithelial tumors
– Sarcoma
• Secondary tumors

Table 19.2 Anal margin neoplasms

Potentially malignant lesions	Bowen's disease
	Paget's disease
	Leukoplakia
	Condyloma accuminata
Malignant lesions	Squamous cell carcinoma
	Basal cell carcinoma
	Verrucous carinoma
	Kaposi's sarcoma

radius of the anal verge with the same gentle traction) or on the skin (those that lie outside of a 5-cm radius of the anal verge) [3]. Skin lesions are typically squamous cell and basal cell cancers, which are usually managed with local excision, when feasible.

Anal Squamous Cell Cancer

Squamous cell cancer (or epidermoid cancer) is the most common malignant neoplasm of the anus. While a number of terms were historically used to distinguish between subtypes of squamous cell anal cancer, including cloacogenic, basaloid, mucoepidermoid, and transitional, the use of these terms has generally fallen out of use, as the majority of squamous malignancies of the anal canal are treated in a similar fashion and have similar prognoses.

Etiology

One of the most common risk factors associated with the development of anal cancer is infection with human papillomavirus (HPV). The incidence of anal cancer is steadily rising, a phenomenon thought to be related to a higher likelihood of having multiple sexual partners or practicing anal receptive intercourse, both of which may increase the likelihood of HPV infection. HPV is strongly associated with the development of premalignant anal squamous intraepithelial neoplasia (AIN), which can progress to invasive squamous cell cancer of the anus [4]. HPV serotypes 16 and 18 are most commonly associated with AIN, though other serotypes may also give rise to premalignant lesions [5]. Up to 98% of tumors from nonexclusively heterosexual men have been found to be positive for HPV, with 73% positive for HPV-16 [6]. The management of AIN and the role of surveillance and treatment, including high-resolution anoscopy, are covered in Chap. 20.

Other risk factors include a history of other sexually transmitted diseases, which frequently cause co-infection with HPV, the presence of other precancerous lesions [such as anal condylomata, cervical intraepithelial neoplasia (CIN) or vulvar intraepithelial neoplasia (VIN)], human immunodeficiency virus (HIV) infection (particularly with a low CD4 count), immunosuppressive medical therapy, and tobacco use. Co-infection with HIV further increases the risk of developing invasive anal cancer. Shiels et al reviewed trends in anal cancer in association with HIV/AIDS, and found that from 1980 to 2005, 8.1% of estimated anal cancer cases were HIV-related, while the period from 2001 to 2005 had the highest proportion of anal cancer in association with HIV infection—1.2% among females and 28.4% among males [7].

Diagnosis

The median age at the time of diagnosis of anal squamous cell cancer is 60–65, with a slightly higher incidence in women (F:M = 1.6:1) [2, 4, 8]. The most common presenting symptom is rectal bleeding, seen in up to 45% of cases, followed by anal pain or a sensation of a palpable mass, present in up to 30% of patients [9, 10]. However, up to one-third of patients may be

asymptomatic at the time of diagnosis or have vague, non-specific symptoms [11]. When bleeding is present, it typically precedes other symptoms. Other non-specific complaints may include incontinence, pruritis, pain when sitting, or anal discharge. Many patients endure their symptoms for some time thinking they may be suffering from hemorrhoids or fissure-in-ano, resulting in a significant delay in diagnosis and treatment. Unfortunately, given the rarity of anal cancer and difficulty of performing a thorough anorectal exam on an uncomfortable patient, is it not uncommon for primary care providers to dismiss or misdiagnose non-specific symptoms or a suspicious lesion as hemorrhoidal disease or fissure-in-ano, further delaying treatment.

Patients with findings suspicious for anal cancer should undergo a detailed history, assessing for risk factors as previously described. A careful inspection of the perianal skin and anal verge should be performed. Digital rectal examination should provide a rough approximation of sphincter function as well as fixation of the tumor to the sphincter. On examination, anal canal squamous cell cancers may be either partially visible at the anal verge or not visible at all. However, they should all be palpable on digital rectal exam. Grossly, anal squamous cell cancer typically appears as a hard irregular mass that may be ulcerated and frequently bleeds easily on contact (Fig. 19.2). In females, a pelvic examination should be performed to determine the extent of fixation of anterior lesions to the posterior vaginal wall. Masses palpated on digital exam should be visualized via anoscopy if the patient will tolerate it; otherwise examination under anesthesia is indicated. A precise description of the size and location of the tumor as well as the degree of fixation to the anal sphincter complex is essential prior to instituting treatment.

Histologic confirmation of malignancy should be performed by biopsy. Several biopsies from the edges of the lesion should be performed. An excisional biopsy should be avoided for all but very small lesions, as this may leave a surgical wound that may not heal after initiation of radiation therapy and can lead to a painful ulceration at the site of excision once radiation has been completed. This subject is discussed in greater detail in Chapter 20.

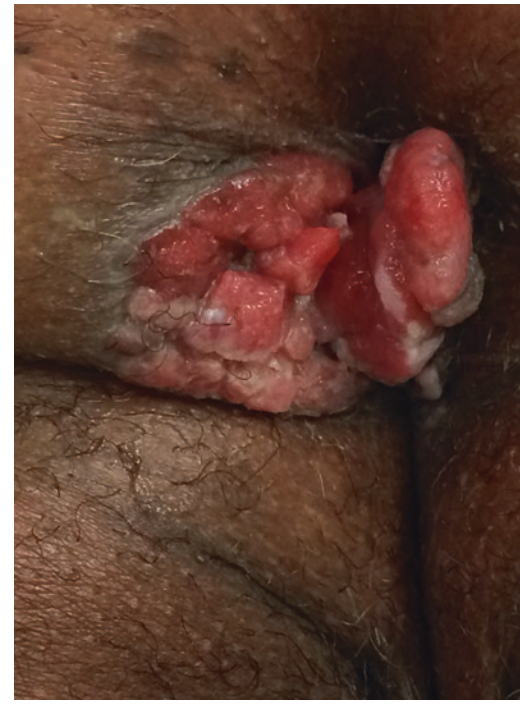


Fig. 19.2 Squamous cell carcinoma of the anus

Physical examination should also include evaluation for enlarged inguinal lymph nodes, as metastases to inguinal lymph nodes may be seen in 30–43% of patients at time of diagnosis [12]. Enlarged lymph nodes may be biopsied via fine needle aspiration (FNA); excisional biopsy should be avoided to minimize the risk of poor wound healing after initiation of radiotherapy.

While it is generally advised that patients with anal cancer undergo colonoscopy to evaluate for synchronous colorectal lesions, there is no definitive link between squamous cell anal cancer and adenomatous colorectal neoplasia [11]. Female patients should undergo routine gynecologic examination, including cervical PAP smear, given the relationship of HPV to both anal and cervical cancer.

Staging

American Joint Committee on Cancer (AJCC) staging of anal squamous cell cancer is clinical, based on findings on physical examination and imaging. Staging of anal cancer differs from

colorectal cancer in that the T stage is dependent upon size of the tumor, not depth of invasion; the N stage is determined by the farthest reach of metastatic nodal disease, not the total number of nodes involved (Tables 19.3 and 19.4). National Comprehensive Cancer Network (NCCN) guidelines suggest that clinical staging should include both locoregional staging, via magnetic resonance imaging (MRI) and/or endoanal ultrasonagraphy (EAUS), as well as evaluation for distant metastatic disease via computed tomography (CT) scan of the chest/abdomen/pelvis or FDG-positron emission tomography CT (PET/CT) [13]. A review of the National Cancer Database found that at the time of diagnosis, 25% of patients with anal cancer were stage I, 52% were stage II, 17% were stage III, and 6% were stage IV [14].

Table 19.3 AJCC staging of anal cancer—definitions of TNM [104]

Primary tumor (T)	
TX	Primary tumor cannot be assessed
T0	No evidence of primary tumor
Tis	Carcinoma-in-situ (Bowen's disease, HISL, AIN II-II)
T1	Tumor ≤2 cm
T2	Tumor >2 cm but <5 cm
T3	Tumor ≥5 cm
T4	Tumor of any size invading adjacent organ(s): vagina, urethra, bladder, etc[a]
Regional lymph nodes (N)	
NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastases
N1	Metastasis in perirectal lymph node(s)
N2	Metastasis in unilateral internal iliac and/or inguinal lymph node(s)
N3	Metastasis in perirectal and inguinal lymph nodes and/or bilateral internal iliac and or inguinal nodes
Distant metastasis (M)	
MX	Distant metastasis cannot be assessed
M0	No distant metastasis
M1	Distant metastasis

HISL high-grade intraepithelial squamous lesion, *AIN* anal intraepithelial neoplasia
[a]Note: direct invasion of rectal wall, perirectal skin, subcutaneous tissue, or sphincter muscle(s) is not classified as T4

Table 19.4 AJCC staging of anal cancer—anatomic staging [104]

Stage	T	N	M
0	Tis	N0	M0
I	T1	N0	M0
II	T2–3	N0	M0
IIIA	T1–3	N1	M0
	T4	N0	M0
IIIB	T4	N1	M0
	Any T	N2–3	M0
IV	Any T	Any N	M1

While EAUS can be a valuable tool in assessing pre-treatment tumor size, depth of invasion, sphincter involvement, and perirectal lymph node involvement, its sensitivity is highly variable and user-dependent. EAUS may be superior to MRI in assessing superficial distal tumors, though the ability to perform an adequate study may be limited when stenotic or painful lesions are present. The addition of three-dimensional (3D) technology to EAUS has improved its sensitivity; 3D-EAUS has been shown to have sensitivities approaching 93% and 82%, respectively, for T and N status [15]. However, while EAUS has the advantages of being easier, quicker, and cheaper than MRI, EAUS has largely been supplanted by MRI in recent years, given the reproducibility of MRI and recent advances in imaging protocols.

MRI is considered by many to be the gold standard in oncologic pelvic staging, providing detailed, high-resolution, multiplanar information. In the case of anal canal squamous cell cancer, MRI allows one to obtain an accurate and reliable assessment of the location and size of the primary tumor, circumferential and craniocaudad extent, involvement of the anal sphincter complex and other adjacent structures, and involvement of pelvic and inguinal lymph nodes. Detailed anatomic information, including the degree of tumor infiltration and involvement of sphincter musculature, can be valuable in the initial assessment of patients with anal squamous cell cancer.

A typical protocol for anal cancer staging consists of pre- and post-contrast enhanced T2-weighted images in coronal, transverse, and sagittal planes, with high spatial resolution [16]. Additionally, a diffusion weighted imaging sequence (DWI) should be included. DWI supplies information regarding water mobility, which can help to assess microstructural

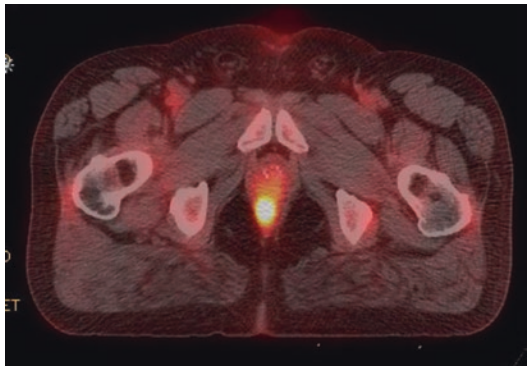


Fig. 19.3 PET/CT demonstrating distal anal canal carcinoma

characteristics of tissue, such as cell density, cell membrane integrity, and ultimately cell viability [17].

Evaluation for distant metastatic disease can be performed either via CT scan of the chest, abdomen, and pelvis or via FDG PET/CT, which is being used with increasing frequency in both the initial staging of anal cancer as well as in assessment of response to treatment. Approximately 98% of anal tumors are FDG avid (Fig. 19.3), making PET/CT an extremely useful imaging modality [11]. Advantages of PET/CT over traditional CT include its ability to identify the primary tumor as well as potential lymph node metastases. PET/CT has been shown to be able to identify the primary tumor in over 90% of cases of anal cancer, compared with less than 60% for conventional CT [18]; PET/CT has also been shown to be able to detect inguinal lymph node involvement in 17–23% of patients in which CT was deemed to show no lymph node involvement [18, 19].

PET/CT is most useful in patients with clinically suspicious lymph node involvement and larger (T2-T4) tumors to assist with initial staging and to establish a pre-treatment baseline. The primary impact of PET/CT on therapy seems to be its superiority in identifying involved pelvic or inguinal lymph nodes, prompting inclusion of these areas in the radiation field [20–22]. Wells et al reported that PET/CT findings in the initial staging of anal cancer altered patient management in 29% of cases [23]. A systematic review published by Jones et al found that PET/CT led to changes in nodal status compared with conventional imaging in 28% of patients; when only studies performing contemporary PET/CT were considered, the TNM stage was altered in 41% of patients [24].

Treatment

Local excision may be considered for the smallest of tumors (usually <1 cm in size) without sphincter involvement or in high-risk patients. Post-excision combined modality treatment (CMT) may be utilized when margins are positive or threatened, with the understanding that healing of the excision site will be hampered by radiotherapy, potentially leading to a chronic non-healing ulcer that can be extremely painful.

Until the 1970s, radical surgery in the form of an abdominoperineal resection (APR) and permanent end colostomy was the standard of care for potentially curable anal squamous cell carcinoma not amenable to local resection. Mortality rates, local failure rates, and the incidence of major complications with this procedure were quite high compared with current surgical standards. In 1974, Norman Nigro published the first in a series of manuscripts that would dramatically alter the means by which anal squamous cell carcinoma would come to be managed. His first report was a series of three patients with anal cancer treated with a combination of pre-operative 5-fluorouricil (5-FU) and mitomycin-C (MMC) given in conjunction with 3000 rads of external beam radiation. Two patients underwent APR and were found to have no residual malignancy in the resected specimens; the remaining patient refused surgery and was disease-free at a follow-up of 14 months [25]. A follow-up report in 1977 added clinical data from an additional 7 patients to the original 3 patients. Of the 9 patients who underwent surgery, 6 had no residual malignancy, 2 had locally advanced (“Duke’s B”) residual malignancy, and 1 was found to have hepatic metastases at the time of laparotomy [26].

In 1983, Nigro published an expanded report of 28 patients managed similarly [27]. Twelve

underwent subsequent APR; 7 had no residual disease in the specimen and 1 had microscopic disease only. The remaining 16 patients all had a complete treatment response and did not undergo surgery; 14 of these underwent excision of the residual scar and were found to have no residual disease. Four patients ultimately died of cancer; all had undergone APR after initial treatment and all had gross residual tumor. Additionally, all had tumors >7 cm in size at the time of initial diagnosis. By 1987, Nigro's cohort had grown to 104 patients; 97 had a complete clinical response after chemoradiation, and 24 followed treatment by undergoing APR—22 had no residual tumor in the specimen. Biopsy of the post-treatment scar was performed in 62 patients, 61 of whom had no residual tumor. The 5-year overall survival rate was 83% [28]. This combined modality treatment (CMT) regimen, termed the "Nigro Protocol," paved the way for future research and led to a major paradigm shift in the management of anal squamous cell carcinoma.

A number of other studies have helped to better define the role of CMT in the management of anal squamous cell cancer. The UK Coordinating Committee on Cancer Research (UKCCCR) prospective randomized trial of radiotherapy alone compared with CMT found a 59% local failure rate with radiotherapy alone compared with a 36% local failure rate with CMT at 42 month follow-up; CMT imparted a 46% reduction in the risk of local failure compared with radiotherapy alone, and the risk of death from anal cancer was significantly reduced in the CMT arm [29]. Twelve-year follow-up of the patients from this study (ACT I Trial) showed that for every 100 patients treated with CMT, there are an expected 25.3 fewer patients with locoregional relapse and 12.5 fewer anal cancer deaths, compared with 100 patients given radiotherapy alone [30].

Similarly, the European Organization for Research and Treatment of Cancer Radiotherapy and Gastrointestinal Cooperative Groups phase III randomized trial of CMT vs. radiotherapy alone found that the addition of chemotherapy to radiotherapy resulted in an increase in the complete remission rate from 54% for radiotherapy alone to 80% for radiotherapy and chemotherapy, and an increase from 85% to 96%, respectively, if results were considered after surgical resections. CMT provided significant improvement in both locoregional control (18% improvement at 5 years) and colostomy-free interval (increased by 32%) [31].

The Radiation Therapy Oncology Group (RTOG)/Eastern Cooperative Oncology Group (ECOG) 87-04 trial, published in 1996, was a phase III randomized trial in which treatment with 5-FU, MMC, and radiotherapy was compared with treatment with 5-FU and radiotherapy. While there was no significant difference in overall survival at 4-year follow-up, colostomy rates were lower (9% v 22%; P = 0.002), colostomy-free survival was higher (71% v 59%; P = 0.014), and disease-free survival was higher (73% v 51%; P = 0.0003) in the treatment arm that included MMC [32].

Other studies have investigated the use of cisplatin in lieu of MMC. The US Gastrointestinal Intergroup trial RTOG 98-11 was a multicenter, phase III, randomized controlled trial comparing treatment with 5-FU plus MMC and radiotherapy vs treatment with 5-FU plus cisplatin and radiotherapy. The 5-year disease-free survival rate was 60% in the MMC-based group compared with 54% in the cisplatin-based group (p = 0.17) and the 5-year overall survival rate was 75% in the MMC-based group and 70% in the cisplatin-based group (P = 0.10). However, the cumulative rate of colostomy was significantly better for MMC-based than cisplatin-based treatment (10% vs 19%; P = 0.02) [33].

The ACT II trial was another randomized phase III trial that compared MMC- or cisplatin-based CMT chemoradiation with or without maintenance chemotherapy (5-FU and cisplatin at weeks 11 and 14). No difference was seen in the rates of achieving complete response between the MMC-based arm and the cisplatin-based arm (90.5% vs 89.6% at 26 weeks; p = 0.64). Additionally, maintenance chemotherapy did not improve progression-free survival [34].

The ACCORD-03 trial, published in 2012, sought to determine if there was an advantage to using induction chemotherapy with 5-FU and cisplatin prior to a standard course of CMT or to

using a high-dose radiation boost. The authors reported no difference in colostomy free-survival rates between groups treated with induction chemotherapy and standard radiotherapy (45 Gy) with 5-FU/MMC, induction chemotherapy and high-dose boost radiotherapy (additional 20–25 Gy) with 5-FU/MMC, standard dose radiotherapy with 5-FU/cisplatin, and high-dose boost radiotherapy with 5-FU/cisplatin [35].

The dosage of external beam radiotherapy and means of delivery have evolved significantly since Nigro's initial reports. The dosage varies based on the size of the tumor and presence or absence of suspected lymph node involvement. Typically, larger tumors will require larger doses of radiation. While Nigro's initial protocol used 30 Gy, patients with anal cancer typically receive a minimum dose of 45–54 Gy to the primary cancer. Current NCCN Guidelines (Version 1.2017) call for a minimum dose of 45 Gy in 1.8 Gy fractions (25 fractions over 5 weeks) to the primary cancer. The inguinal nodes, pelvis, anus, and perineum should be included in the initial radiation fields, with the superior field border at L5-S1 and the inferior border at the anus with a minimum 2.5-cm margin around the anus and tumor. The lateral borders should include the lateral inguinal lymph nodes, but attempt to reduce the radiation dose to the femoral heads. After 17 fractions (30.6 Gy), an additional 14.4 Gy should be given in 8 fractions, with the superior field reduced to the bottom of the sacroiliac joints. Additional field reduction off the inguinal nodes should occur after 36 Gy for node-negative lesions. For T2 lesions, T3/4 lesions, or N1 lesions, an additional boost of 9–14 Gy in 1.8–2 Gy fractions to the original primary tumor volume and involved nodes plus a 2 to 2.5-cm margin is usually delivered [13].

Toxicity with radiotherapy is common but fortunately, adverse effects are typically minor and usually self-limited. Short-term and long-term side effects are listed in Table 19.5. Local toxicity, namely dermatitis and pain, may necessitate "breaks" in radiotherapy protocols, delaying completion of treatment and potentially affecting outcomes. Intensity-modulated radiation therapy (IMRT) is a modality utilized to reduce toxicity to surrounding structures and potentially eliminate toxicity-related treatment delays. IMRT utilizes detailed shaping of radiation beams, allowing for more precise delivery to target tissues and sparing normal tissues, including the perianal/perineal skin, external genitalia, and bladder. A retrospective study from Memorial Sloan Kettering Cancer Center found no differences in 2-year local recurrence-free survival, distant metastasis-free survival, colostomy-free survival, and overall survival, comparing patients with squamous cell anal cancer treated with IMRT compared with conventional 3-dimensional radiotherapy (3DRT) [36]. The RTOG 0529 trial prospectively assessed the utility of IMRT in reducing acute morbidity of CMT for anal cancer, and found that IMRT was associated with significant sparing of acute grade 2+ hematologic and grade 3+ dermatologic and gastrointestinal toxicity [37]. Current NCCN guidelines (Version 1.2017) indicate that IMRT is preferred over conventional radiotherapy in the management of anal squamous cell cancer [13].

Table 19.5 Side effects of radiotherapy for anal cancer

Short term	Dermatitis
	Pain
	Local tissue edema
	Increased fecal urgency and frequency
	Weakness, fatigue
	Nausea
	Vaginal discomfort/discharge
Long term	Anal stenosis
	Fecal incontinence
	Radiation proctitis
	Vaginal stenosis
	Dyspareunia
	Infertility
	Lymphedema

In terms of chemotherapy dosing, current NCCN Guidelines (Version 1.2017) for the management of localized, non-metastatic squamous cell cancer of the anus recommend CMT with 5-FU (continuous infusion 100 mg/m^2/day on days 1–4 and 29–32) and MMC (10 mg/m^2 IV bolus days 1 and 29) with concurrent radiotherapy. Alternatively, oral capecitabine may be substituted for 5-FU,

though it must be taken twice daily throughout the duration of radiotherapy and is typically associated with a higher incidence of adverse effects and treatment interruption. Similarly, cisplatin may be used in lieu of MMC, though it is generally associated with higher rates of toxicity. For the management of metastatic disease, NCCN Guidelines recommend CMT with 5-FU, cisplatin, and concurrent radiotherapy [13].

Cetuximab, an anti-epidermal growth factor receptor 1 (EGFR-1) monoclonal antibody, was studied in combination with CMT utilizing radiotherapy, 5 FU and cisplatin in a phase 1 trial. Despite a response rate of 95%, the study was closed early due to severe toxicity, including thromboembolism (26%), grade 3/4 radiation dermatitis (52%), and grade 3/4 diarrhea (44%) [38]. The ACCORD-16 trial was a phase II trial evaluating concurrent use of cetuximab with CMT for the treatment of anal cancer that also was closed early due to excessive toxicity [39].

Evaluation of Treatment Response and Surveillance

Clinical follow-up by careful physical examination and regular imaging is critical in the assessment of response to treatment with CMT and in ongoing surveillance. Digital rectal exam, anoscopy, and evaluation of inguinal nodes should initially be performed 8–12 weeks after completion of CMT. If no residual tumor or suspicious inguinal adenopathy is identified, the patient is considered to be in remission; surveillance should include DRE every 3–6 months for 5 years, anoscopy every 6–12 months for 3 years, and contrast-enhanced CT of the chest/abdomen/pelvis or PET/CT annually for 3 years if the initial tumor was T3-4 and/or inguinal node positive. Routine post-treatment biopsy of scar at the previous tumor site is not indicated.

If persistent disease is noted at the time of initial post-treatment evaluation, one should resist the urge to biopsy the residual lesion at first, as the effects of radiotherapy typically continue to cause tumor regression for weeks to months after completion of therapy. The patient should be re-evaluated in 4 weeks, and if there is regression or lack of progression, continued observation and re-evaluation of the patient in 3 months is recommended. If persistent disease is noted at 6 months following completion of CMT or if progressive disease arises, the suspicious lesion should be biopsied; a positive biopsy indicates that at that point the patient has progressive disease and should be restaged. In the absence of metastatic disease, APR is indicated, if the patient is medically fit to undergo surgery. Alternatively, depending on the initial radiation dose, the patient may be a candidate for an additional radiation boost. If re-staging reveals the presence of metastatic disease, chemotherapy with 5-FU and cisplatin is indicated.

MRI after completion of CMT has been advocated by some for the evaluation of response to treatment. Kochhar et al assessed the use of an MRI-determined tumor regression grading (TRG), in which scores ranged from 1 (complete response) to 5 (no response), in the assessment of local response and detection of salvageable early relapse after CMT for anal squamous cell carcinoma. They found that on post-CMT MRI's performed 3 and 6 months after completion of treatment, TRG 1/2 scores had a 100% negative predictive value, whereas TRG 4/5 scores on MRI 6 months post-CMT had a 100% positive predictive value. All patients with TRG 4/5 score on MRI 6 months post-CMT underwent salvage R0 resections [40].

Post-CMT PET/CT may also be helpful in determining response to treatment. Vercillino et al reported that during post-treatment follow-up, PET/CT had a sensitivity of 93% and specificity of 81% on a per-examination basis, with a negative predictive value of 94% [41]. Teagle et al similarly reported a sensitivity of 100%, specificity of 74%, and negative predictive value of 100% [42].

If, during the course of surveillance, local recurrence is detected, APR is indicated in the absence of metastatic disease. Inguinal node recurrence may be managed with inguinal node dissection, with consideration for radiotherapy, if not previously administered, and/or chemotherapy

with 5-FU (or capecitabine) and MMC. Patients found to have distant metastatic disease during the course of follow-up should be offered chemotherapy with 5-FU and cisplatin.

Salvage Treatment

Persistent or recurrent disease can be seen in up to 30% of patients following initial CMT [11]. Risk factors include HIV-positivity, high T and/or N stage at time of initial diagnosis, and interruption of treatment during CMT. After confirming progressive or recurrent disease by biopsy and excluding distant metastatic disease, salvage surgery is generally indicated. Some advocate for an additional 9 Gy of radiotherapy prior to surgery [11]. The extent of salvage surgery may range from local excision to APR to pelvic exenteration, depending on the extent of disease present. Salvage APR is associated with 5-year locoregional control rates of 30–77% [43–45]. Wound complications occur commonly, owing to large perineal incisions involving previously radiated tissue. A number of studies have shown that flap reconstruction of the perineum, using either the rectus abdominus or gracilus muscle, results in significantly fewer wound healing complications [46–50].

Functional Results After Radiotherapy

While the vast majority of patients with anal squamous cell cancer treated with CMT will have excellent oncologic outcomes, functional outcomes are often overlooked. Long-term complications, such as anal ulcers, strictures, fibrosis, stenosis, and fistulae are being seen less frequently with increased utilization of IMRT. Other long-term effects of pelvic radiotherapy include urinary dysfunction (including frequency, urgency, incomplete bladder emptying, incontinence, and dysuria), and sexual dysfunction (including impotence, dyspareunia, and vaginal stenosis).

Das et al surveyed patients who had been treated for anal squamous cell cancer with definitive radiotherapy, with or without chemotherapy, using the Functional Assessment of Cancer Therapy-Colorectal (FACT-C) and Medical Outcomes Study (MOS) Sexual Problems Scale. The authors found that the median FACT-C score was 108 of a best possible score of 136. Lower scores were more commonly seen in younger patients and those reporting depression or anxiety. The median score on the MOS Sexual Problems Scale was 67 out of a best possible 100 [51].

Joseph et al surveyed patients with anal squamous cell cancer undergoing CMT utilizing IMRT at baseline, after treatment, and during follow-up, using EORTC core (QLQ-C30) and colorectal (QLQ-CR29) questionnaires. They found that all C30 functional symptoms, except emotional and cognitive functioning, were impaired at end of treatment but recovered by 3-month follow-up. The majority of CR29 symptom scores were worse at end of treatment but recovered by 3 months, except fecal incontinence, diarrhea, urinary incontinence, and dyspareunia. Fecal incontinence returned to baseline at 12 months, while diarrhea, urinary incontinence, and dyspareunia persisted [52].

A Danish study looking at quality of life after radiotherapy for anal cancer found that, at a median 33 months after radiotherapy, incontinence to solid stool, liquid stool, and gas occurred at least monthly in 31%, 54%, and 79% of patients. Forty percent of patients reported "great distress" from fecal incontinence at least monthly, and fecal urgency occurred at least once monthly in 87% of patients. Urinary incontinence occurred at least once monthly in 48% of patients. Sexual desire was severely decreased in 58% and only 24% were satisfied with their sexual function [53].

Bentzen et al. compared quality of life scores in anal cancer survivors treated with CMT to those of a reference group using normative data, and found statistically significant impairment of function, including increased stool frequency, fatigue, diarrhea, fecal incontinence, flatulence, impotence in males, and dyspareunia and decreased sexual interest in females. Global quality of life was significantly reduced in anal cancer survivors [54].

Treatment of HIV-Positive Patients

HIV infection is a known risk factor for the development of anal canal, due to immunosuppression and HPV co-infection from anal-receptive intercourse [55, 56]. A low CD4 count may necessitate an altered CMT regimen in certain individuals. A CD4 count >200 is generally felt to be acceptable in terms of minimizing treatment-related toxicity with a standard CMT regimen of 5-FU, MMC, and 45 Gy of radiotherapy. While patients with a CD4 count <200 have a higher incidence of treatment-related morbidity, this has not been found to be associated with decreased overall survival [11].

Anal Adenocarcinoma

Adenocarcinoma of the anal canal is extremely rare, accounting for 3% of all anal cancers. These tumors tend to be mucinous adenocarcinomas that are slow growing but locally very aggressive. While the majority arises from the columnar epithelium of the upper anal canal proximal to the anal transition zone, they may also originate from the stratified columnar epithelium in the ducts of anal glands or from chronic anal fistulae. Anal adenocarcinomas that arise from the proximal anal canal are clinically indistinguishable from traditional colorectal adenocarcinoma, but have a higher risk of metastases along the inguinal and femoral lymph node chains. Immunohistochemical staining of adenocarcinomas arising from the proximal anal canal shows CK20 positivity and CK7 negativity, whereas anal adenocarcinomas arising from the anal glands are typically CK7 positive.

Anal canal adenocarcinoma presents in a similar fashion to anal canal squamous cell cancer; typical symptoms include rectal bleeding, pain, tenesmus, and altered bowel patterns. Thorough examination, including digital rectal examination, anoscopy, and palpation of inguinal nodes should be performed. A biopsy should be performed to confirm the diagnosis (Fig. 19.4), and colonoscopy should be performed to exclude concomitant colonic pathology. Clinical staging via imaging studies is similar to that for anal squamous cell carcinoma, and a similar staging system, based on tumor size and furthest extent of involved lymph nodes, is used.

Historically, primary surgical management was the mainstay of therapy, either via local excision for high-risk patients or for palliation in patients with metastatic disease, or via APR for

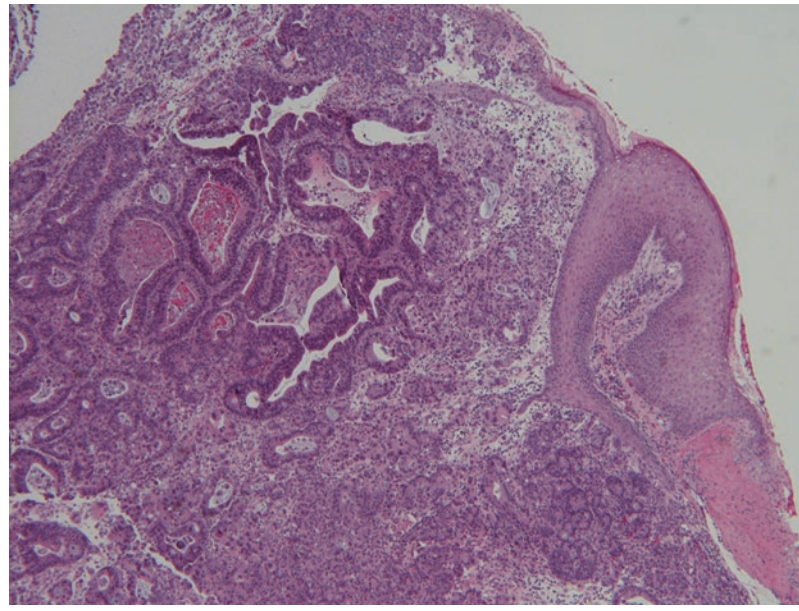


Fig. 19.4 Anal canal adenocarcinoma

those being treated with curative intent. With the advent of neoadjuvant chemoradiation for rectal adenocarcinoma, most have adopted the practice of offering neoadjuvant therapy, followed by radical surgical excision (APR). Observation of patients who have a complete clinical response to CMT, as is being practiced more commonly with rectal adenocarcinoma, is generally not advocated due to the aggressive nature of anal adenocarcinoma. Alternatively, local excision followed by adjuvant therapy (chemoradiation or radiation alone) may be feasible in certain cases.

Data regarding outcomes is sparse given the rarity of the condition, and the majority of published literature consists of case reports and small retrospective series. Chang et al reported a series of 34 patients treated over a 20-year period, 28 of which were treated with curative intent. Local excision followed by chemoradiotherapy or radiotherapy alone was performed in 13 patients, and 15 patients underwent APR with either neoadjuvant or adjuvant chemoradiotherapy. Median disease-free survival and overall 5-year survival did not differ significantly between local excision and APR (13% vs. 32%, $p = 0.055$ and 43% vs. 63%, $p = 0.3$, respectively), though APR was found on multivariate analysis to be predictive of both disease free survival ($p = 0.004$) and overall survival ($p = 0.045$) [57].

Bertelson et al. published a series of 18 patients over a period of 15 years, half of which were stage III/IV at the time of diagnosis. One patient refused treatment, 3 were given palliative chemotherapy, 1 underwent initial APR, and the remaining 13 patients underwent initial chemoradiation therapy. Of the 13 patients who received neoadjuvant therapy, 8 underwent subsequent radical resection, 3 progressed during neoadjuvant treatment and became unresectable, 1 had a complete pathologic response and was observed, and 1 did not complete neoadjuvant treatment and was lost to follow-up. Two patients with stage II disease were disease free over eight years, and 1 was disease free after 26 months; four patients had persistent or recurrent local disease, and 10 developed metastatic disease. Seven patients died with disease at a median 16 months, and the other seven were alive with disease at a median follow-up of 10 months [58].

Anal Melanoma

Anal melanoma accounts for less than 1% of all melanomas and represents 1–4% of all anorectal malignancies [59, 60]. Mean age at presentation is 60 years, and there is a female predominance [61]. Anal melanomas may arise from a number of sites, including the transitional epithelium of the anal canal, the anoderm, or the mucocutaneous junction. Tumors may be pigmented or non-pigmented; early pigmented lesions of the anoderm can be mistaken for thrombosed external hemorrhoids. Approximately 30% of lesions are amelanotic, and diagnosis depends on immunohistochemical evidence of melanin pigment [62].

Anorectal melanomas exhibit biologic behaviors different from those of cutaneous melanomas, as they demonstrate a more aggressive nature, tend to be more locally advanced and/or metastatic at the time of diagnosis, and are associated with poorer long-term survival rates [63]. The most common presenting symptoms are rectal bleeding, pain, change in bowel habits, tenesmus, and the presence of a palpable mass. Morphologically they tend to appear polypoid or ulcerated, and satellite lesions are not uncommon. Biopsy is indicated to confirm the diagnosis (Fig. 19.5). Staging should include a CT scan of the chest, abdomen, and pelvis or PET/CT to evaluate for distant metastatic disease.

The overall prognosis is quite grim for anal melanoma. Surgical excision is the mainstay of treatment, as these tumors tend to be chemo- and radio-resistant. Tumors >1-cm in size are unlikely to be cured. APR may offer some survival advantage for early stage lesions, though given that the majority of lesions are locally advanced or metastatic at the time of diagnosis, local excision may be a more appropriate means of achieving palliation.

Brady et al published one of the largest retrospective series, which included 71 patients with anal melanoma over a 64-year period, reporting a 17% 5-year survival and a median survival of 19 months. While there was no significant difference in 5-year survival rates between patients treated with APR and wide local excision (27%

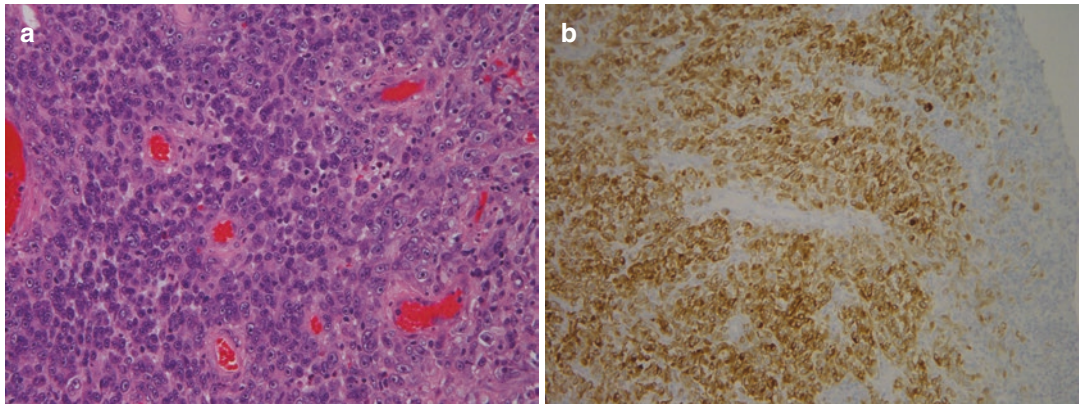


Fig. 19.5 (**a**) Epithelioid anal melanoma, H&E stain; (**b**) Anal melanoma, S-100 immunostain

vs. 5%, p = 0.11), 9 of 10 long-term survivors had undergone treatment with APR. The median size of the tumor in long-term survivors was 2.5 cm, compared with 4.0-cm in non-long-term survivors [64].

Podnos et al reviewed the Surveillance, Epidemiology, and End Results (SEER) database and found a total of 126 patients diagnosed with anal melanoma from 1973 to 2001. Mean age was 69.2 years and 61% were females. Median survival was 34 months in patients with localized disease, 13 months in patients with regional spread, and 10 months for those with distant disease. Five-year survival was 32% for localized disease, 17% for regional disease, and 0% for distant disease. Survival was unaffected by age at diagnosis, operation performed, or use of radiation therapy [65].

A more recent review of the SEER database from the Cleveland Clinic reported 160 patients, 55% of who underwent local excision and 45% of who underwent radical resection. The median survival of the 2 groups was similar (17 vs 28 months, p = 0.3); rectal resection and local excision were associated with similar survival for patients with both regional and localized stages of disease at presentation. The authors argued for a limited role for radical resection given lack of superior survival [66]. An even more recent review of the SEER database reported a 2.5% 10-year survival for patents with anal melanoma [67].

Sarcoma/Gastrointestinal Stromal Tumor (GIST)

Anal sarcomas are exceedingly rare and produce symptoms similar to other anal malignancies. Biopsy and imaging are essential in establishing a diagnosis and extent of disease. Anal sarcomas may be either intra- or extra-luminal and may show differentiation resembling any tissue of mesodermal origin. Variations include rhabdomyosarcoma, leiomyosarcoma, fibrosarcoma, and liposarcoma. These tumors tend to be advanced at the time of diagnosis. In the absence of metastatic disease, treatment is generally surgical, either by local excision or APR. These tumors are generally radioresistant. Recurrence rates are high, and long-term survival is quite poor.

Gastrointestinal stromal tumors (GISTs) are the most common mesenchymal neoplasms of the gastrointestinal tract. While they most commonly occur in the stomach and small bowel, rare cases of anal canal GISTs have been reported. GISTs arise in the smooth muscle pacemaker interstitial cell of Cajal, and their behavior is driven by mutations in *c-KIT*, platelet-derived growth factor receptor alpha, (PDRFRA), or BRAF kinase. For localized primary GIST's surgical resection is the mainstay of treatment, if feasible. Imatinib, a tyrosine kinase inhibitor, can be used as adjuvant therapy for high-risk lesions or as neoadjuvant therapy for larger lesions where downsizing of the tumor may be necessary before

surgical resection. Tumor size and mitotic index are the two most important factors in determining risk stratification. Tumor size <2 cm and/or a mitotic rate of <5 mitoses/50 high power fields (hpf) is considered low risk, while tumor size >5 cm and/or a mitotic rate of >10/50 hpf is considered high risk for developing metastatic disease, and adjuvant treatment with imatinib should be considered. In patients with tumors between 2 and 5 cm or with 5–10 mitoses/hpf, a decision regarding adjuvant therapy should be made on an individual basis [68].

Paget's Disease

Paget's disease, initially described in association with breast cancer, can occur in a number of extramammary locations, including the anogenital region, where it is thought to arise from apocrine sweat glands. Perianal Paget's disease was first reported by Darier and Coulillaud in 1893 [69]; it represents approximately 6.5% of all cases of Paget's disease and less than 1% of all anal diseases [70]. It is more commonly seen in Caucasians, with a median age at presentation of 60 years and a strong female predominance (3–4:1) [71].

When present in the perianal region, Paget's disease typically presents as an erythematous, eczematous rash that often weeps fluid (Fig. 19.6); clinically it is often confused with other perianal skin conditions, such as Bowen's disease, pruritis ani, hidradenitis supporitiva, or Crohn's disease. Symptoms on presentation are non-specific, and include pruritis, pain with defecation, bleeding, and discharge. The non-specific nature of presenting symptoms and the ambiguous nature of its gross appearance often lead to significant delays in diagnosis. Patients often give a history of a number of unsuccessful trials of topical corticosteroids and other local measures. Diagnosis is confirmed by biopsy, which reveals intraepithelial adenocarcinoma characterized by the presence of large, rounded, multi-vacuolated "Pagetoid" cells containing abundant mucin (Fig. 19.7); cells are typically CK7, CK19, and c-erb B2 positive on immunohistochemical staining [72]. The diagnosis of Paget's disease should prompt an evaluation of the colon via endoscopy, as upwards of 50% of patients with Paget's disease will also have a concomitant colorectal neoplasm [73].

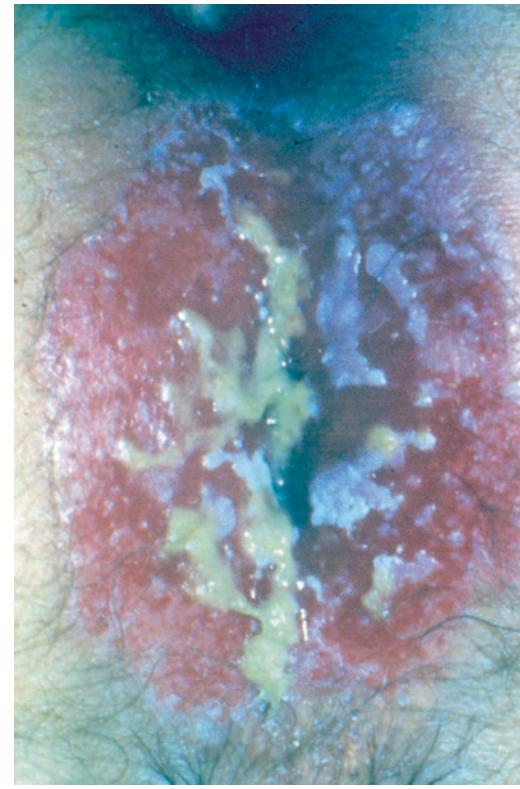


Fig. 19.6 Perianal Paget's disease

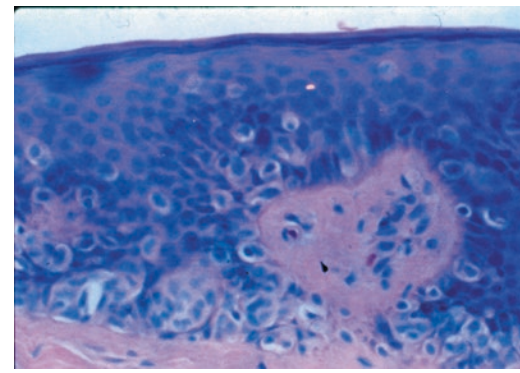


Fig. 19.7 Perianal Paget's disease

Wide local excision is the preferred means of treating perianal Paget's disease, when it can be

accomplished without debilitating effects on anorectal function. Historically, pre-operative anal "mapping" with perianal biopsies was recommended to delineate the extent of disease and achieve microscopically negative resection margins [74]. However, in light of the high recurrence rate after surgery for perianal Paget's disease, the value of such extensive mapping procedures has been questioned [75], especially given the resulting large tissue defects that are frequently too large to close primarily and require cutaneous advancement flaps, myocutaneous rotational flaps, or split-thickness skin grafts [76–78].

While data regarding long-term outcomes is limited to a number of case reports and small retrospective series, the problems frequently encountered post-operatively include recurrence and the presence of concomitant invasive cancer. Marchesa et al published a series of 14 patients with perianal Paget's disease and follow-up longer than 5 years, which differentiated between local excision (with macroscopic clearance) and wide local excision (with >1 cm microscopic clearance of margins). Actuarial 8-year survival was 0% in the local excision group and 40% (SE = 21.9) in the wide local excision group. All patients who had recurrence after wide local excision were treated with repeat wide local excision, with no further recurrences [79].

McCarter et al reported a series of 27 patients from Memorial Sloan-Kettering Cancer Center with perianal Paget's disease, 74% of which were treated with wide excision. Local recurrence occurred in 37% of all patients and 30% of these treated with wide excision. An invasive component was seen in almost half (44%) of all patients. A colostomy was required in 22% of patients, and adjuvant chemoradiotherapy was used in 22% of patients. At a median follow-up of 67 months, 56% had no evidence of disease, while 2 patients had died of metastatic disease. Overall and disease-free survival at five years was 59% and 64%, respectively; these dropped significantly to 33% and 3% by ten years [80].

A more recent series from Memorial Sloan-Kettering Cancer Center described 65 patients with perianal Paget's disease, 63% of which had invasive disease. Synchronous malignancies unrelated to the primary were noted in 8 patients. Non-invasive disease was treated with wide local excision, while invasive disease was treated by wide local excision (78%) or abdominoperineal resection (22%). At a median follow-up of 5.3 years, local recurrence was seen in 29% of those with non-invasive disease and 56% of those with invasive disease; 63% of patients required multiple operations for tumor clearance. In patients with invasive disease, the means of surgical resection (wide local excision vs. abdominoperineal resection) did not alter recurrence or disease-specific survival [75].

Another series, reported by Isik et al., described 25 patients with perianal Paget's disease, 4 of whom had concurrent anorectal adenocarcinoma at the time of diagnosis. After index procedures (local excision, wide local excision, abdominoperineal resection, and radiotherapy), 5 patients developed invasive carcinoma, and 13 patients required reoperation for recurrent Paget's disease or invasive cancer. Overall survival did not differ in patients treated with local excision based on margin status at index excision, indicating that local recurrences can be successfully treated with further surgery [81].

A series from the Mayo Clinic refuted the aggressive nature of Paget's disease, in spite of its high recurrence rate. In this series of 13 patents with perianal Paget's disease, there was a 61% 5-year recurrence rate, with most recurrences managed with wider local excision. Overall five-year and ten-year survival was 67%, which was no different from an age-matched control population [82].

Functional outcomes after wide excision and reconstructive procedures must be carefully considered, particularly in terms of fecal continence. Another study from the Mayo Clinic surveyed patients who had undergone repair of a perianal defect following surgery for Paget's disease or Bowen's disease using the fecal incontinence quality of life scale and SF-36. While SF-36 scores did not differ from the normative population, 9 of 14 patients reported some degree of altered continence [83]. Given the potential functional consequences of extensive local resection

followed by reconstruction for perianal Paget's disease, a number of non-invasive treatments, such as topical imiquimod, radiotherapy, and photodynamic therapy, have been utilized with varying degrees of success [84–89]. Nonetheless, surgical excision remains the treatment of choice, when feasible; chemoradiotherapy has a role in the presence of concomitant anorectal adenocarcinoma and may also be used in conjunction with surgical excision when invasive perianal Paget's disease is present.

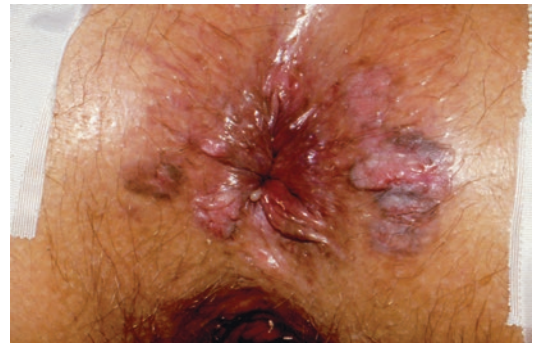


Fig. 19.8 High-grade squamous intraepitheal lesion (Perianal Bowen's disease)

High-Grade Squamous Intraepithelial Lesion

High-grade squamous intraepithial lesion (HSIL) is a non-keratinizing intraepithelial squamous cell carcinoma first described by John Bowen in 1912 [90], and first reported in the perianal region by Vickers in 1939 [91]. Previously referred to as perianal Bowen's disease, HSIL is often considered in some ways to be analogous to HPV-mediated AIN, though the two entities have very different clinical characteristics. While HSIL is more common in females in the fifth decade of life, AIN is more commonly seen in males, especially those with HIV infection and an immunocompromised state. The natural history of HSIL is generally benign, with less than 5% progressing to invasive carcinoma [92]; the risk of AIN progressing to invasive cancer is still being defined, but it is generally accepted as being much higher than this.

As with perianal Paget's disease, perianal HSIL typically presents with non-specific complaints, such as anal itching, burning, seepage, and pain with defecation. Up to 30% may present with a palpable mass lesion [93]. Physical examination reveals raised, irregular, scaly, brownish-red plaques with eczematoid features (Fig. 19.8). The plaques may have a "crust" or may weep serous fluid. Clinically, HSIL is often mistaken for other dermatologic conditions, such as leukoplakia, eczema, psoriasis, and Paget's disease.

Suspicious lesions should be biopsied in a full-thickness fashion; this can often be done in the office setting using a punch biopsy. Histologically, HSIL demonstrates disordered epidermal hyperplasia with parakeratosis and hyperkeratosis in the superficial surface layers, and mitotic figures in all layers (Fig. 19.9). "Bowenoid" cells, large atypical cells with haloed large hyperchromatic nuclei, are typically present.

Unlike Paget's disease, the presence of other concomitant malignancies or progression of the index lesion to malignancy is quite rare in the setting of perianal HSIL. The standard of care is wide surgical excision. Because microscopic disease often extends beyond grossly visible disease, a systematic 4-quadrant biopsy technique, including intra-anal biopsies, to map the extent of disease has previously been advocated [94, 95]. However, as is the case with perianal Paget's disease, given the low risk of progression to invasive cancer, high rates of post-operative recurrence, large skin defects requiring advancement flaps, and potential functional issues, the utility of this has come into question.

Outcomes data is limited to small retrospective series and case reports, given the rarity of perianal HSIL. Beck et al. reported a series of 33 patients from the Cleveland Clinic, 27 of whom were managed with wide local excision or simple excision; only 1 patient developed a new invasive skin cancer during a mean follow-up of 3.7 years [94]. A later series from the same institution found local recurrence rates to be 23.1% after wide local excision, 53.3% after simple local excision, and 80% after CO_2 vaporization; recurrence rates estimated by Kaplan–Meier analysis were

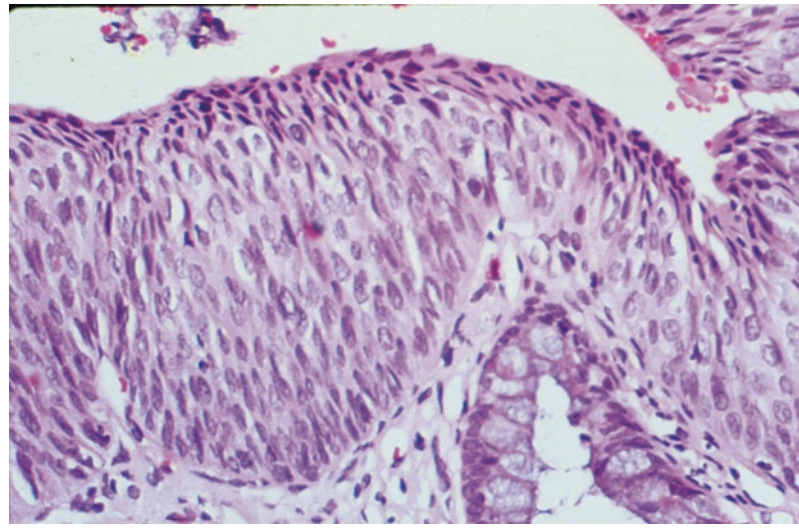


Fig. 19.9 High-grade squamous intraepitheal lesion (Perianal Bowen's disease)

significantly lower comparing radically treated patients (abdominoperineal resection and wide local excision) and conservatively treated patients (simple excision and vaporization). Three of 47 patients developed an invasive cancer in the post-op period—all had been initially treated conservatively. The median time to recurrence was 38.5 months after conservative treatment and 41.5 months after radical treatment, highlighting the need for long-term follow-up [95].

Sarmiento et al also reported a 31% 5-year recurrence rate for patients with perianal HSIL managed with local excision; all but 1 recurrence was managed with wider local excision. Five-year survival was 75%, lower than an age-matched population, though only 1 death was attributable to HSIL [96]. In contrast, Margenthaler et al found a much lower recurrence rate in a series of 25 patients with perianal HSIL. Twenty-three patients in this report underwent wide local excision, 19 of which underwent formal mapping. Only three recurrences were seen, 2 of which had positive margins after wide local excision (one with mapping) and the third of which had clear margins after mapping [93].

When wide surgical excision is not feasible or refused by the patient, other treatment options exist. Topical 5-fluorouracil (5-FU) has been reported as an effective means of managing perineal HSIL. Graham et al reported a series of 11 patients, 8 of which were treated with topical 5-FU (5%) for 16 weeks. One patient required 8 additional weeks for incomplete resolution, but one year after completion of therapy, all but 1 patient, who was HIV positive, were free of HSIL [97]; others have reported similar experiences [98]. The use of radiotherapy and photodynamic therapy has also been reported to produce favorable results. This subject is discussed in greater detail in Chap. 20.

Anal Margin Squamous Cell Cancer

The anal margin extends from the junction of non-hair-bearing and hair-bearing squamous epithelium outwards onto the perianal skin for a distance of 5-cm. Squamous cell cancers of this region exhibit behavior similar to other cutaneous squamous cell cancer, draining into regional lymph node basins. They typically present between the ages of 65 and 75.

Diagnosis is often delayed due to mistaking lesions for hemorrhoidal disease. Symptoms include a painful perianal mass, bleeding, pruritis, and drainage/discharge. Suspicious lesions should be biopsied, and a CT of the chest, abdomen, and pelvis should be performed to exclude metastatic disease. Staging is similar to that of anal canal squamous cell cancer. Careful palpation of the inguinal lymph nodes should be done to evaluate for nodal extension. While the risk of nodal

involvement is low with T1 lesions, up to 24% of T2 lesions and 67% of T3 lesions will have nodal metastases at the time of diagnosis [99].

In addition to tumor staging, the involvement and proximity of the anal sphincter to the site of the tumor is essential in guiding management. Treatment for smaller (T1, T2) lesions without nodal metastasis is surgical excision with a 1 cm margin, if possible without compromising sphincter function. Wound closure may necessitate a rotational or pedicle skin flap. Surgical excision of larger lesions may result in a significant soft tissue defect or necessitate excision of a portion of the sphincter complex to achieve negative margins. Management of these larger lesions that closely oppose the sphincter complex, as well as those with metastatic lymph node involvement, should be with CMT, given in a similar manner as for anal canal squamous cell cancer.

Anal Margin Basal Cell Cancer

Basal cell cancers of the anal margin are rare, accounting for 0.2% of anorectal neoplasms and 0.27% of all cutaneous basal cell cancers [11]. They more frequently are seen in men, and typically occur in the sixth decade of life. They are frequently associated with other skin lesions, and the diagnosis of an anal basal cell cancer should trigger a thorough dermatologic examination.

Anal basal cell cancers appear similar to other cutaneous basal cell cancers, typically as a mass with central ulceration and a raised pearly border (Fig. 19.10). Complaints are non-specific and may include bleeding, pain with sitting, and pruritis. These lesions tend to be very slow growing and very rarely metastasize. Treatment is usually via wide local excision, if feasible without compromising sphincter function. Skin grafting or advancement flaps may be necessary for wound closure. In rare instances, APR may be necessary to achieve negative margins. Positive surgical margins are associated with a 29% local recurrence rate [100].

Paterson el al reported a series of 21 cases of anal basal cell cancer; 33% had multiple basal cell cancers at other sites. Most were treated with local excision and there were no local recurrences

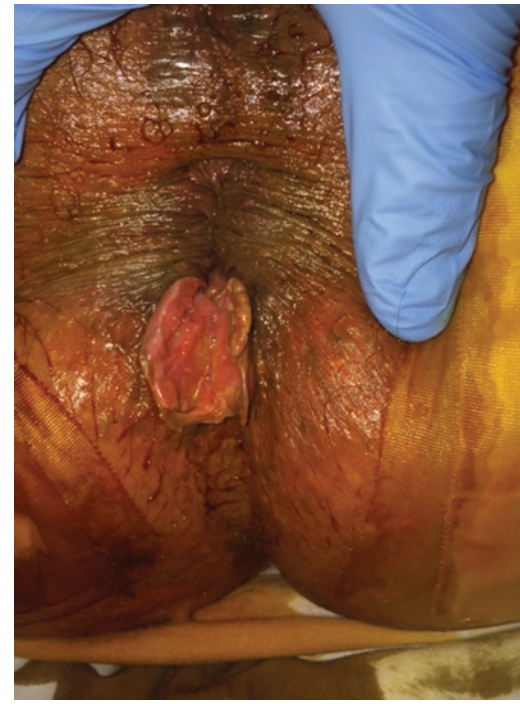


Fig. 19.10 Anal margin basal cell carcinoma

[101]. Gibson et al reported a series of 51 basal cell cancers of the perianal and genital regions, 15 of which were classified as perianal; again, the majority were treated with local excision [102]. The cancer-specific survival rate in both series was 100%.

Conclusion

While neoplasms of the anal canal and anal margin are relatively rare, a thorough knowledge of the variety of lesions seen in this anatomic region is essential. Presenting symptoms tend to be vague and non-specific; a thorough history and physical exam and a high index of suspicion are often necessary to achieve an accurate diagnosis and institute appropriate treatment in a timely fashion. Squamous cell carcinoma of the anal canal is commonly seen in association HPV and HIV infection, and is typically managed with combined modality chemoradiation with excellent oncologic results, and reasonable functional results. Less common malignancies of the anal canal, including anal adenocarcinoma and melanoma, have much poorer prognoses.

Squamous cell and basal cell carcinomas of the anal margin can typically be managed with local excision in the absence of metastatic disease. Pre-malignant conditions of the anal margin, including Paget's disease and HSIL are rare but should be included in the differential diagnosis of patients with complaints of anal discomfort or itching that do not improve with usual measures.

References

1. Simpson JAD, Scholefield JH. Diagnosis and management of anal intraepithelial neoplasia and anal cancer. BMJ. 2011;343:d6818.
2. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2017. CA Cancer J Clin. 2017;67:7–30.
3. Pineda CE, Welton ML. Management of anal squamous intraepithelial lesions. Clin Colon Rectal Surg. 2009;22:94–101.
4. Chin JY, Hong TS, Wo JY. Anal cancer: current and future treatment strategies. Gastrointest Cancer Targets Ther. 2013;3:19–27.
5. Shridhar R, Shibata D, Chan E, Thomas CR. Anal cancer: current standards in care and recent changes in practice. CA Cancer J Clin. 2015;65:139–62.
6. Daling JR, Madeleine MM, Johnson LG, et al. Human papilloma virus, smoking, and sexual practices in the etiology of anal cancer. Cancer. 2004;101:270–80.
7. Shiels MS, Pfeiffer RM, Chaturvedi AK, et al. Impact of the HIV epidemic on the incidence rates of anal cancer in the United States. J Natl Cancer Inst. 2012;104:1591–8.
8. Ryan DP, Compton CC, Mayer RJ. Carcinoma of the anal canal. N Engl J Med. 2000;342:782–800.
9. Osborne MC, Maykel J, Johnson EK, Steele SR. Anal squamous cell carcinoma: an evolution in disease and management. World J Gastroenterol. 2014;20:13052–9.
10. Tanum G, Tveit K, Karlsen KO. Diagnosis of anal carcinoma – doctor's finger still the best. Oncology. 1991;48:383–6.
11. Samdani T, Nash GM. Anal cancer. In: Steele SR, Hull TL, Read TE, et al., editors. The ASCRS textbook of colon and rectal surgery. 3rd ed. Cham: Springer; 2016. p. 357–71.
12. Billingham R. Neoplasms of the anus and the perianal skin. In: Mazier WP, Levien DH, Luchtefeld MA, Senegore AJ, editors. Surgery of the colon, rectum, and anus. Philadelphia: WB Saunders; 1995. p. 205–28.
13. NCCN clinical practice guidelines in oncology – anal carcinoma (version 1.2017 – November 23, 2016). Available from: https://www.nccn.org/professionals/physician_gls/pdf/anal.pdf. Accessed March 23, 2017.
14. Bilimoria KY, Bentrem DJ, Rock CE, et al. Outcomes and prognostic factors for squamous-cell carcinoma of the anal canal: analysis of patients from the National Cancer Data Base. Dis Colon Rectum. 2009;52:624–31.
15. Kolev NY, Tonev AY, Ignatov VL, et al. The role of 3-D endorectal ultrasound in rectal cancer: our experience. Int Surg. 2014;99:106–11.
16. Granata V, Fusco R, Reginelli A, et al. Radiological assessment of anal cancer: an overview and update. Infect Agent Cancer. 2016;11:52.
17. Granata V, Fusco R, Catalano O, et al. Early assessment of colorectal cancer patients with liver metastases treated with antiangiogenic drugs: the role of intravoxel incoherent motion in diffusion-weighted imaging. PLoS ONE. 2015;10:e0142876.
18. Cotter SE, Grigsby PW, Siegel BA, et al. FDG-PET/CT in the evaluation of anal carcinoma. Int J Radiat Oncol Biol Phys. 2006;65:720–5.
19. Ed W, Heriot AG, Ng M, et al. The impact of 18-fluorodeoxyglucose positron emission tomography on the staging, management and outcome of anal cancer. Br J Cancer. 2009;100:693–700.
20. Bhuva NJ, Glynne-Jones R, Sonoda L, et al. To PET or not to PET? That is the question. Staging in anal cancer. Ann Oncol. 2012;23:2078–82.
21. Caldarella C, Annunziata S, Treglia G, et al. Diagnostic performance of positron emission tomography /computed tomography using fluorine-18 fluorodeoxyglucose in detecting locoregional nodal involvement in patients with anal cancer: a systematic review and meta-analysis. Sci World J. 2014;2014:196068.
22. Mistrangelo M, Pelosi E, Bellò M, et al. Role of positron emission tomography-computed tomography in the management of anal cancer. Int J Radiat Oncol Biol Phys. 2012;84:66–72.
23. Wells IT, Fox BM. PET/CT in anal cancer – is it worth doing? Clin Radiol. 2012;67:535–40.
24. Jones M, Hruby G, Solomon M, et al. The role of FDG-PET in the initial staging and response assessment of anal cancer: a systematic review and meta-analysis. Ann Surg Oncol. 2015;22:3574–81.
25. Nigro ND, Vaitkevicius VK, Considine B Jr. Combined therapy for cancer of the anal canal: a preliminary report. Dis Colon Rectum. 1974;17:310–2.
26. Buroker TR, Nigro NM, Bradley G, et al. Combined therapy for cancer of the anal canal: a follow-up report. Dis Colon Rectum. 1977;20:677–8.
27. Nigro ND, Seydel HG, Considine B, et al. Combined preoperative radiation and chemotherapy for squamous cell carcinoma of the anal canal. Cancer. 1983;51:1826–9.
28. Nigro ND. Multidisciplinary management of cancer of the anus. World J Surg. 1987;11:446–51.
29. UKCCCR Anal Cancer Trial Working Party. Epidermoid anal cancer: results from the UKCCCR randomized trial of radiotherapy alone versus radiotherapy, 5-fluorouracil, and mitomycin. UKCCCR Anal Cancer Trial Working Party. UK Coordinating

Committee on Cancer Research. Lancet. 1996;348:1049–54.
30. Northover J, Glynne-Jones R, Sebag-Montefiore D, et al. Chemoradiation for the treatment of epidermoid anal cancer: 13-year follow-up of the first randomised UKCCCR Anal Cancer Trial (ACT I). Br J Cancer. 2010;102:1123–8.
31. Bartelink H, Roelofsen F, Eschwege F, et al. Concomitant radiotherapy and chemotherapy is superior to radiotherapy alone in the treatment of locally advanced anal cancer: results of a phase III randomized trial of the European Organization for Research and Treatment of Cancer Radiotherapy and Gastrointestinal Cooperative Groups. J Clin Oncol. 1997;15:2040–9.
32. Flam M, John M, Pajak TF, et al. Role of mitomycin in combination with fluorouracil and radiotherapy, and of salvage chemoradiation in the definitive nonsurgical treatment of epidermoid carcinoma of the anal canal: results of a phase III randomized intergroup study. J Clin Oncol. 1996;14:2527–39.
33. Ajani JA, Winter KA, Gunderson LL, et al. Fluorouracil, mitomycin, and radiotherapy vs fluorouracil, cisplatin, and radiotherapy for carcinoma of the anal canal: a randomized controlled trial. JAMA. 2008;299:1914–21.
34. James RD, Glynne-Jones R, Meadows HM, et al. Mitomycin or cisplatin chemoradiation for treatment of squamous-cell carcinoma of the anus (ACT II): randomised, phase 3, open-label, 2 x 2 factorial trial. Lancet Oncol. 2013;14:516–24.
35. Peiffert D, Tournier-Rangeard L, Gerard JP, et al. Induction chemotherapy and dose intensification of the radiation boost in locally advanced anal carcinoma: final analysis of the randomised UNICANCER ACCORD 03 trial. J Clin Oncol. 2012;30:1941–8.
36. Rothenstein DA, Dasgupta T, Chou JF, et al. Comparison of outcomes of intensity-modulated radiotherapy and 3-D conformal radiotherapy for anal squamous cell carcinoma using a propensity score analysis. J Clin Oncol. 2011;29:2011.
37. Yates A, Carroll S, Kneebone A, et al. Implementing intensity-modulated radiotherapy with simultaneous integrated boost for anal cancer: 3 year outcomes at two Sydney institutions. Clin Oncol. 2015;27:700–7.
38. Van Damme N, Deron P, Van Roy N, et al. Epidermal growth factor receptor and K-RAS status in two cohorts of squamous cell carcinomas. BMC Cancer. 2010;10:189.
39. Deutsch E, Lemanski C, Pignon JP, et al. Unexpected toxicity of cetuximab combined with conventional chemoradiotherapy in patients with locally advanced anal cancer: results of the UNICANCER ACCORD 16 phase II trial. Ann Oncol. 2013;24:2834–8.
40. Kochhar R, Renehan AG, Mullan D, et al. The assessment of local response using magnetic resonance imaging at 3- and 6-month post chemoradiotherapy in patients with anal cancer. Eur Radiol. 2017;27:607–17.
41. Vercellino L, Montravers F, de Parades V, et al. Impact of FDG PET/CT in the staging and the follow-up of anal carcinoma. Int J Color Dis. 2011;26:201–10.
42. Teagle AR, Gilbert DC, Jones JR, et al. Negative 18F-FDG-PET-CT may exclude residual or recurrent disease in anal cancer. Nucl Med Commun. 2016;37:1038–45.
43. Papaconstantinou HT, Bullard KM, Rothenberger DA, Madoff RD. Salvage abdominoperineal resection after failed Nigro protocol: modest success, major morbidity. Color Dis. 2006;8:124–9.
44. Van der Wal BC, Cleffken BI, Gulec B, et al. Results of salvage abdominoperineal resection for recurrent anal carcinoma following combined chemoradiation therapy. J Gastrointest Surg. 2001;5:383–7.
45. Ghouti L, Houvenaeghel G, Moutardier V, et al. Salvage abdominoperineal resection after failure of conservative treatment in anal epidermoid cancer. Dis Colon Rectum. 2005;48:16–22.
46. Butler CE, Gündeslioglu AO, Rodriguez-Bigas MA. Outcomes of immediate rectus abdominus myocutaneous flap for reconstruction for irradiated abdominoperineal resection defects. J Am Coll Surg. 2008;206:694–703.
47. Hinojosa MW, Parikh DA, Menon R, et al. Recent experience with abdominal perineal resection with vertical rectus abdominus myocutaneous flap reconstruction after preoperative pelvic radiation. Am Surg. 2009;75:995–9.
48. Chessin DB, Hartley J, Cohen AM, et al. Rectus flap reconstruction decreases perineal wound complications after pelvic chemoradiation and surgery: a cohort study. Ann Surg Oncol. 2005;12:104–10.
49. Devulapalli C, Jia Wei AT, DiBiagio JR, et al. Primary versus flap closure of perineal defects following oncologic resection: a systematic review and meta-analysis. Plast Reconstr Surg. 2016;137:1602–13.
50. Singh M, Kinsley S, Huang A, et al. Gracilis flap reconstruction of the perineum: an outcomes analysis. J Am Coll Surg. 2016;223:602–10.
51. Das P, Cantor SB, Parker CL, et al. Long-term quality of life after radiotherapy for the treatment of anal cancer. Cancer. 2010;116:822–9.
52. Joseph K, Vos LJ, Warkentin H, et al. Patient reported quality of life after helical IMRT based concurrent chemoradiation of locally advanced anal cancer. Radiother Oncol. 2016;120:228–33.
53. Sunesen KG, Nørgaard M, Lundby L, et al. Long-term anorectal, urinary and sexual dysfunction causing distress after radiotherapy for anal cancer: a Danish multicenter cross-sectional questionnaire study. Color Dis. 2015;17:O230–9.
54. Bentzen AG, Balteskard L, Wanderàs EH, et al. Impaired health-related quality of life after chemoradiotherapy for anal cancer: late effects in a national cohort of 128 survivors. Acta Oncol. 2013;52:736–44.
55. Frisch M, Biggar RJ, Goedert JJ. Human papillomavirus-associated cancers in patients with human

immunodeficiency virus infection and acquired immunodeficiency syndrome. J Natl Cancer Inst. 2000;92:1500–10.
56. Machalek DA, Poynten M, Jin F, et al. Anal human papillomavirus infection and associated neoplastic lesions in men who have sex with men: a systemic review and meta-analysis. Lancet Oncol. 2012;13:487–500.
57. Chang GJ, Gonzales RJ, Skibber JM, et al. A twenty-year experience with adenocarcinoma of the anal canal. Dis Colon Rectum. 2009;52:1375–80.
58. Bertelson N, Blumetti J, Cintron J, et al. Anal adenocarcinoma: outcomes in an uncommon malignancy. Am Surg. 2015;81:1114–7.
59. Chang AE, Kernell LH, Menck HR. The National Cancer Data Base report on cutaneous and noncutaneous melanoma: a summary of 84,836 cases from the past decade. The American College of Surgeons Commission on Cancer and the American Cancer Society. Cancer. 1998;83:1664–78.
60. Parra RS, de Almeida ALNR, Badiale GB, et al. Melanoma of the anal canal. Clinics. 2010;65:1063–5.
61. Zhong J, Zhou JN, Xu FP, Shang JQ. Diagnosis and treatment of anorectal malignant melanoma: a report of 22 cases with literature review. Ai Zheng. 2006;25:619–24.
62. Garrett K, Kalady MF. Anal neoplasms. Surg Clin North Am. 2010;90:147–61.
63. Chen H, Cai Y, Liu Y, et al. Incidence, surgical treatment, and prognosis of anorectal melanoma from 1973 to 2011: a population-based SEER analysis. Medicine. 2016;95:e2770.
64. Brady MS, Kavolius JP, Quan SH. Anorectal melanoma. A 64 year experience at Memorial Sloan Kettering Cancer Center. Dis Colon Rectum. 1995;38:146–51.
65. Podnos YD, Tsai NC, Smith D, Ellenhorn JD. Factors affecting survival in patients with anal melanoma. Am Surg. 2006;72:917–20.
66. Kiran RP, Rottoli M, Pokala N, Fazio VW. Long-term outcomes after local excision and radical surgery for anal melanoma: data from a population database. Dis Colon Rectum. 2010;53:402–8.
67. Metildi C, McLemore EC, Tran T, et al. Incidence and survival patterns of rare anal canal neoplasms using the surveillance epidemiology and end results registry. Am Surg. 2013;79:1068–74.
68. Fletcher CD, Berman JJ, Corless C, et al. Diagnosis of gastrointestinal stromal tumors: a consensus approach. Int J Surg Pathol. 2002;10:81–9.
69. Darier J, Coulillaud P. Concerning a case of Paget disease of the perineal and scrotal area. Ann Dermatol Syphiligr. 1893;4:25–33.
70. Kyriazanos ID, Stamos NP, Miliadis L, et al. Extra-mammary Paget's disease of the perianal region: a review of the literature emphasizing the operative management technique. Surg Oncol. 2011;20:e61–71.
71. Berardi RS, Lee S, Chen HP. Perianal extramammary Paget's disease. Surg Gynecol Obstet. 1988;167:359–66.
72. Banerjee S, Chatterjee M, Chand K. Extramammary Paget's disease. Indian J Dermatol Venereol Leprol. 2005;71:417–20.
73. Sahai A, Kodner IJ. Premalignant neoplasms and squamous cell carcinoma of the anal margin. Clin Colon Rectal Surg. 2006;19:88–93.
74. Beck DE, Fazio VW. Perianal Paget's disease. Dis Colon Rectum. 1987;30:263–6.
75. Perez DR, Trakarnsanga A, Shia J, et al. Management and outcome of perianal Paget's disease: a 6-decade institutional experience. Dis Colon Rectum. 2014;57:747–51.
76. Murakami K, Tanimura H, Ishimoto K, et al. Reconstruction with bilateral gluteus maximus rotation flap after wide local excision for perianal extramammary Paget's disease. Report of two cases. Dis Colon Rectum. 1996;39:227–31.
77. Gaertner WB, Hagerman GF, Goldberg SM, Finne CO. Perianal Paget's disease treated with wide excision and gluteal flap reconstruction: report of a case and review of the literature. Dis Colon Rectum. 2008;51:1842–5.
78. St Peter SD, Pera M, Smith AA, et al. Wide local excision and split-thickness skin graft for circumferential Paget's disease of the anus. Am J Surg. 2004;187:413–6.
79. Marchesa P, Fazio VW, Oliart S, et al. Long-term outcome of patients with perianal Paget's disease. Ann Surg Oncol. 1997;4:475–80.
80. McCarter MD, Quan SH, Busam K, et al. Long-term outcome of perianal Paget's disease. Dis Colon Rectum. 2003;46:612–6.
81. Isik O, Aytac E, Brainard J, et al. Perianal Paget's disease: three decades experience of a single institution. Int J Color Dis. 2016;31:29–34.
82. Sarmiento JM, Wolff BG, Burgart LJ, et al. Paget's disease of the perianal region – an aggressive disease? Dis Colon Rectum. 1997;40:1187–94.
83. Conklin A, Hassan I, Chua HK, et al. Long-term functional and quality of life outcomes of patients after repair of large perianal skin defects for Paget's and Bowen's disease. J Gastrointest Surg. 2009;13:951–5.
84. Mirer E, El Syaed F, Ammoury A, et al. Treatment of mammary and extramammary Paget's skin disease with topical imiquimod. J Dermatolog Treat. 2006;17:167–71.
85. Vereecken P, Awada A, Ghanem G, et al. A therapeutic approach to perianal Paget's disease: topical imiquimod can be useful to prevent or defer surgery. Med Sci Monit. 2007;13:CS75–7.
86. Velenik V, Segedin B, Anderluh F, et al. Radiotherapy for perianal Paget's disease: a case report. Tumori. 2008;94:750–3.
87. Hata M, Omura M, Koike I, et al. Role of radiotherapy as curative treatment of extramammary Paget's disease. Int J Radiat Oncol Biol Phys. 2011;80:47–54.

88. Yasar B, Yasar S, Gunes P. Extramammary Paget's disease of the perianal region treated successfully with radiotherapy. Int J Color Dis. 2015;30:711–2.
89. Runfola MA, Weber TK, Rodriguez-Bigas MA, et al. Photodynamic therapy for residual neoplasms of the perianal skin. Dis Colon Rectum. 2000;43:499–502.
90. Bowen JT. Precancerous dermatoses: a study of 2 cases of chronic atypical epithelial proliferation. J Cutan Dis. 1912;30:241–55.
91. Vickers PM, Jackman RJ, McDonald JR. Anal carcinoma in situ: report of three cases. South Surg. 1939;8:503–7.
92. Cleary RK, Schaldenbrand JD, Fowler JJ, et al. Perianal Bowen's disease and anal intraepithelial neoplasia: review of the literature. Dis Colon Rectum. 1999;42:945–51.
93. Margenthaler JA, Dietz DW, Mutch MG, et al. Outcomes, risk of other malignancies, and need for formal mapping procedures in patients with perianal Bowen's disease. Dis Colon Rectum. 2004;47:1655–60. discussion 1660-1
94. Beck DE, Fazio VW, Jagelman DG, Lavery IC. Perianal Bowen's disease. Dis Colon Rectum. 1988;31:419–22.
95. Marchesa P, Fazio VW, Oliart S, et al. Perianal Bowen's disease: a clinicopathologic study of 47 patients. Dis Colon Rectum. 1997;40:1286–93.
96. Sarmiento JM, Wolff BG, Burgart LJ, et al. Perianal Bowen's disease: associated tumors, human papillomavirus, surgery, and other controversies. Dis Colon Rectum. 1997;40:912–8.
97. Graham BD, Jetmore AB, Foote JE, Arnold LK. Topical 5-fluorouracil in the management of extensive anal Bowen's disease: a preferred approach. Dis Colon Rectum. 2005;48:444–50.
98. Welch ML, Grabski WJ, McCollough ML, et al. 5-fluorouracil iontophoretic therapy for Bowen's disease. J Am Acad Dermatol. 1997;36(6 Pt 1):956–8.
99. Newlin HE, Zlotecki RA, Morris CG, et al. Squamous cell carcinoma of the anal margin. J Surg Oncol. 2004;86:55–62.
100. Nielsen OV, Jensen SL. Basal cell carcinoma of the anus – a clinical study of 34 cases. Br J Surg. 1981;68:856–7.
101. Paterson CA, Young-Fadok TM, Dozois RR. Basal cell carcinoma of the perianal region: 20-year experience. Dis Colon Rectum. 1999;42:1200–2.
102. Gibson GE, Ahmed I. Perianal and genital basal cell carcinoma: a clinicopathologic review of 51 cases. J Am Acad Dermatol. 2001;45:68–71.
103. https://www.iarc.fr/en/publications/pdfs-online/patgen/bb2/bb2-chap7.pdf. Accessed 1 April 2017.
104. Edge SB, Byrd DB, Compton CC, et al. AJCC cancer staging manual. 7th ed. New York: Springer; 2010.

Anal Intraepitheial Neoplasia

20

Amy L. Lightner, Cindy J. Kin, and Mark L. Welton

Introduction

Anal squamous cell carcinoma (ASCC) is an uncommon malignancy caused by infection with oncogenic strains of *Human papilloma virus* (HPV). The precursor lesion, anal intraepithelial neoplasia III (AIN III) or high-grade squamous intraepithelial lesion (HSIL), is also caused by infection with HPV [1–3]. Although these infections are extremely common with a peak incidence in the third decade of life, they usually resolve spontaneously by the end of the decade and without detectable virus in immunocompetent patients [4, 5]. This tends not to be true in high risk groups—those who practice anoreceptive intercourse and those immunocompromised from drugs or disease. At particular risk are *Human immunodeficiency virus* (HIV)-infected men who have sex with men as patients who are coinfected with HIV and HPV tend to have higher levels of HPV, and are more likely to have persistent HPV infection [6–8].

Of particular concern are the specific oncogenic subtypes HPV 16 and 18, which have been identified as precursors to cervical intraepithelial neoplasia [9, 10] and anal intraepthithelial neoplasia (AIN) [11]. Although the frequency of progression of high grade AIN, or HSIL, is unknown, data suggests the long term risk is in the range of 8.5–13% [2, 3, 12]. Studies have estimated the incidence ranges between is 131 and 137 per 1000,000 men in HIV positive MSM, a population in which the incidence of anal cancer is on the rise [13, 14].

Colorectal surgeons are often referred patients with ‘pain down there’, and ‘bump down there’ or the common diagnosis of hemorrhoids. Frequently, on exam, there is no hemorrhoidal disease but rather visible abnormal tissue. Thus, it is important to consider AIN, understand the treatment options and their varying efficacy, and counsel patients regarding the need for ongoing surveillance. Additional detailed information is offered in Chap. 19.

Nomenclature and Anatomy

The interchangeable use of AIN and LSIL and HSIL can create confusion when communicating and reviewing the literature on this topic. The classification of terminology for HPV associated lesions of the lower anogenital tract

A. L. Lightner
Department of Colon and Rectal Surgery, Cleveland Clinic, Cleveland, OH, USA
e-mail: Lightner.amy@mayo.edu

C. J. Kin
Department of Surgery, Stanford University School of Medicine, Stanford, CA, USA
e-mail: cindykin@stanford.edu

M. L. Welton (✉)
Fairview Health Services, Corporate Department and Department of Surgery, University of Minnesota, Minneapolis, MN, USA
e-mail: mwelton1@fairview.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_20

(cervix, vulva, anus, perianus, penis, etc), was recently re-evaluated with consensus regarding nomenclature. A two-tiered nomenclature with low-grade (LSIL) and high-grade squamous intraepithelial lesions (HSIL) was recommended, with modifiers of AIN II and III as needed [15]. LSIL corresponds to AIN I and HSIL corresponds to AIN II and III. Carcinoma in situ, Bowen's disease, and severe dysplasia are all equivalent to HSIL and those terms should be abandoned. For the purposes of this chapter, we will use LSIL and HSIL throughout.

Before diagnosis and treatment patterns can be articulated, one must have an accurate depiction of the anatomy and consistent nomenclature in order to communicate findings among care providers. In fact, the lack of clear understanding of the natural history of HSIL, arguably based on a lack of consistent anatomic terminology, has been erroneously used as an argument for the non-treatment of HSIL [2, 12]. Anal cancer is defined as a squamous cell carcinoma that may *not* be seen at all or in its entirety while gentle traction is placed on the buttocks. In contrast, a perianal cancer is a squamous cell carcinoma within 5 cm of the anus that *is completely visualized* while gentle traction is placed on the buttocks (Fig. 20.1a, b). The term transformation zone was borrowed from the gynecologic literature to direct clinicians to a region 0–10 cm above the dentate line where squamous cell carcinomas may occur in the distal rectal mucosa. This is a region of squamous metaplasia dynamically varying in extent over time. This immature mucosa is at particular risk for HPV infection [16].

Clinicians are encouraged to denote the location of lesions, whether HSIL, LSIL or Squamous cell carcinoma, in relation to standard landmarks—anterior/posterior/left/right—and anal or perianal—rather than using a clock face and the dentate line. If the clock face is used, 12 o'clock must be defined because the position of the patient moves the clock-face.

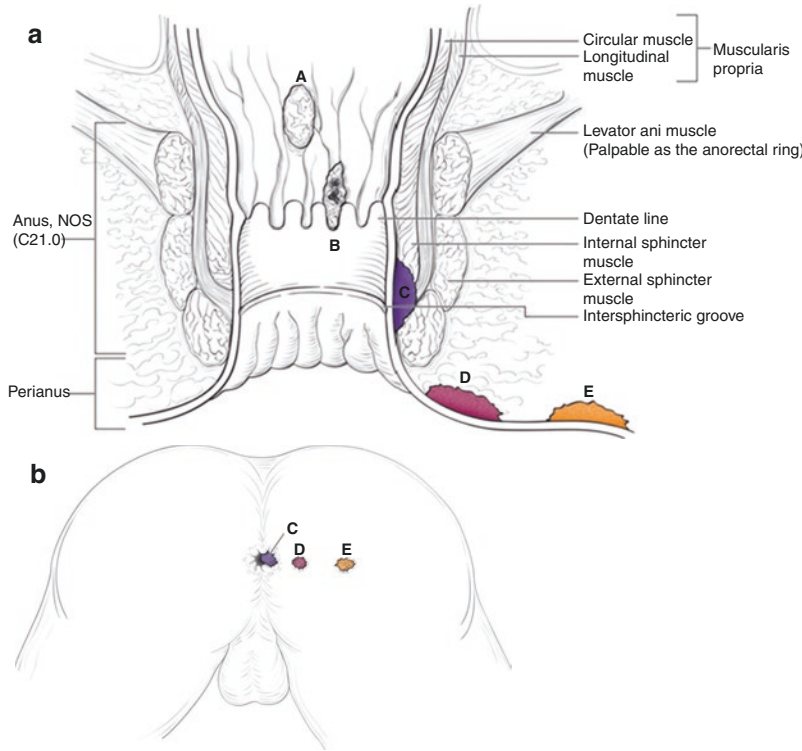


Fig. 20.1 (**a**, **b**) Anal cancer (A–C), perianal cancer (D), and skin cancer (E) as visualized with gentle traction placed on the buttocks

Prevention

HPV infection is etiologically associated with 90–96% of anal cancers [17, 18], with HPV 16 being the dominant strain, present in 65–89% of the anal cancers [11, 17, 19], followed by HPV type 18. With the development of vaccines that target HPV, the potential to prevent HPV, and ultimately ASCC, is a reality. The 9-valent HPV (9vHPV) vaccine is the only HPV vaccine currently used in the United States. Three HPV vaccines were licensed by the U.S. Food and Drug Administration (FDA) by 2014: bivalent (2vHPV), quadrivalent (4vHPV), and 9-valent HPV vaccines. Since late 2016, only 9-valent HPV vaccine is available for distribution in the United States. The 9-valent HPV vaccine protects against nine HPV types, including seven types that can cause cancer [20, 21]. A planned substudy of that trial analyzed the impact of the HPV vaccine on the development of HSIL in 602 HIV negative MSM [22]. Although none of the 602 healthy men aged 16–26 developed ASCC within the 3-year follow-up period, there were 5 cases of grade HSIL in the vaccine arm and 24 cases in the placebo arm. This is an observed efficacy of 77.5% for HSIL, which suggests the quadrivalent HPV vaccine may reduce the risk of ASCC in this patient population. In addition, the incidence of persistent HPV infection decreased by 95%.

For patients who present with condyloma acuminatum or low-grade squamous intraepithelial lesion (LSIL), it is important to note these patients are not approached the same way as HSIL; both condyloma and LSIL have very low potential for malignancy [23]. There is no data to support the direct progression of LSIL to HSIL or ASCC. Rather LSIL appears to be a marker in certain at risk groups for presence of HPV. Thus, those patients that are symptomatic may have their lesions excised or destroyed for symptomatic control, but not to prevent ASCC. Subsequent follow up of these patients depends heavily on age, risk factors, underlying disease states, and sexual practice patterns.

Screening

Compared with cervical cancer, anal cancer is rare. For the year 2016 SEER data for the United States projects 12,990 women will be diagnosed with cervical cancer and 4120 will die of the disease while 8080 patients will be diagnosed with anal cancer and 1080 will die of the disease (https://seer.cancer.gov). Since the introduction of the Papanicolaou (Pap) testing, the incidence of cervical cancer has decreased dramatically and the trend continues to be positive. This success with screening has led to a template for screening for anal cancer in high risk groups where overall the trend is heading in a less favorable direction. The highest risk group for the development of anal cancer are MSM regardless of HIV status [14], and among HIV positive MSM, the incidence of anal cancer is 42 to 131 per 100,000, a rate higher than the 35 per 100,000 of cervical cancer prior to the introduction of the Pap test [18]. This same population, have higher rates of HPV and HSIL, both precursors to ASCC; 72–92% of HIV positive MSM have detectable HPV and 50% have biopsy proven HSIL [23, 24]. Despite these statistics universal screening has yet to be adopted due to the need for more widespread adoption of high-resolution anoscopy (HRA), the need for randomized control trial proving the efficacy of screening, and the lack of national screening guidelines for anal cancer.

Diagnosis

A thorough history should be conducted including previous known HPV infections or other sexually transmitted diseases, sexual history specifically regarding anoreceptive intercourse, HIV status and CD4 count, previous anal conditions, local symptoms, and smoking history.

HSIL is typically asymptotic. When symptomatic, patients may complain of local symptoms such as pruritis, bleeding, discharge, irritation, and tenesmus. Physical exam should include visual inspection of the perianal skin and may reveal subtle changes on the skin or more obvious raised wart-like plaques. Digital rectal exam and either anoscopy or high resolution anoscopy (HRA) should be performed as part of the routine workup. Digital rectal exam may reveal subtle mucosal/submucosal masses or quite obvious masses. Anoscopy may confirm

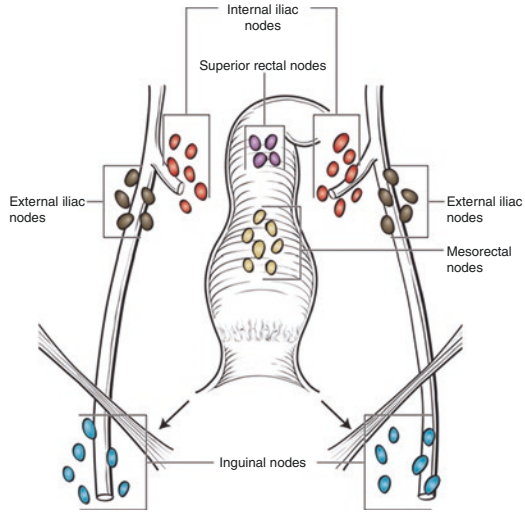


Fig. 20.2 Lymph node description. Mesorectal. Inguinal: superficial, deep. Superior rectal (hemorrhoidal). External iliac. Internal iliac (hypogastric). All other nodal groups represent sites of distant metastasis

presence of a palpable lesion. HRA may reveal a distinct vascular pattern within the acetowhitened mucosa. These vessel changes are characteristic of HSIL regardless of the underlying tissue type—distal rectal mucosa or anus. Additionally, examination of the inguinal nodes should be performed to exclude involvement, which may be present in the setting of ASCC (Fig. 20.2).

Ultimately, the diagnosis of LSIL and HSIL requires histopathology. A biopsy is diagnosed as LSIL when 20–25% of the epithelium is replaced by abnormal basaloid cells, characterized by an increased nuclear to cytoplasmic ratio. LSIL is characterized by the presence of koilocytes, enlarged cells with a cytoplasmic halo surrounding the nucleus that is indicative of HPV replication. HSIL is diagnosed when abnormal basaloid cells replace more than 50% of the epithelium.

Treatment

The goal of treating HSIL is the prevention of ASCC while maintaining anal function, continence of stool and gas. Several therapies are available for the treatment of HSIL including surgical excision, electrocautery, topical imiquimod, and topical fluoruracil (5-FU). Unfortunately, data regarding the efficacy of treatment is largely limited to case series. Only one randomized control trial has been conducted comparing treatment options, and only one clinical trial is currently listed looking at efficacy of observation versus treatment.

Historically, surgery was a dominant player in the treatment options for HSIL. In fact, in 2000, a survey of 663 members of the ASCRS found that 87% of respondents chose surgical excision with margins as the optimal treatment for HSIL [25]. However, a number of subsequent studies suggested surgery may not be the optimal treatment approach. Brown et al reported 34 patients with HSIL treated surgically in the UK. Within 41 months, 14 of 34 patients had macroscopic recurrences and 25% of patients had anal function defects postoperatively [26]. Scholefield et al reported on 35 patients who underwent limited excision for HSIL and were followed 63 months. Three of 35 (9%) had progression to ASCC [2]. Watson et al. reported their experiences of 72 patients treated surgically, of which nine patients developed incontinence, and four of these required colostomy. Despite their aggressive surgical approach, 8 patients (11%) progressed to invasive ASCC [3]. These investigations suggested surgical excision is not ideal for HSIL due to incomplete excisions, frequent recurrences, and complications including stenosis and incontinence. They argued further that because chemoradiation for small invasive anal carcinoma is effective, a less radical approach may be warranted because early surgical intervention with the associated complications may compromise later definitive treatment.

Results from subsequent investigations suggest that HRA may be the optimal treatment approach. The use of HRA allows targeted destruction of suspicious lesions with the lowest reported rates of progression to cancer with simultaneous preservation of anorectal function. HRA is used to identify dysplastic epithelium under the magnification of a standard colposcope or operating microscope (Fig. 20.3). The technical application of HRA itself is discussed in more

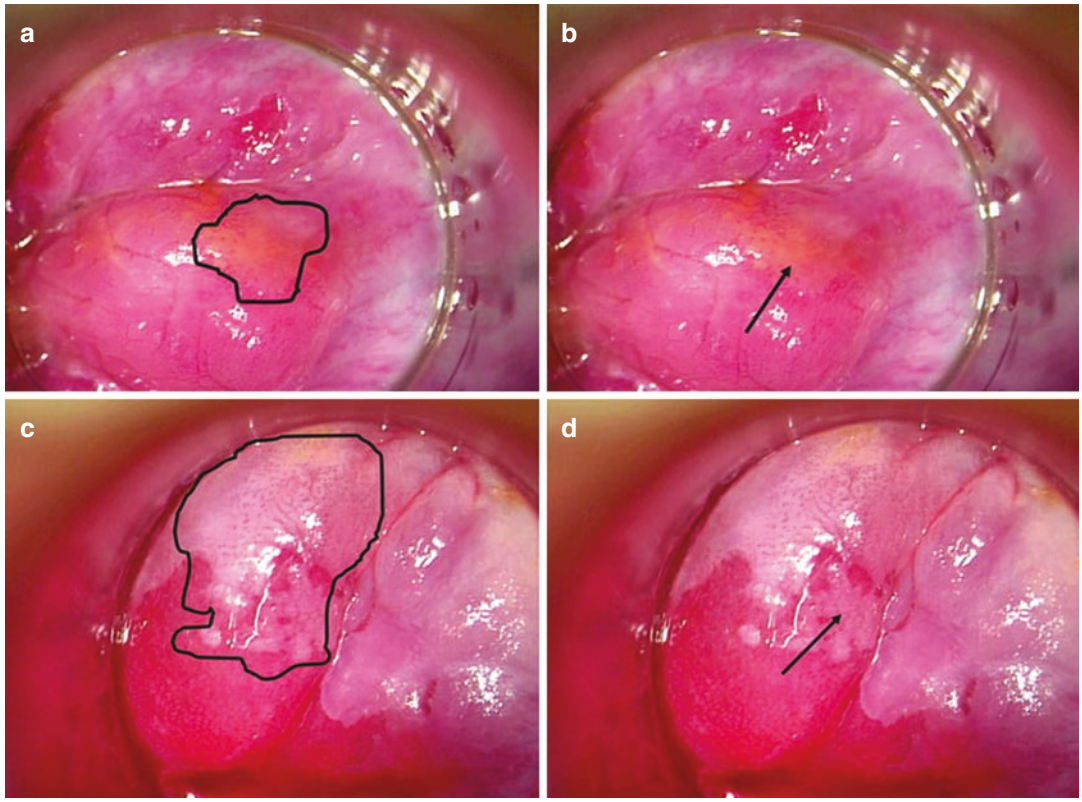


Fig. 20.3 High resolution anoscopy images of LSIL and HSIL after the application of acetic acid. Biopsies of visualized lesions confirmed HRA appearances and region biopsied is indicated with arrows in images (**b**, **d**). (**a**, **b**) Demonstrate anal LSIL in the distal rectal mucosa with subtle punctate vessel changes. The geography of the lesion is emphasized in the left frame with a black border. (**c**, **d**) Distal rectal mucosa where HSIL is visible. The left image has the lesion highlighted with a black border focusing the reader on the serpiginous, cerebriform vessels and the outline of the entire lesion. The right image demonstrates the mosaic pattern created by blood vessels in an aceto-white background. With permission from [48] © 2011 Springer

detail in the section regarding our treatment approach, but, briefly, HRA can be used with either targeted infrared coagulation (IRC) or electrocautery (EC). Both procedures are outpatient with only enemas given in preparation. IRC coagulates lesions using 1.6 s pulses until the entire surface and an approximately 3 mm surrounding border are coagulated. The coagulated tissue may then scraped off with a small cotton Q-tip or debrided with biopsy forceps. This is repeated until the submucosal vessels are identified and coagulated. HRA EC, unlike IRC, uses bipolar cautery creating a smoke plume that requires a smoke evacuator to prevent transmission of HPV. Across the four listed studies (Table 20.1) regarding HRA targeted IRC for HSIL, there was no reported anal function compromise, 10–38% had recurrence of HSIL, and none had progression to ASCC [27–30]. Similarly, in the two listed studies regarding HRA targeted EC, there was no reported anal function compromise, 17–31% had recurrence of HSIL, and 0.4% had progression to anal squamous cell carcinoma [31, 32]. Of note, recurrence of HSIL was higher in HIV patients and patients with higher burden of disease.

The use of topical fluorouracil (5-FU) and imiquimod have the advantages of treating AIN by the patient themselves without compromising anorectal function. However, topical treatments have the disadvantage of extended treatment courses and significant side effects including

Table 20.1 Results from published studies regarding HRA targeted IRC for HSIL

Study ID	Patients	Anal function compromised (%)	HSIL at last f/u (%)	Developed ASCC (%)
Surgery				
Excision				
Watson et al. [3]	10/62 immunocompromised	13	Not reported	11
Scholefield et al. [2]	6/35 immunocompromised	0	Not reported	9
Devaraj and Cosman [12]	40 HIV + MSM	3	Not reported	8
Brown et al. [26]	34 M and F	15	Not reported	0
Marchesa et al. [42]	16 M, 31 F	0	38%	6
HRA-targeted IRC				
Goldstone et al. [28]	52 HIV-MSM/44 HIV + MSM	0	HIV+18%; HIV-10%	0
Weis et al. [30]	99M/25F all HIV+	0	Treated 13%; untreated 93%	0
Stier et al. [29]	16 M/2 F all HIV+	0	38%	0
Cranston et al. [27]	68 HIV + MSM	0	36%	0
HRA-targeted EC				
Marks and Goldstone [31]	132 HIV + MSM; 100 HIV-MSM	0	HIV+31%; HIV-17%	0.4
HRA-targeted EC f/u IRC or TCA				
Pineda et al. [37]	194/246 immunocompromised	0.8	22%	1.2
Topical medical therapy				
5-FU				
Snyder et al. [43]	11 HIV + MSM	0	72%	0
Richel et al. [38]	46 HIV + MSM	0	30%	0
Graham et al. [33]	1/9 HIV+	0	13%	13 (n = 1)
Imiquimod				
Wieland et al. [44]	28 HIV + MSM	0	9%	0
Kreuter et al. [45]	10 HIV + MSM	0	Not reported	0
Fox et al. [34]	64 HIV + MSM	0	39%	3
Van der Snoek et al. [46]	44 HIV + MSM	Not reported	34%	Not reported
TCA				
Singh et al. [47]	54 MSM; 35 HIV+	0	39%	0
Cranston et al. [27]	72 HIV + MSM	Not reported	20%	Not reported
RCT				
Richel et al. [35]	246 HIV+MSM	0	At 72 weeks: 71% imiquimod; 58% 5-FU; 68% EC	1.2% (n = 3)

perianal pain and irritation that result in non-compliance. Treatment with 5-FU is not standardized with variable frequency and amounts reported. Despite several treatment interruptions due to side effects and variable protocols administered, there was very little progression to ASCC. Only one patient among the three studies listed in Table 20.1 had progression to ASCC [33]. Similarly the use of topical imiquimod 5% cream applied three times daily has very little progression to ASCC, with only one series reporting 2 patients with progression (3%) [34]. When topical medical treatments are prescribed the patients should be told that symptoms of itching, burning, and pain are evidence that imiquimod is working and is not a sign that treatment should be discontinued. Additionally, imiquimod may cause transient flu

like symptoms the day following treatment. If no signs of erythema or erosions develop while on imiquimod the frequency can be increased throughout the treatment course. Unfortunately, the low adherence rate and typical treatment interruptions with the use of topical imiquimod for treatment of HSIL may be prohibitive to recommending this agent as an optimal treatment.

Randomized controlled trials have begun to compare the aforementioned treatment approaches. One looking at 246 HIV-positive MSM found that electrocautery had significantly increased rates of complete resolution compared to both topical imiquimod and topical fluorouracil, and therefore concluded EC was the superior treatment option [35]. However, it is important to note that recurrence rates of HSIL were still high in all treatment groups, underscoring the need for frequent surveillance and follow up. At week 24, 48 and 72, 22%, 46%, and 67% of patients had recurrence respectively. Specifically, recurrence at 72 weeks was found in 71% (n = 10/14) of patients treated with imiquimod, 58% (n = 7/12) of patients treated with 5-FU, and 68% (n = 13/19) of patients treated with EC. Treatment side-effects, most commonly pain, bleeding and itching were significantly more common in the imiquimod and 5-FU group at 43% and 27% respectively, than the noted 18% in the electrocautery group.

Expectant Management

Due to the efficacy of chemoradiation for ASCC, there has been the suggestion that expectant management, which has no immediate associated costs or side effects, may be effective for HSIL rather than treatment. A trial addressing this point was conducted at a university and VA practice. Forty 40 HIV infected patients were followed for a mean of 32 months [12]. Patients had a clinical exam every 6 months, and biopsies of new macroscopic or symptomatic disease. Of the 40 patients, 28 had HSIL. Three of the 28 patients developed ASCC at 10, 16 and 84 months, all of whom had a cancer less than 2.5 cm in diameter. This trial suggested that very few patients progressed to cancer, and, if cancer developed they were diagnosed at an early stage. To better understand this question, the ANCHOR trial, a large ongoing randomized phase III trial comparing topical or ablative treatment with active monitoring in HIV-positive patients with HSIL is currently ongoing. The primary measure is time to anal cancer. The study is estimated to be completed in 2022 (clinicaltrials.gov NCT02135419) and may provide additional answers regarding active monitoring versus treatment in a high-risk group with HSIL. Unfortunately, no trials are currently underway for low risk patient cohort with HSIL, likely because there are so few patients, and even fewer who progress to ASCC.

Practical Application of the Data

Several limitations exist when interpreting the aforementioned data. Studies of HSIL screening and treatment practices are largely comprised of immunosuppressed patients. The only RCT to date includes only high risk HIV+ MSM, limiting the applicability of their results to other patient cohorts. Treatments reported for HSIL are not standardized, and reports of treatment outcome are mainly in the form of case series and open-label studies, with the only one aforementioned RCT.

Despite these limitations, there is strong evidence that HSIL, left untreated, can and does progress to ASCC [1]. Once diagnosed with ASCC, unless the lesion is less than 2 cm in size and can be locally excised with clear margins, these patients require chemotherapy with radiation, and possible surgical intervention, all with associated morbidity and mortality, which is 80% for even the earliest lesions. Thus, since several treatment options do exist for HSIL, and some with nearly zero progression to ASCC [36–38] with one RCT demonstrating EC as the superior choice [35] patients with HSIL should be actively treated to prevent progression to ASCC.

Therapy with HRA targeted EC may be an outpatient office based procedure without need for anorectal preparation or narcotics upon dismissal if the lesions are above the dentate line or

quite limited in the anal mucosa or perianal skin. Alternatively, for extensive disease below the dentate line involving anal mucosa and or perianal skin, the patients may be treated on an outpatient basis and discharged with instructions for Sitz baths, topical analgesics (5% Lidocaine Cream—Recticare (Ferndale labs) preferred, and either Ultram, Tylenol with codeine, NSAIDS or Tylenol. HRA targeted destruction is technically easy and can be performed by colorectal surgeons, family practitioners, gynecologists and advanced practice providers, to name a few.

As a practicing colorectal surgeon, most patients will be referred for colorectal evaluation with a chief complaint, or reason for referral, of hemorrhoids. In those in whom hemorrhoids are clearly not the actual need being met by our evaluation, a detailed history should be performed to document risk factors for anal dysplasia including HPV infection (anal-genital warts), history of receptive anal intercourse or sexually transmitted disease, a history of cervical vulvar or vaginal cancer, immunosuppression after solid organ transplant or HIV infection, hematologic malignancies, certain autoimmune disorders including Crohn's disease [39] and smoking. Physical exam is focused with perianal inspection, digital rectal exam, and anoscopy with inspection of other involved areas as indicated. We prefer the operating room for the initial examination and treatment, and for needed re-treatment of extensive disease or disease complicated by benign disease (e.g. overlying hemorrhoidal tissue or complicating fistulous disease). HRA is preferred for our initial evaluation and treatment because we feel we get the best exposure with the sphincters completely relaxed with an anal block which allows for flattening of the hemorrhoidal complexes and clear visualization of the tissues that might otherwise hide at the base of a large hemorrhoidal complex if visualized with a plastic anoscope in the office.

In the operating room, the patient is positioned prone jack knife with the buttocks taped apart. Anesthesia with MAC local and 0.25% Marcaine in the subcutaneous tissues and 0.5% in the sphincters for the anal block are administered. A thorough examination looking for hyperpigmentation, erythema, elevation, or scaling is performed. The distal rectal mucosa, anal mucosa, and perianal skin is then treated with 3% acetic acid by placing one acetic acid soaked raytec in the anal canal and distal rectum, and one over the anus/perianus. We use an operating microscope for magnification. We look for a distinct vascular pattern within the acetowhitened rectal and anal mucosa or perianal skin that is characteristic of HSIL regardless of the underlying tissue type. Any concerning lesions are biopsied and then treated with needle tip cautery [32]. A deep burn is avoided by quickly moving superficially across the surface of the tissue, sparing the surrounding normal mucosa. Our experience is we can limit the depth of injury to less than that with excision which may contribute significantly to our low observed rate of complications [37]. This is safe and effective in both HIV (+) and HIV (−) men and women [36].

Ongoing Surveillance

How to follow "low-risk" patients with LSIL remains unclear as patients with condyloma acuminatum (low-grade intraepithelial neoplasia LSIL, AIN-1) have a very low potential for malignancy [23]. Treatment should probably only be offered to symptomatic patients or those who simply want to have the lesions removed (the vast majority). This is where routine typing of HPV may be beneficial in triaging follow up. For "high-risk" patients with LSIL, LSIL can be a marker for the presence of HSIL and therefore annual surveillance with digital anal rectal exam, anal cytology and HRA may be beneficial for early detection of HSIL. For patients who have been treated for HSIL, a one and six month follow up exam with anoscopy is reasonable. If the patient is not involved in high risk behavior then annual exam with digital anal examination and anal cytology is sufficient. If involved in high risk behavior, HRA should be added to this algorithm annually. If immunosuppressed, or if the patient has "high risk disease", this interval may be shortened to 3–6 months on a case by case basis. If a recurrence is found, the patient should be treated in the office with trichloracetic acid, IRC

or hyfercation unless complex as noted above. With this approach there is excellent control of HSIL and minimal progression to cancer [28, 32, 37, 39, 40]; even in the setting of recurrent disease, HSIL can be cleared in approximately 80% of patients [37, 40].

Limitations to Treatment

There are several limitations to the treatment of HSIL. The first, as already mentioned, is the lack of consistency in definitions and anatomy. Second, there is paucity of randomized controlled trials looking at surveillance versus treatment or the comparison of treatment practices. Thus, many argue they are not sure which lesions will progress to cancer. However, this is not substantiated by the literature. Third, HRA has been shown to have low reimbursement rates with a lack of billing codes, and many surgeons report it is a painful procedure [41]. Thus, there has been a lack of widespread adoption of HRA to office based practice among colon and rectal surgeons.

Summary

Ultimately, the goals of treating patients with HSIL are preventing morbidity associated with the treatment of anal cancer and mortality from anal cancer itself without causing disturbances of anal function, i.e., continence of stools and flatus. Fortunately, there are low cost, outpatient tools to treat HSIL, and evidence to support their effectiveness in preventing ASCC. Although there is an ongoing trial looking at surveillance rather than treatment for HSIL, at this time, treatment should be endorsed especially given its ease to perform. Ultimately, prevention, screening, and treatment of anal HSIL should be as widespread as that for cervical dysplasia. But to achieve this goal, clinicians need to be educated and dedicated to the eradication of this disease; that includes learning HRA and willingness to follow patients longitudinally. Hopefully, in the future, rates of ASCC will be minimized with the use of HPV vaccine and screening for HSIL.

References

1. Berry JM, Jay N, Cranston RD, et al. Progression of anal high-grade squamous intraepithelial lesions to invasive anal cancer among HIV-infected men who have sex with men. Int J Cancer. 2014;134(5):1147–55.
2. Scholefield JH, Castle MT, Watson NF. Malignant transformation of high-grade anal intraepithelial neoplasia. Br J Surg. 2005;92(9):1133–6.
3. Watson AJ, Smith BB, Whitehead MR, Sykes PH, Frizelle FA. Malignant progression of anal intra-epithelial neoplasia. ANZ J Surg. 2006;76(8):715–7.
4. Ho GY, Bierman R, Beardsley L, Chang CJ, Burk RD. Natural history of cervicovaginal papillomavirus infection in young women. N Engl J Med. 1998;338(7):423–8.
5. Woodman CB, Collins S, Winter H, et al. Natural history of cervical human papillomavirus infection in young women: a longitudinal cohort study. Lancet. 2001;357(9271):1831–6.
6. Ahdieh L, Klein RS, Burk R, et al. Prevalence, incidence, and type-specific persistence of human papillomavirus in human immunodeficiency virus (HIV)-positive and HIV-negative women. J Infect Dis. 2001;184(6):682–90.
7. Critchlow CW, Surawicz CM, Holmes KK, et al. Prospective study of high grade anal squamous intraepithelial neoplasia in a cohort of homosexual men: influence of HIV infection, immunosuppression and human papillomavirus infection. AIDS. 1995;9(11):1255–62.
8. Del Mistro A, Insacco E, Cinel A, Bonaldi L, Minucci D, Chieco-Bianchi L. Human papillomavirus infections of the genital region in human immunodeficiency virus seropositive women: integration of type 16 correlates with rapid progression. Eur J Gynaecol Oncol. 1994;15(1):50–8.
9. Bosch FX, Lorincz A, Munoz N, Meijer CJ, Shah KV. The causal relation between human papillomavirus and cervical cancer. J Clin Pathol. 2002;55(4):244–65.
10. Walboomers JM, Jacobs MV, Manos MM, et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. J Pathol. 1999;189(1):12–9.
11. Hoots BE, Palefsky JM, Pimenta JM, Smith JS. Human papillomavirus type distribution in anal cancer and anal intraepithelial lesions. Int J Cancer. 2009;124(10):2375–83.
12. Devaraj B, Cosman BC. Expectant management of anal squamous dysplasia in patients with HIV. Dis Colon Rectum. 2006;49(1):36–40.
13. D'Souza G, Wiley DJ, Li X, et al. Incidence and epidemiology of anal cancer in the multicenter AIDS cohort study. J Acquir Immune Defic Syndr. 2008;48(4):491–9.
14. Silverberg MJ, Lau B, Justice AC, et al. Risk of anal cancer in HIV-infected and HIV-uninfected individuals in North America. Clin Infect Dis. 2012;54(7):1026–34.

15. Darragh TM, Colgan TJ, Cox JT, et al. The lower anogenital squamous terminology standardization project for HPV-associated lesions: background and consensus recommendations from the College of American Pathologists and the American Society for Colposcopy and Cervical Pathology. Arch Pathol Lab Med. 2012;136(10):1266–97.
16. Welton MLSS, Goodman KA, et al. AJCC cancer staging manual. 8th ed. New York: Springer; 2016. p. 275–84.
17. Abramowitz L, Jacquard AC, Jaroud F, et al. Human papillomavirus genotype distribution in anal cancer in France: the EDiTH V study. Int J Cancer. 2011;129(2):433–9.
18. Chaturvedi AK. Beyond cervical cancer: burden of other HPV-related cancers among men and women. J Adolesc Health. 2010;46(4 Suppl):S20–6.
19. Wong AK, Chan RC, Aggarwal N, Singh MK, Nichols WS, Bose S. Human papillomavirus genotypes in anal intraepithelial neoplasia and anal carcinoma as detected in tissue biopsies. Mod Pathol. 2010;23(1):144–50.
20. Garland SM, Hernandez-Avila M, Wheeler CM, et al. Quadrivalent vaccine against human papillomavirus to prevent anogenital diseases. N Engl J Med. 2007;356(19):1928–43.
21. Giuliano AR, Palefsky JM, Goldstone S, et al. Efficacy of quadrivalent HPV vaccine against HPV Infection and disease in males. N Engl J Med. 2011;364(5):401–11.
22. Palefsky JM, Giuliano AR, Goldstone S, et al. HPV vaccine against anal HPV infection and anal intraepithelial neoplasia. N Engl J Med. 2011;365(17):1576–85.
23. Chin-Hong PV, Berry JM, Cheng SC, et al. Comparison of patient- and clinician-collected anal cytology samples to screen for human papillomavirus-associated anal intraepithelial neoplasia in men who have sex with men. Ann Intern Med. 2008;149(5):300–6.
24. Palefsky JM, Holly EA, Ralston ML, Jay N, Berry JM, Darragh TM. High incidence of anal high-grade squamous intra-epithelial lesions among HIV-positive and HIV-negative homosexual and bisexual men. AIDS. 1998;12(5):495–503.
25. Cleary RK, Schaldenbrand JD, Fowler JJ, Schuler JM, Lampman RM. Treatment options for perianal Bowen's disease: survery of American Society of Colon and Rectal Surgeons Members. Am Surg. 2000;66(7):686–8.
26. Brown SR, Skinner P, Tidy J, Smith JH, Sharp F, Hosie KB. Outcome after surgical resection for high-grade anal intraepithelial neoplasia (Bowen's disease). Br J Surg. 1999;86(8):1063–6.
27. Cranston RD, Baker JR, Liu Y, Wang L, Elishaev E, Ho KS. Topical application of trichloroacetic acid is efficacious for the treatment of internal anal high-grade squamous intraepithelial lesions in HIV-positive men. Sex Transm Dis. 2014;41(7):420–6.
28. Goldstone SE, Hundert JS, Huyett JW. Infrared coagulator ablation of high-grade anal squamous intraepithelial lesions in HIV-negative males who have sex with males. Dis Colon Rectum. 2007;50(5):565–75.
29. Stier EA, Goldstone SE, Berry JM, et al. Infrared coagulator treatment of high-grade anal dysplasia in HIV-infected individuals: an AIDS malignancy consortium pilot study. J Acquir Immune Defic Syndr. 2008;47(1):56–61.
30. Weis SE, Vecino I, Pogoda JM, Susa JS. Treatment of high-grade anal intraepithelial neoplasia with infrared coagulation in a primary care population of HIV-infected men and women. Dis Colon Rectum. 2012;55(12):1236–43.
31. Marks DK, Goldstone SE. Electrocautery ablation of high-grade anal squamous intraepithelial lesions in HIV-negative and HIV-positive men who have sex with men. J Acquir Immune Defic Syndr. 2012;59(3):259–65.
32. Pineda CE, Berry JM, Welton ML. High resolution anoscopy and targeted treatment of high-grade squamous intraepithelial lesions. Dis Colon Rectum. 2006;49(1):126.
33. Graham BD, Jetmore AB, Foote JE, Arnold LK. Topical 5-fluorouracil in the management of extensive anal Bowen's disease: a preferred approach. Dis Colon Rectum. 2005;48(3):444–50.
34. Fox PA, Nathan M, Francis N, et al. A double-blind, randomized controlled trial of the use of imiquimod cream for the treatment of anal canal high-grade anal intraepithelial neoplasia in HIV-positive MSM on HAART, with long-term follow-up data including the use of open-label imiquimod. AIDS. 2010;24(15):2331–5.
35. Richel O, de Vries HJ, van Noesel CJ, Dijkgraaf MG, Prins JM. Comparison of imiquimod, topical fluorouracil, and electrocautery for the treatment of anal intraepithelial neoplasia in HIV-positive men who have sex with men: an open-label, randomised controlled trial. Lancet Oncol. 2013;14(4):346–53.
36. Pineda CE, Berry JM, Jay N, Palefsky JM, Welton ML. High resolution anoscopy in the planned staged treatment of anal squamous intraepithelial lesions in HIV-negative patients. J Gastrointest Surg. 2007;11(11):1410–5. discussion 1415-1416
37. Pineda CE, Berry JM, Jay N, Palefsky JM, Welton ML. High-resolution anoscopy targeted surgical destruction of anal high-grade squamous intraepithelial lesions: a ten-year experience. Dis Colon Rectum. 2008;51(6):829–35. discussion 835-827
38. Richel O, Wieland U, de Vries HJ, et al. Topical 5-fluorouracil treatment of anal intraepithelial neoplasia in human immunodeficiency virus-positive men. Br J Dermatol. 2010;163(6):1301–7.
39. Shah SB, Pickham D, Araya H, et al. Prevalence of anal dysplasia in patients with inflammatory bowel disease. Clin Gastroenterol Hepatol. 2015;13(11):1955.e1951–61.e1951.
40. Goldstone RN, Goldstone AB, Russ J, Goldstone SE. Long-term follow-up of infrared coagulator ablation of anal high-grade dysplasia in men who have sex with men. Dis Colon Rectum. 2011;54(10):1284–92.

41. Chang GJ, Berry JM, Jay N, Palefsky JM, Welton ML. Surgical treatment of high-grade anal squamous intraepithelial lesions: a prospective study. Dis Colon Rectum. 2002;45(4):453–8.
42. Marchesa P, Fazio VW, Oliart S, Goldblum JR, Lavery IC. Perianal Bowen's disease: a clinicopathologic study of 47 patients. Dis Colon Rectum. 1997;40(11):1286–93.
43. Snyder SM, Siekas L, Aboulafia DM. Initial experience with topical fluorouracil for treatment of HIV-associated anal intraepithelial neoplasia. J Int Assoc Phys AIDS Care. 2011;10(2):83–8.
44. Wieland U, Brockmeyer NH, Weissenborn SJ, et al. Imiquimod treatment of anal intraepithelial neoplasia in HIV-positive men. Arch Dermatol. 2006;142(11):1438–44.
45. Kreuter A, Hochdorfer B, Stucker M, et al. Treatment of anal intraepithelial neoplasia in patients with acquired HIV with imiquimod 5% cream. J Am Acad Dermatol. 2004;50(6):980–1.
46. van der Snoek EM, den Hollander JC, van der Ende ME. Imiquimod 5% cream for five consecutive days a week in an HIV-infected observational cohort up to 32 weeks in the treatment of high-grade squamous intraepithelial lesions. Sex Transm Infect. 2015;91(4):245–7.
47. Singh JC, Kuohung V, Palefsky JM. Efficacy of trichloroacetic acid in the treatment of anal intraepithelial neoplasia in HIV-positive and HIV-negative men who have sex with men. J Acquir Immune Defic Syndr. 2009;52(4):474–9.
48. Welton ML, Raju NL. Anal Cancer In: Beck DE, Roberts PL, Saclarides TJ, Senagore AJ, Stamos MJ, Wexner SD, editors. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 337–57.

Rectal Carcinoma: Imaging for Staging

21

Mit Dattani and Gina Brown

Introduction

In the modern day multimodality management of rectal cancer, a growing number of treatment options are available, the choice of which is largely determined by tumour related factors. An accurate and reproducible staging system is therefore invaluable for rectal cancer multidisciplinary teams, which rely increasingly on radiological prognostication to individualise treatment plans. This information is equally important for counselling patients, who will need to make informed decisions by weighing the oncological merits of a radical resection, against the impact on quality of life ensuing from the multimodality management of their cancer.

Indeed, pre-operative rectal cancer assessment has evolved beyond the determination of conventional prognostic features such as depth of tumour invasion, nodal involvement and metastatic spread. Tumour threatened resection margins which require neo-adjuvant treatment, or involved anal sphincters for which extensive surgery offers the best chance of cure are just as important in guiding treatment decisions, if not more, as the absolute TNM stage. Moreover, additional prognostic determinants such as extramural vascular invasion, which were until now only evaluable in the post-resection specimen, are being diagnosed on pre-operative imaging. In this regard, advances in imaging technology, largely driven by magnetic resonance imaging (MRI) over the last two decades, have enabled the selection of appropriate treatment strategies, which optimise the balance between oncological and functional outcome. More recently, imaging has found a novel role in assessing the response after neo-adjuvant treatment, which in selected cases mitigates the need for surgery with the detection of a complete response following (chemo)radiotherapy. The current imaging modalities available to stage rectal cancer include endorectal ultrasound scan (ERUS), MRI, computed tomography (CT) and positron emission tomography (PET). These techniques have their own strengths and limitations, and often play a complementary role in what is a challenging aspect of rectal cancer management. This chapter summarises the evidence base and the utility of the different imaging modalities that underpin the current standards of care in rectal cancer management.

M. Dattani
Pelican Cancer Foundation,
Basingstoke, Hampshire, UK

G. Brown (✉)
The Royal Marsden NHS Foundation Trust and
Imperial College of London, London, UK
e-mail: gina.brown@rmh.nhs.uk

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_21

Imaging Modalities

Endorectal Ultrasound

History and Technique

The clinical application for ultrasound was first developed by Wild and Reid in 1952, who used a linear B-mode transducer in the diagnosis of breast lesions, "with a view to future applications at other sites" [1]. But it was not until 1983 that an advanced version of their 'echoendo probe' was utilised by Dragsted and Gammelgaard to evaluate the depth of invasion in rectal cancer. They assessed 13 patients with rectal cancer using a 4.5 MHz rotating transducer probe, and correctly identified the depth of mural infiltration in 11 of the patients when compared to subsequent histopathology [2]. In the two remaining patients, the technique was limited owing to the presence of a stricturing tumor, which the probe could not access. These initial findings were confirmed in 1985 by Hilderbrandt and Feifel in a slightly larger series comprising 25 patients [3]. More importantly, they objectively defined the reporting criteria for depth of rectal wall invasion based on the TNM classification system, which is still universally used. Denoted by the prefix 'u' to indicate evaluation by endorectal ultrasound (ERUS), the depth of tumour invasion is staged according to the level of disruption of the five distinct anatomical layers of the rectal wall (Fig. 21.1a, b) by the tumour, which appears as a hypoechoic irregular lesion. Beynon et al. [4] first proposed the five layer model following their careful study comparing ultrasonographic appearances of the rectal wall with that of sequentially dissected out histological layers in the normal rectum. The differential acoustic impedance across the rectal wall gives the appearance of a concentric ring of alternating hyper- and hypoechoic layers as shown in Fig. 21.1c, and described below:

Mucosa: Hyperechoic layer
Muscularis mucosae: Hypoechoic layer
Submucosa: Hyperechoic layer
Muscularis propria: Hypoechoic layer
Serosa/perirectal fat: Hyperechoic layer

Despite vast advances in the ERUS equipment over the years, the basic principles of imaging remain unchanged. The procedure is not labour intensive, and is simple enough to be performed by a colorectal surgeon in a clinic setting with the consent of the patient. Sedation is seldom required, although it is usually necessary to give the patient an enema to avoid image distortion because faeces in the rectum. The patient is normally positioned in the left lateral decubitus position, following which a digital rectal examination and a proctosigmoidoscopy is performed to clinically assess the size, fixity and position of the lesion being investigated. Any rectal residue should be suctioned to provide an optimal image. A rigid or flexible endorectal probe is then inserted into the rectal cavity. The tip has a rotating transducer covered by a balloon, which is filled with a variable volume of degassed water after insertion. This ensures coupling between the transducer and the rectal wall without any acoustic interference from air within the rectum. Imaging is normally carried out starting from the proximal end, gradually withdrawing the probe distally whilst meticulously assessing the preservation or loss of the normal anatomical layers of the rectal wall. The adjacent perirectal tissue is also scanned to evaluate any potentially involved mesorectal lymph nodes. Real time images are acquired and transmitted to a screen for image capture and interpretation in a clockwise manner.

A range of probes with varying frequencies are available, depending on the intended aim of ERUS and bearing in mind that the focal length is inversely related to the frequency. As an example, a high frequency probe will give higher resolution images, but at a lower depth of penetration. This may be useful in assessing the depth of invasion, whereas a lower frequency may be more relevant in imaging the deeper perirectal tissues, albeit at the expense of image resolution. Frequencies of between 7 and 10 MHz will provide a focal length of 1–5 cm and are usually sufficient for the purpose of staging rectal neoplasms.

Primary Rectal Cancer Staging: The Role of ERUS

Depth of Invasion

The precise assessment of tumour depth into the rectal wall is of particular importance, given the possibility of a local transanal excision in selected cases of early rectal cancer, thus avoiding major resectional surgery and its associated morbidity.

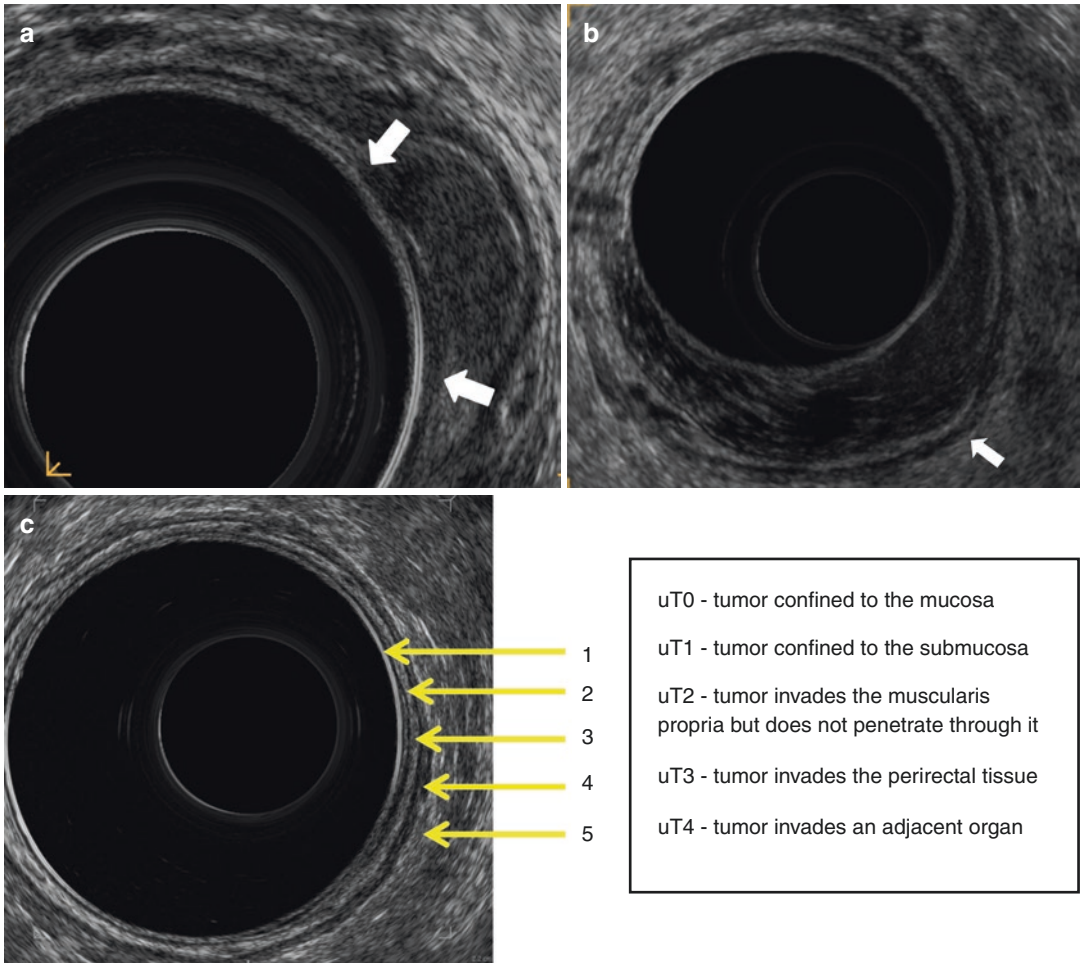


Fig. 21.1 (**a**) uT1 lesion. The middle white hyperechoic layer between the white arrows has been disrupted by the bulging tumour, indicating invasion into the submucosa. However, the outer black hypoechoic line indicating the muscularis propria is preserved. (**b**) uT1 lesion. Submucosal invasion by the tumour (*white arrow*) is indicated by the loss of the hypoechoic muscularis propria layer. However, the outermost white layer which is indicative of the perirectal fat is still preserved, demonstrating that the tumour is still confined to the bowel wall. (**c**) The five-layer rectal wall model of an ERUS and the corresponding depth of invasion (uT stage) as determined by degree of preservation of the different anatomical layers. Images courtesy of Dr. A Corr, St. Mark's Hospital, London. U.K.

Conversely, a locally advanced and unresectable tumour may benefit from neo-adjuvant treatment, rendering it operable and improving the chances of a curative resection following sufficient downsizing. These decisions depend on the accuracy of ERUS, or other imaging modalities, at determining the depth of rectal wall invasion, or 'T' stage. As discussed previously, ERUS evaluation of T-stage is reported according to a modified TNM classification system (see Table 19.2) and denoted by the prefix 'u' to reflect the imaging modality.

There is a wide variation in the accuracy of ERUS predicted T-stage, with estimates ranging between 63% and 96% [5], and a reported mean of approximately 85% [6]. A meta-analysis of 42 studies with over 5000 patients who underwent ERUS for rectal cancer staging between 1984 and 2006 found a pooled sensitivity of 81–96% and specificity of 91–98% for evaluating the T stage when compared to histopathology [7]. Whilst these results are certainly impressive, and comparably better than the reported accuracy of CT and MRI in assessing the depth of mural invasion [8], caution is

warranted in the absolute interpretation of pooled analyses of heterogeneous studies. Several studies included in the meta-analysis were single centre assessments, often with a small sample size, which was less than 30 patients in some cohorts, or a selection bias tending towards the inclusion of early and late stage disease in which the risks of inaccurate staging are low. Indeed, a common finding of ERUS is the low accuracy in T2 rectal cancer staging, with frequent overstaging cited in several series [9]. The main reason postulated is the difficulty in accurately distinguishing between a T2 tumour that invades deep into the muscularis propria, from an early T3 with microscopic infiltration of the perirectal fat [5]. This is a consequence of the inability to differentiate peritumoural desmoplastic reaction from genuine neoplastic invasion in the perirectal tissues with ERUS [10]. It is argued that the preoperative misclassification of a T2 rectal cancer bears little clinical consequence [11, 12], and whilst this is true for outcomes of T2 and 'early' T3 rectal cancers that undergo primary resectional surgery [13], the risks of overstaging could expose patients to contend with the toxicity of neo-adjuvant treatment, particularly in countries where this is standard practice for a T3N0 staged rectal cancer with no other adverse features [14]. Conversely, an understaged T2 cancer may be offered a local excision treatment in selective cases, with the prospect of having to undergo a potentially difficult salvage procedure subsequent to histological analysis.

Harewood [6] assessed the accuracy of ERUS staging for rectal cancer in his review of 41 publications in the English literature, and made two important observations worthy of discussion. Firstly, that the accuracy of ERUS for evaluating the depth of mural invasion in rectal cancer was inversely proportional to the sample size of the study. He suggested that publication bias of previously reported smaller studies may have over inflated the accuracy of ERUS as the imaging modality of choice. In this context, his second observation was the decline in ERUS accuracy for rectal cancer T-staging in the more recently published data, which is shown in Table 21.1 [15–24] for studies with over 100 patients.

Table 21.1 Accuracy of ERUS in determining the depth of rectal wall invasion

Study	Year	Patient recruitment	Setting	No. of patients	T staging accuracy (%)
Akasu et al. [15]	2000	1991–1996	Single-centre, Japan	309	80
Garcia-Aguilar et al. [16]	2002	Data not given	Single-centre, U.S.A	545	69[a]
Marusch et al. [17][b]	2002	1999	Multi-centre, Germany (n = 49)	422	63
Mackay et al. [11]	2003	1991–2001	Multi-centre, Australia (n = 2)	356	77
Manger et al. [18]	2004	1994–2002	Single-centre, Germany	357	77
Kauer et al. [19]	2004	1990–2000	Single-centre, Germany	458	69
Zammit et al. [20]	2005	1998–	Single-centre, U.K	117	76
Ptok et al. [21]	2006	2000–2003	Multi-centre, Germany (n = 331)	3501	66
Badger et al. [22][c]	2007	1999–2004	Single-centre, U.K	131	72
Goertz et al. [23][c]	2008	1990–2003	Single-centre, Germany	333	71
Morris et al. [24][c]	2011	1999–2007	Single-centre, Australia	233	82
Marusch et al. [25]	2011	2000–2008	Multi-centre, Germany (n = 384)	7096	65
Ashraf et al. [26][b]	2012	1992–2008	Multi-centre, U.K (n = 21)	165	55[d]
Restivo et al. [27]	2015	1997–2012	Single-centre (Italy)	220	65

[a]uT0-T4 tumours; uT1-T4 in all other studies
[b]No information on neo-adjuvant treatment provided. In all other studies, patient who had neo-adjuvant treatment were excluded
[c]Some patient had short course neo-adjuvant radiotherapy with immediate surgery
[d]uT0-T3 tumours only

A notable pattern in Table 21.1 is the relatively lower accuracy of ERUS in multi-centre studies, apart from Mackay et al. [11], in which the staging was carried out by two surgeons across two hospital sites. The inference is that widespread adoption of ERUS outside expert centres can compromise its reliability as an accurate staging modality. Marusch et al. [25] found that the accuracy of T-staging dropped from 73% at centres performing more than 30 ERUS per year to 63% at centres with less than 10 cases per year, thus advocating for a centralised service provided by experienced operators. Indeed, in a large study from Minnesota [16], the pathological T-stage of the tumour and ERUS operator were the only two independent factors affecting the accuracy of staging. Moreover, ERUS has been plagued with high inter-observer variability, which although in some cases may be secondary to procedural aspects, it is more commonly a consequence of operator experience [19]. In the context of a protracted learning curve associated with ERUS [5], the initial operator variability plateaus with increasing the case load, as well as standardising the technique and interpretation of staging criteria [26–28].

Lymph Node Involvement

Beyond the rectal wall is the moderately echogenic fatty tissue which contains the lymphovascular drainage system of the rectum. Assessment of potentially metastatic lymph nodes within the mesorectum continues to present a problem for all imaging modalities, including ERUS. The reported accuracy for ERUS based nodal staging is even less than that for evaluating the depth of invasion. A recent meta-analysis of over 5000 patients found a 57% sensitivity and 80% specificity for ERUS predicted involved lymph nodes [29], with a mean accuracy of 73% [5]. The main limitation in assessing lymph nodes is the lack of valid ultrasonographic criteria to discriminate between malignant and inflammatory nodal tissue. The commonly applied size criterion of 5mm or more to define a malignant lymph node is arbitrary and of poor predictive value when compared to gold standard histopathology. Kim et al. [30] found that up to 18% of lymph nodes less than 5 mm contained metastases, and whilst reducing the size threshold to 3mm improved the overall accuracy of predicting metastatic nodes, this significantly compromised the specificity with the inherent risks of over-treatment in this group [15].

The addition of secondary characteristics, such as echogenicity, border features and contour, to dimensional assessment of lymph nodes may increase the discriminatory power of ERUS in evaluating metastatic nodes. Thus, a hypoechoic round node with a smooth delineated border is more likely to be metastatic lymph node than an inflammatory one, although even this combination of additive features has been shown to give conflicting results [22, 31, 32]. One way of ameliorating these issues, particularly in equivocal cases, has been the suggestion of fine needle aspiration (FNA) for cytology sampling of mesorectal lymph nodes [31]. Whilst technically feasible and safe to perform, ERUS guided FNA has not been shown to improve the accuracy of lymph node staging in rectal cancer [33], and is certainly not routinely practised.

Limitations of ERUS

Technical limitations of ERUS are best considered in relation to the rectal anatomy, or the tumour itself. In the latter case, large polypoid or stenotic tumours cannot be adequately assessed because of the inability of the probe to traverse the narrow lumen [5, 23]. Moreover, lesions in the upper rectum may be inaccessible for evaluation, and those in the lower rectum have been subject to difficult staging owing to loss of the five layer sonographic appearance in the rectal ampulla wall [34]. Further anatomical distortion is seen with a wide bore and rigid ERUS probe, or the water filled balloon, which both stretch the rectal wall and impair accurate visualisation. Finally, the angulation of the probe at the tumour interface, faecal residue in the rectum, prior biopsy of the lesion, and the valves of Houston are all potential confounders that have resulted in over-staging of the rectal lesion [9, 23].

The major limitation of ERUS, however, is its inability to accurately define important perirectal anatomical structures, most notably the mesorectal

fascia. The relationship of a rectal cancer to this crucial oncological landmark is predictive of circumferential resection margin (CRM) involvement, which is an independent risk factor for local recurrence following TME surgery [35]. Current multimodality treatment of rectal cancer therefore mandates the precise evaluation of the mesorectal fascia, as it determines the need for neo-adjuvant treatment, or the plane and type of surgery where curative resection is achievable, both of which have significant implications for the patient.

Future Perspectives of ERUS

Advancements in ERUS technology have overcome some of the limitations described above, including the advent of endoscopic ultrasound miniprobes, which enables access to the more proximal rectal lesions, as well as assessment of large stricturing tumours [36]. Furthermore, three-dimensional (3D) ERUS has recently been show to improve diagnostic performance because of higher resolution and multi-planar image acquisition of the rectal wall and surrounding anatomy, including the mesorectal fascia in few cases [9, 18, 30]. Strain elastography is another novel and complementary technique to ERUS, which relies on the differential resistance of tissues to strain, depending on whether there is any malignant infiltration [37]. Early indications from these evolving technologies hold promise for the future of accurate preoperative staging, which will be dictated by robust evidence of their effectiveness in clinical practice.

Magnetic Resonance Imaging

High-resolution magnetic resonance imaging (MRI) plays a fundamental role in modern day multidisciplinary management of rectal cancer. The ability of MRI to precisely depict and characterise a rectal cancer, and its relationship to important pelvic anatomical structures such as the sphincter complex and mesorectal fascia, is pivotal in its effectiveness as a preoperative staging modality. Thus, MRI evaluated local staging of rectal cancer has important implications not only in prognostication of the disease, but also in tailoring treatment that whilst maximising the chances of a successful cure, spares the patient from the effects of unwarranted multimodality treatment. The introduction of phased-array surface coils has enabled the acquisition of high spatial resolution images with equally good soft tissue contrast for interpretation, which makes MRI based stratification an ideal staging modality.

MRI Technique

Whilst institutional protocols will vary somewhat, the main principles of MRI technique for local rectal cancer staging are universal, and require thin slice, high spatial resolution T2-weighted images (1 mm 3 voxel size) with a small field of view encompassing the rectal tumour and its surrounding perirectal tissue. Bowel preparation is unnecessary, and an intramuscular injection of 20mg hyoscine butylbromide is helpful to minimise peristaltic artefact from the small bowel. Endorectal coil use is not recommended because of the several limitations that apply to ERUS as well, and not least because of the superior quality imaging acquired with modern day pelvic surface coils. Moreover, the routine use of endorectal contrast is also not advocated, and may in fact impair accurate interpretation of mural invasion by stretching of a full rectum. Intravenous gadolinium contrast does not improve diagnostic accuracy, and is also not recommended as it needlessly prolongs the examination [38]. Similarly diffusion weighted MRI has not added to the diagnostic accuracy in rectal cancer staging and results in unacceptable prolongation of the scans which patients may find distressing.

The patient lies supine on the MRI table and a phased-array surface coil is placed around the pelvis to secure the patient in position, thus minimising movement artefact. MRI scanning is then initiated in a cranio-caudal fashion as the patient advances into the magnet core, which should ideally be of 1.5 T field strength, or higher. The first sequences are to locate the rectal tumour being investigated, and are acquired as T2-weighted fast spin-echo (T2W-FSE) images in the sagittal

and coronal plane. Based on the longitudinal axis of the tumour from these initial images, thin section orthogonal sequences of the tumour and adjacent perirectal tissues are then obtained in the axial plane. The meticulous planning of this angulation, prior to imaging, is critical to enable accurate assessment of depth of invasion by the tumour. These images should be acquired using a 16 cm field of view and a matrix resolution of 256 × 256 pixels with a 3 mm thickness to achieve a 0.6 × 0.6 mm in plane resolution and 1.1 mm^3 voxel resolution. To achieve adequate signal to noise and interpretability a minimum of 4–6 signal averages is required (approximately 7 min scan duration). A further scan should be performed to cover at least 5 cm above the top of tumour to evaluate the draining nodes and vessels for tumour spread. The rest of the pelvis is then imaged from the iliac crests to the pubic symphysis with a large field of view.

Appropriate consideration must also be given to MRI planning for distal third rectal cancers, owing to anatomical features of the anorectum in the low pelvis. At this level, the mesorectum and its fascia taper sharply into non-existence, being replaced by the sphincter complex. The abrupt change in calibre and angulation of the rectum risks a tumour at this level being overstaged, especially if perpendicularity of the imaging planes is not maintained. Optimal angulation to achieve high-resolution coronal sequences will clearly delineate the sphincter complex and its relationship to the tumour, the benefits of which cannot be overstated for the planning of a primary surgical resection. The awareness of common pitfalls and artefacts related to MRI of the pelvis, and how to minimise their impact on diagnostic interpretation have been reviewed by Zand et al. [39].

Primary Rectal Cancer Staging: The Role of MRI

Depth of Invasion

Brown et al. [40] first reported MRI as an accurate method of staging mural spread in rectal cancer, by prospectively comparing section-for-section in vivo MRI images to in vitro rectal cancer specimen images, and finally correlating them to gold standard histopathology. They argued that the poor results in previous studies could be accounted for by the use whole body surface coils and thick sections that afforded poor quality imaging for interpretation. Since then, high spatial resolution thin slice MRI has become the imaging choice for preoperative evaluation of rectal cancer, with a sensitivity of 87% and a specificity of 75% for T-stage assessment as reported in a meta-analysis of just under 2000 patients [41]. The depth of invasion is reported according to the signal intensity criteria, with the tumour having an intermediate signal intensity that is higher than the muscularis propria, but lower than the submucosa. The latter is normally seen as a thick layer just deep to a very fine line of low signal intensity mucosa. An overall mrT-stage is accorded, as derived from TNM staging of rectal cancers (Table 21.2) [12].

As in the case of ERUS staging, some of the reported variability in the accuracy of mrT-stage evaluation is because of an apparent difficulty in differentiating a T2 from an 'early' T3 rectal cancer. The risk of overstaging at this interface is well recognised, but can be avoided by recognis-

Table 21.2 MRI staging criteria for depth of invasion (mrT-stage)

MRI signal characteristics	MRI T-stage
Low signal in the submucosal layer, replacement of the submucosal layer by abnormal signal not extending into circular muscle layer	T1
Intermediate signal intensity within muscularis propria. Outer muscle coat replaced by tumour of intermediate signal intensity that does not extend beyond the outer rectal muscle into the perirectal fat	T2
Broad-based bulge or nodular projection (not fine spiculation) of intermediate signal intensity projecting beyond outer muscle coat	T3*
Extension of abnormal signal into adjacent organ, extension of tumour signal through the peritoneal reflection	T4

Adapted from [12]

*T3 is further subdivided depending on the depth of extramural invasion from the muscularis propria to the outer edge of the tumour; T3a: <1 mm, T3b: 1–5 mm, T3c: 5–15 mm; T3d: >15 mm

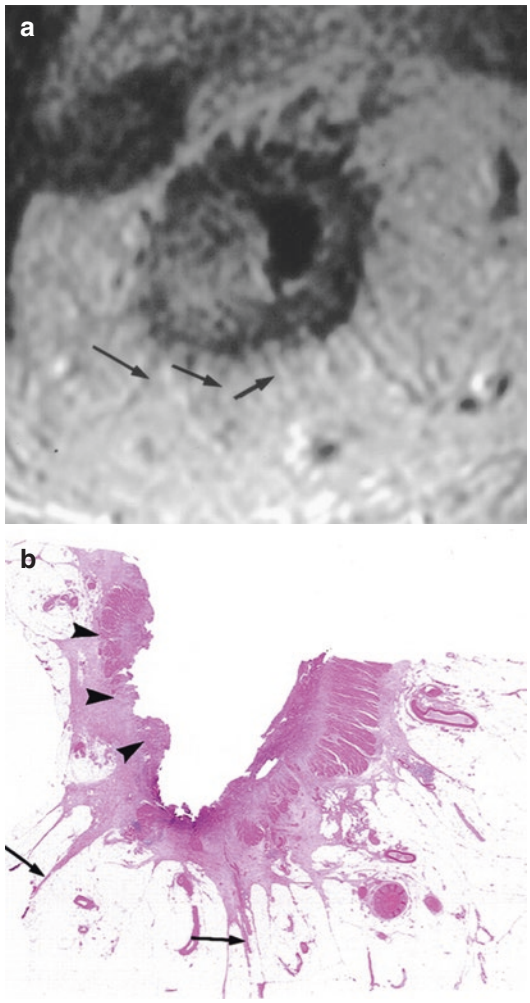


Fig. 21.2 (**a**) Axial T2-weighted MR sections of a mrT2 rectal cancer confined to the bowel wall. The long, low intensity spikes of fibrosis in the perirectal fat (*arrows* in **a** and **b**) demonstrate extramural desmoplasia, and not T3 extension (**b**) Corresponding histopathology slice (haematoxlin-eosin stain) of the same tumour showing the tumour margin (*arrowheads*) which is still intramural (Adapted from Ref. [40])

ing the obvious differences between the peritumoural desmoplastic reaction in the extramural fat and the characteristic nodular broader front of infiltration that is observed in early T3 tumours (Fig. 21.2a, b).

More recently, the depth of extramural invasion within the mesorectum has been found to be a risk factor for local recurrence, and is therefore of prognostic relevance in the preoperative setting, particularly because the largest proportion of rectal cancers seen at presentation are of T3 stage. Merkel et al. [13] subdivided a large series of over 800 pT3 rectal cancers into whether they had extramural invasion of less than 5 mm (pT3a), or more than 5 mm (pT3b), and found a significant difference in the 5 year cancer-specific survival of 85% and 54%, respectively, irrespective of the lymph node status. They also showed that survival for a pT2 cancer was comparable to a pT3a cancer, and on this basis, it can be argued that neo-adjuvant treatment for this cohort of patients is unlikely to be of any significant benefit. The precise evaluation of extramural spread, and thus the sub-staging of T3 rectal cancers (Table 21.2)**,** is of major importance in the era of multimodality treatment. The sub-classification of this heterogeneous group of rectal cancers has been reflected in the pathological TNM staging of rectal cancers [42]. Based on this classification, the MERCURY [43] study found that the MRI assessment of extramural invasion in rectal cancer correlated to within 0.5 mm of histological measurement in 295 cases who had primary surgery. In this context, the group later reported that for MRI staged 'good' prognosis rectal cancers (mrT1-T3b), the 5-year local recurrence rate was 3% with primary surgery alone, regardless of the MRI reported lymph node status [44]. The combination of MRI staging followed by good quality TME surgery avoided the need for neo-adjuvant treatment in 30% of rectal cancer patients without any major oncological compromise [44].

Lymph Node Involvement

The soft tissue contrast afforded by MRI makes it the optimal imaging modality to identify local mesorectal lymph nodes. Despite this, the lack of a universally accepted set of diagnostic criteria in discriminating between a benign and a malignant lymph node presents the main challenge in accurate prediction of nodal involvement. Whilst the presence of any visible mesorectal lymph nodes is largely obsolete for defining metastatic involvement, size criterion remains an important, if controversial, determinant. In a morphometric analysis of nearly 13,000 lymph node retrieved from rectal cancer specimens, Dworak et al. [45] demonstrated considerable overlap in the size of reactive and metastatic lymph nodes. Despite this, a range of

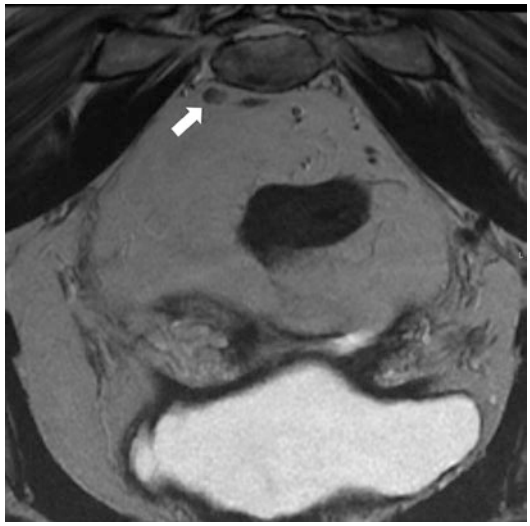


Fig. 21.3 A 8mm mesorectal lymph node (*arrow*) close to the mesorectal fascia on a T2-weighted axial image, showing a homogenous signal and regular border contour. This was subsequently confirmed on histology as a benign node

cut-offs have been used over the years to predict a metastatic lymph node, with size thresholds of 3–10 mm used as a diagnostic criteria [46–48]. Unsurprisingly, these arbitrary measurements have yielded an accuracy of between 43-85% when compared with standard histological assessment, confirming the view that lymph node size has a poor predictive value for nodal staging [49], as shown in Fig. 21.3.

Focus has subsequently shifted to the morphological appearances of lymph nodes on MRI, which has been shown to be a better discriminator of nodal involvement. This is because tumour infiltration into a lymph node disrupts the capsular integrity, as well as the signal intensity owing to necrosis within the node. Brown et al. [50] first demonstrated this phenomenon in their meticulous study of comparing lymph nodes in the dissected pathology specimen to their corresponding MRI images in a section-by-section analysis. They reported that an irregular border and mixed signal intensity in a MRI detected lymph node had a sensitivity of 85%, and a specificity of 97% in correctly predicting histological nodal involvement. Conversely, normal or reactive nodes are likely to have a homogeneous signal intensity with a well-defined, smooth border. The combination of these features as a diagnostic criteria had a predictive accuracy which was superior to various size cut-offs applied to the same cohort [50].

A recent meta-analysis of MRI studies for rectal cancer staging confirmed the poor accuracy that has plagued preoperative lymph node evaluation with all types of imaging modalities. Al-Sukhni and colleagues [41] reported a sensitivity of 77% and specificity of only 71% for MRI predicted lymph node involvement, which is probably a reflection of the heterogeneity in the diagnostic criteria employed by the individual studies. Indeed, most studies continue to use size criteria of various cut-offs [51, 52], and it is plausible that pooling these results into a meta-analysis leads to the reported sub-optimal accuracy for MRI nodal evaluation.

A novel technique to improve the accuracy of MRI nodal assessment has been the development of lymph node specific contrast agents, most notably ultra-small superparamagnetic iron oxide particles (USPIO) [53]. These particles are preferentially taken up by normal lymphoid tissue and then ingested by macrophages, resulting in a 'dark' signal intensity after delayed imaging on a T2*-weighted sequence. Thus, inflammatory nodes with a high concentration of macrophages should be discernible from metastatic lymph nodes, which demonstrate a high 'white' signal intensity because of no USPIO uptake. Although early results of its application were promising [54, 55], the lack of validating evidence from larger population studies has limited its current utilisation in clinical practice.

The overarching debate in recent times has been the significance of mesorectal lymph nodes [56, 57], especially with the popularisation of anatomically precise rectal cancer surgery based on the principles of TME. Quirke et al. [58] found that in good quality mesorectal plane TME specimens, where the rectum and its surrounding lymphovascular mesorectum were excised as an intact package, the risk of local recurrence at 3 years was 4% without neo-adjuvant radiotherapy. Thus, some have argued that as optimal TME surgery achieves good locoregional control, lymph node status should not mandate routine adjunctive treatment [56], suggesting instead

a 'hierarchical' set of adverse prognostic features that include extramural venous invasion and the circumferential resection margin. At present however, assessment of lymph nodes in the pre-operative setting has an important role, for example where local excision is being considered to avoid the risks of major resectional surgery.

Prediction of Circumferential Resection Margin Involvement

The relevance of the circumferential resection margin (CRM) was first postulated in a seminal paper by Quirke et al. [59] in 1986, in which they reported the association of pelvic recurrence with tumour presence at what they termed the 'lateral' margin of rectal cancer specimens. An involved CRM has since become one of the most important and well-established prognostic factor in rectal cancer, and is associated with an increased risk of local recurrence, distant metastases and reduced survival [60–63]. The preoperative prediction of an involved or threatened CRM, therefore, has significant implications on the need for neo-adjuvant treatment, planning the type and plane of surgery in order to maximise the chances of a curative resection, and most crucially, counselling the patient about the potentially adverse outcomes.

The anatomical equivalent of the surgical CRM is the mesorectal fascia [64]; a thin embryological fibroareolar sheath that envelopes the rectum and its surrounding fatty lymphovascular mesorectum, thus forming a natural oncological barrier. It is beyond this fascia that they 'holy plane' of TME is pursued to achieve the surgical excellence of resecting an oncologically intact specimen. On axial MRI sections, the mesorectal fascia appears as a low signal intensity circumferential structure that encases the mesorectum (Fig. 21.4a, b), which itself is of high signal intensity similar to fat.

Brown and colleagues [40] first demonstrated the feasibility of MRI in visualising the mesorectal fascia in a small, single centre study comprising 28 patients. Subsequently, they reported a 92% accuracy in predicting involvement of the pathological CRM if tumour invasion was within 1mm of the mesorectal fascia on MRI [12]. Whilst there was initial uncertainty about the optimal distance between tumour and mesorectal fascia to predict a threatened margin, a ≤1 mm threshold is now universally accepted as a standard, and has the benefit of conforming to the histopathological definition of an involved CRM [63]. Distance criteria of ≤2 mm [65], or even ≤5 mm [66] have been used and advocated, and although this unsurprisingly increases the sensitivity of predicting CRM involvement, the overall accuracy of a ≤1 mm cut-off is far superior as reported in a recent meta-analysis [67]. Moreover, Taylor et al. [68] showed in a large multi-centre study that with a cut-off criteria of tumour ≤5 mm from the mesorectal fascia to predict pathological CRM involvement, up to 13 additional patients would need neo-adjuvant

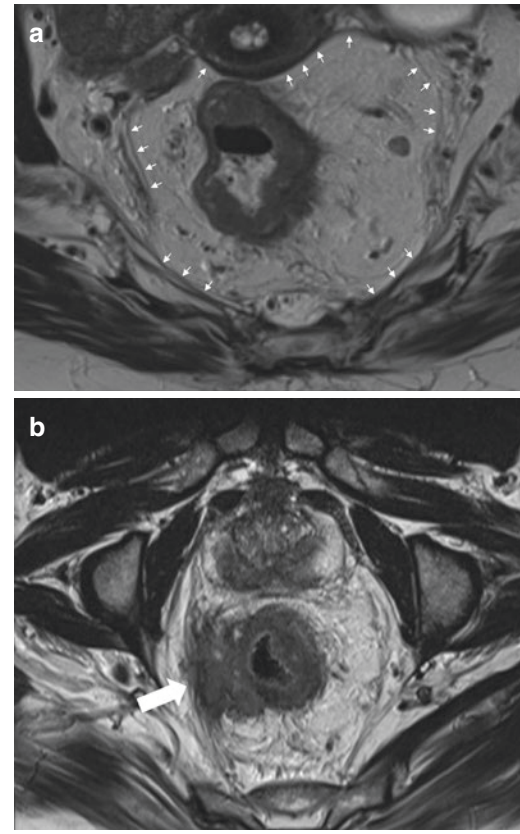


Fig. 21.4 (**a**) Axial T2-weighted MRI section showing the circumferential mesorectal fascia (*white arrows*) encasing the mesorectum. In this case, the mesorectal fascia has not been invaded by the tumour (not shown). (**b**) Axial-Oblique T2-weighted image of a mid rectal tumour (*white arrow*) that has perforated through the mesorectal fascia on the right, with surrounding inflammatory changes

treatment in order to prevent one local recurrence, representing overtreatment in this group.

The MERCURY study [69], a European multi-centre prospective observational study, reported a MRI accuracy of 88% in predicting CRM involvement, and an even higher negative predictive value of 94% when validated against the gold standard pathological assessment of CRM involvement. On this basis, when the MRI predicted mesorectal fascia is clear of tumour, primary surgery based on the principles of TME can be recommended to achieve a R0 resection with a high degree of certainty. The MERCURY group subsequently found that MRI assessment of the CRM status was an independent prognostic marker, predictive of the 5-year local recurrence and survival rate [35]. This series forms the largest contributor to a recent meta-analysis of 1600 patients, which found a 74% sensitivity and a 93% specificity in the use of MRI to assess involvement of the mesorectal fascia in rectal cancer staging, prior to any treatment [67].

Pelvic Side Wall Lymph Nodes

As alluded to previously, MRI staging enables evaluation of the whole pelvis, including assessment of the lateral wall compartment in which prominent lymph nodes are occasionally seen. The clinical significance and management of these pelvic side wall lymph nodes (PSWLN) in rectal cancer remains contentious, but it is purported to be one of the reasons for locoregional failure despite optimal TME surgery, which does not address extra-mesorectal disease [70]. This is particularly pertinent in the distal third rectal cancers, owing to the preferential lateral lymphatic spread of low lying tumours along the internal iliac artery, and then to various lymph node stations on the pelvic side wall [71, 72]. Sugihara et al. [73] reported a histologically confirmed 15% incidence of metastatic PSWLN in cancers below the peritoneal reflection, compared to a significantly lower 8% incidence in upper rectal cancers from a large multi-centre cohort. In the East, and particularly Japan, PSWLN dissection is therefore widely pursued and advocated, accepting the risks associated with what is an otherwise major and high morbidity procedure [72, 74]. A meta-analysis of 20 studies, which were mostly retrospective non-randomised cohorts, comparing curative TME resection and PSWLN dissection versus TME alone found no difference in the local recurrence rates between the two strategies [75]. In this context, clinical practice in North America and Europe has been to either ignore suspicious PSWLN seen on pre-operative imaging, or more commonly, to offer chemoradiotherapy. Currently, there is no evidence based consensus on which approach offers the best oncological outcome, largely limited by the lack of an accurate predictor of PSWLN involvement that can guide treatment choice.

Debate continues about what constitutes a 'suspicious' PSWLN on MRI, much like in the optimal diagnostic criteria for predicting a metastatic mesorectal lymph node, as discussed previously. Although size is considered a poor discriminant, it is still employed with various cut-offs to base decisions about neo-adjuvant treatment, or the need to pursue PSWLN dissection [76, 77]. The MERCURY group have instead adopted morphological MRI criteria of mixed signal intensity and irregular contour to define an involved PSWLN (Fig. 21.5a, b) [78]. Judged by these criteria, they reported a 12% incidence of MRI suspicious PSWLN in 325 patients with rectal cancer, limited of course by the absence of histological validation. These patients had a significantly poorer disease free survival compared to those without MRI suspicious PSWLN, however, when neo-adjuvant radiotherapy was factored into the analysis, the difference was no longer apparent between the two groups [78].

Extramural Vascular Invasion

Extramural vascular invasion (EMVI) is defined as the presence of tumour cells in the microvasculature beyond the muscularis propria, and is a well-established adverse prognostic factor [79–81]. Whilst EMVI is more prevalent in locally advanced T3/4 rectal cancers, it can present as discontinuous foci with early stage intramural tumours [82], and must be sought for to improve the accuracy of prognostication. Post-operatively, histologically confirmed EMVI has been shown to be associated with a higher risk of local and

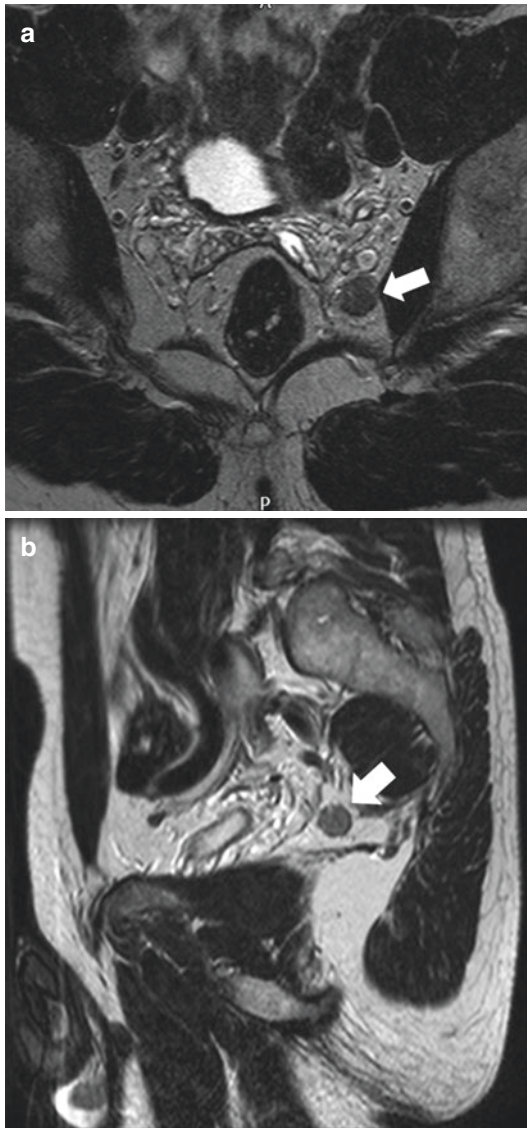


Fig. 21.5 Axial (**a**) and Saggital (**b**) T2-weighted MRI section showing a 14mm metastatic left pelvic side wall lymph node (*white arrow*). Note the heterogeneous signal intensity and irregular border which is suggestive of tumour infiltration. (Images courtesy of Mr. B Moran, Basingstoke and North Hampshire Hospital, U.K.)

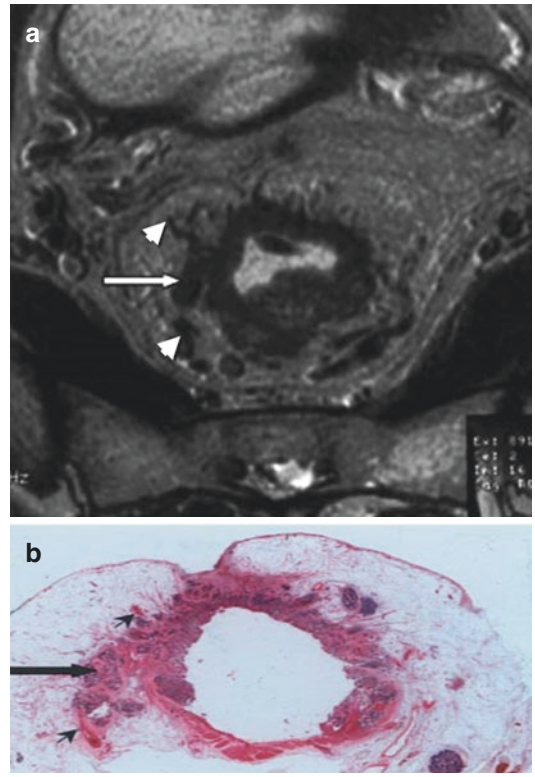


Fig. 21.6 (**a**) Axial T2-weighted MRI section showing EMVI with the corresponding H&E stained histological whole mount section. (**b**) A tongue of tumour is seen extending into the perirectal fat (*arrow*) associated with a vessel, which appears as a signal void on MRI (*arrowheads*)

distant failure [80, 81, 83, 84], and poorer overall survival [85, 86], regardless of the nodal status or depth of mural invasion [87, 88]. The reported incidence of histopathological EMVI in rectal cancer varies from 9 to 61% [89], and to a large extent reflects the variability in reporting amongst pathologist. The diagnostic yield is influenced by several factors, including the lack of standardised pathological reporting criteria [90], the processing and number of tissue blocks examined [86, 91], expertise of the reporting pathologist [92], and the use, or not, of ancillary specialised stains to improve detection [91, 93].

Recent interest has been generated by the ability of MRI to detect EMVI pre-operatively, as part of standard rectal cancer staging. Brown and colleagues [12] characterise EMVI as intermediate signal intensity serpiginous structures in the mesorectal fat, similar to tumour signal, that are seen extending into a signal void tubular structure which represents a blood vessel (Fig. 21.6a, b).

In this seminal study, MRI correctly predicted histological EMVI in 15 out of 18 cases where large veins were involved, with small calibre

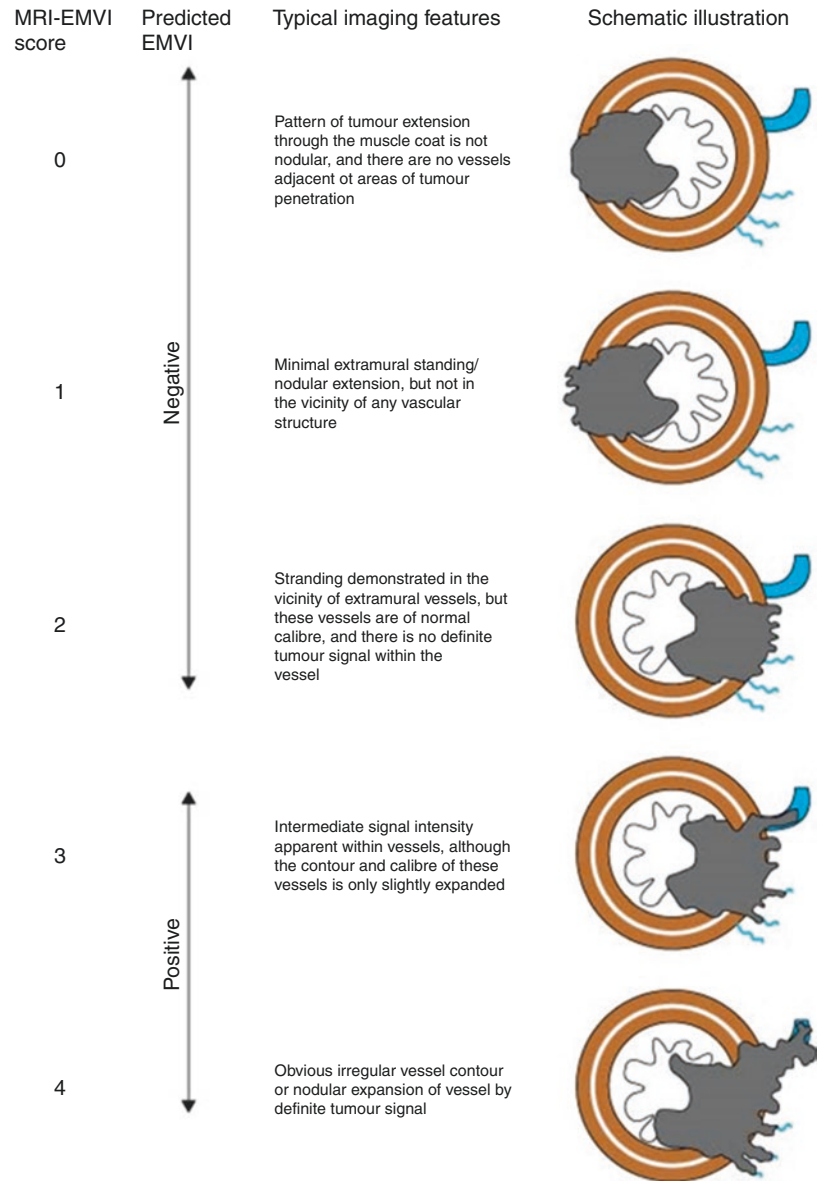


Fig. 21.7 EMVI Grading system. With permission John Wiley and Sons [95]

vascular invasion being missed even after retrosepctive review [12].

The heterogeneous relationship of perirectal vasculature and tumour presence has led to the formulation of a MRI-detected EMVI grading system which consists of 4 defining criteria (Fig. 21.7): pattern of tumour margin; location of tumour relative to major vessels; calibre of vessels; vessel border [94]. A five-point grading score based on combination of the above criteria has been proposed to improve the diagnostic accuracy of MRI predicted EMVI [94], such that grade 0–2 are effectively EMVI negative, whereas grade 3–4 are strongly suggestive of the presence of EMVI.

Based on this grading system, MRI predicted pathological EMVI with a high specificity ranging between 88% and 96%, but a variable sensitivity of 29–62% [95–97]. The low sensitivity of MRI predicted EMVI may be due to the inability to accurately visualise small calibre vessels (<3 mm), even in a high resolution setting.

Alternatively, it is perhaps more likely that EMVI was underreported in histopathology evaluation either because of vessel obliteration during specimen handling [95], or as some authors have alluded, sub-optimal pathological interpretation, leading to false negative reports [97]. Indeed, it has been suggested that MRI evaluation of EMVI may be more accurate than histopathological assessment [91], with an incidence of 22–39% reported in the literature using the above MRI grading score [95–98].

The presence of MRI detected EMVI has been shown to predict disease relapse [95], and in a large series of 450 rectal cancer patients, it was found to be an independent risk factor for synchronous metastases [97]. Bugg et al. [98] subsequently showed in a cohort of 200 patients that MRI detected EMVI was associated with an almost fourfold risk of developing metachronous metastases within 1 year of rectal cancer diagnosis. In this context, the presence of EMVI on MRI is of significant relevance, as it may indicate tumour embolisation into the systemic circulation with possible micrometastases at the time of presentation, which remain undiagnosed because of the limitations of current imaging modalities. More crucially, present day multimodality treatment in the form of neo-adjuvant chemoradiotherapy and TME surgery does not address this issue, and may in part account for the good local control that has been achieved with this approach, but the failure to prevent distant relapse and improve survival. Although not routine practice, it may be that MRI detected EMVI patients are the ideal candidates, amongst other high risk patients, for up-front systematic chemotherapy in order to secure distant control and improve survival, as is being trialled in randomised studies [99].

MRI Evaluation of Low Rectal Cancer

The rectum is arbitrarily divided into 3 parts depending on the height from the anal verge, as measured by a rigid sigmoidoscope when the patient is in the left lateral position; low rectum is up to 6 cm from the anal verge, mid rectum is from 7 to 11 cm, and the upper rectum is from 12 to 15 cm [100]. The importance of this classification relates to the anatomical relationship of the rectum to other pelvic viscera, and in particular the safety provided by the mesorectum in the mid rectum, or a lack thereof, in the low rectum whereby a locally advanced tumour is likely to compromise preservation of the anal sphincters. Given that these distances will vary somewhat between individual patients, a more objective MRI based definition of low rectal cancer has been proposed as "an adenocarcinoma with its lower edge at, or below, the origin of the levators on the pelvic sidewall" [101].

Approximately one third of all rectal cancers will be 'low' according to this definition [102]. The mainstay of a curative surgical resection for low rectal cancer (LRC) is either a low anterior resection (LAR), or in up to 45% of cases, an abdominoperineal excision (APE) that results in a permanent stoma [103].

The merit of pre-operatively evaluating LRC as a discrete entity, and thus individualising a treatment plan, is related to the historically poor outcomes associated with an APE, compared to anterior resection for upper- and mid rectal tumours which have seen vast prognostic improvements following the widespread adoption of TME surgery. Multiple studies have shown that patients undergoing an APE have a higher rate of pathological CRM involvement—over 30% in some large series—resulting in higher rates of local recurrence and poorer survival [104–106]. This marked difference in outcomes can be explained by the surgical challenges of operating within the narrow confines of the low pelvis on a segment of the rectal tube which is devoid of the protective mesorectum, which tapers sharply into non-existence at the proximal insertion point of the sphincters. These difficulties culminate in the resection of a sub-optimal surgical specimen, often with a 'waist' around the lowest part of the mesorectum, or in some cases an iatrogenic perforation into the tumour or bowel [106, 107]. A greater awareness of these pitfalls, coupled with the refinement of surgical techiniques to ensure a more cylindrical specimen, has led to the use of an extended or extralevator APE (ELAPE) [108], particularly when the levators or sphincter complex have been invaded by tumour. But

the radicality of such an operation is associated with a significant perineal defect which is not always suitbale for primary closure, occasionally requiring reconstructive surgery with myocutaneous flaps, or a biological mesh to achieve wound closure and prevent herniation [109]. Despite these techniques, there remains a risk of perineal wound morbidity which is enhanced with the use of neo-adjuvant radiotherapy [109, 110]. Moreover, the early results of studies comparing standard APE against ELAPE have been mixed, and because not every LRC warrants an ELAPE, an accurate staging system to tailor the optimal plane of surgery, or appropriately select patients for neo-adjuvant therapy is highly valued [111].

To address these complexities in the management of LRC, an MRI based anatomical staging system has been devised which assesses the relationship of the tumour to both the intersphinteric space and levator muscle [102, 112] (Table 21.3).

Salerno et al. [113] retrospectively validated this staging system and demonstrated that stage 3 and 4 low rectal tumours had an 18-fold increased risk of a pathologically involved CRM, compared with stage 1 and 2 tumours. When the latter group had a standard APE without radical en-bloc resection of the levators, the CRM was involved in over 50% of the cases. Thus, according to the LRC staging system, tumours categorised as stage 3 or 4 will require an ELAPE, or exenterative surgery if adjacent viscera are involved in order to achieve a clear resection margin. Conversely, stage 1 or 2 low rectal cancers can safely achieve a clear CRM with an intersphicteric resection, with a colo-anal anastomosis where feasible and indicated (Fig. 21.8).

Table 21.3 MRI based staging system for low rectal cancer

MRI stage for LRC	Description of stage assessment
Stage 1	Tumour confined to the bowel wall and does not extend through the full thickness; intact outer muscle coat
Stage 2	Tumour replaces the muscle coat but does not extend into the intersphincteric space
Stage 3	Tumour invades the intersphincteric space or lies within 1mm of the levator muscle
Stage 4	Tumour invades the external anal sphincter and is within 1mm and beyond 1mm of the levator muscle, with or without invading adjacent structures

A composite MRI staging system for LRC has subsequently been developed which encompasses the assessment of tumour proximity to mesorectal fascia, as well as the involvement of the intersphicteric space which can be used to define the surgical plane of excision. Thus, the low rectal plane can be considered 'safe' to achieve a complete surgical resection when tumour does not invade both of the aforementioned structures (Fig. 21.9).

The MERCURY II [103] study was the first to prospectively validate this LRC staging system in 279 patients recruited from 14 centres across Europe, and achieved and overall pathological CRM involvement of 9%, which is significantly lower than the historically reported rates. Reassuringly, when the MRI predicted low rectal cancer plane was safe (Stage 1 and 2 tumours and MRF clear), the rate of CRM involvement was reduced to only 4%, confirming the utility of MRI in aiding the pre-operative decision making process. Furthermore, the combination of a MRI evaluated safe low rectal cancer plane with no other adverse prognostic features (<mrT3c, mrN2 and no mrEMVI) resulted in CRM involvement in only 1 out of 62 cases (1.6%). None of these 62 patients were deemed to require neo-adjuvant therapy based on the MRI staging, and managed to safely avoid the additional co-morbidity of chemoradiation by proceeding straight to surgery, without any compromise of the short term oncological outcomes.

On multivariate analyses, three additional MRI risk factors were identified that predicted an involved CRM, namely, a tumour located at a height of less than 4cm, anterior quadrant invasion, and the presence of EMVI [103]. Based on these findings, the group proposed a risk stratification model according to which the presence of all 4 adverse features predicted a risk probability of up to 60% for an incomplete resection. These

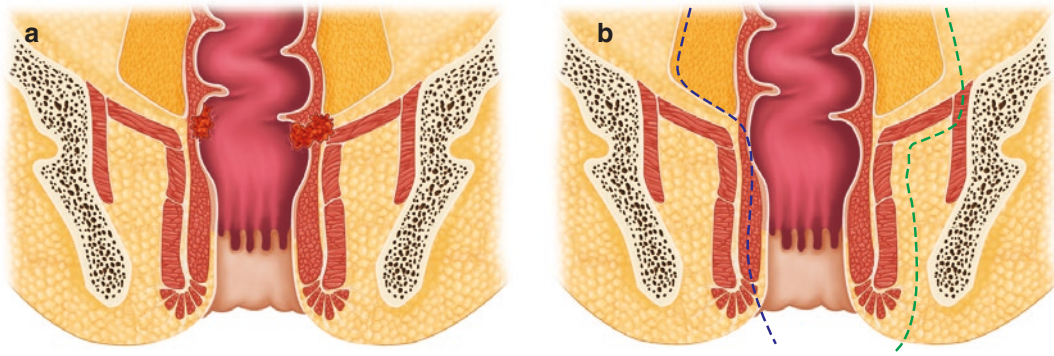


Fig. 21.8 Pictorial description of low rectal cancer and plane of resection in an oblique coronal view. (**a**) The tumour on the left depicts an early stage low rectal cancer that has not breached the muscularis propria/internal sphincter, and would therefore be oncologically suitable for a standard APE, or a restorative intersphicnteric resection as shown by the dashed green line in (**b**). The tumour on the left in (**a**) has extended beyond the intersphincteric space into the levator ani and puborectalis muscle. This would require an extralevator APE (ELAPE) as shown by the dashed blue lines in (**b**) to achieve a clear CRM (Adapted from Battersby et al. Exp Rev *Gastroenterol Hepatol* 2014;8:703–19)

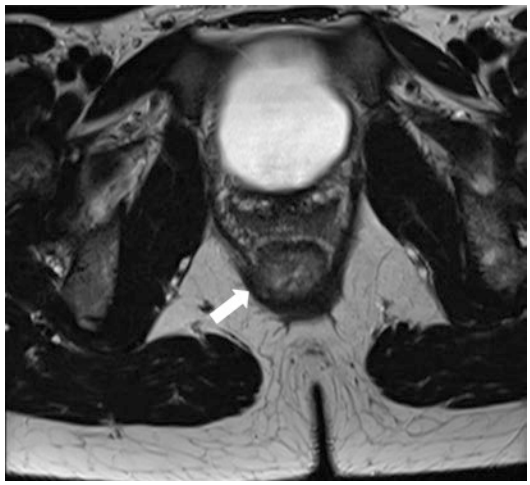


Fig. 21.9 Axial MRI of low rectal cancer invading the intersphincteric plane

are precisely the patients who may benefit from the addition of neo-adjuvant chemoradiotherapy to achieve downstaging from an 'unsafe' to a 'safe' low rectal cancer plane, or in the case of poor responders, consideration of exenterative surgery.

Staging for 'Beyond TME' Surgery

Approximately 5–10% of patients will present with a locally advanced rectal cancer that requires multivisceral resection beyond the conventional TME plane in order to achieve a R0 resection [114]. Despite the risks of significant morbidity and mortality, and the effect on patients' quality of life after what is potentially mutilating surgery, a clear pathological resection margin is the most important determinant of survival in patient with non-metastatic disease [115]. Accurate pre-operative staging can not only help determine the plane of surgery required to achieve an en-bloc resection, but also mitigate the need for a default exenterative procedure and its associated consequences. Pelvic high resolution MRI remains the choice of imaging in most specialist centres, according to an expert consensus statement by the 'Beyond TME' collaborative [114]. More recently, MRI staging according to pelvic surgical compartments, rather than involvement of individual organs, has been proposed as an oncologically superior method of staging because it facilitates the selection of anatomical planes of dissection. Georgiou et al. [116] reported a high diagnostic accuracy of compartment invasion by tumour (ROC >87%) on such a MRI based staging system, in which there was also good inter-observer agreement for both recurrent and primary rectal cancer requiring curative resection beyond the TME plane. However, prospective validation of

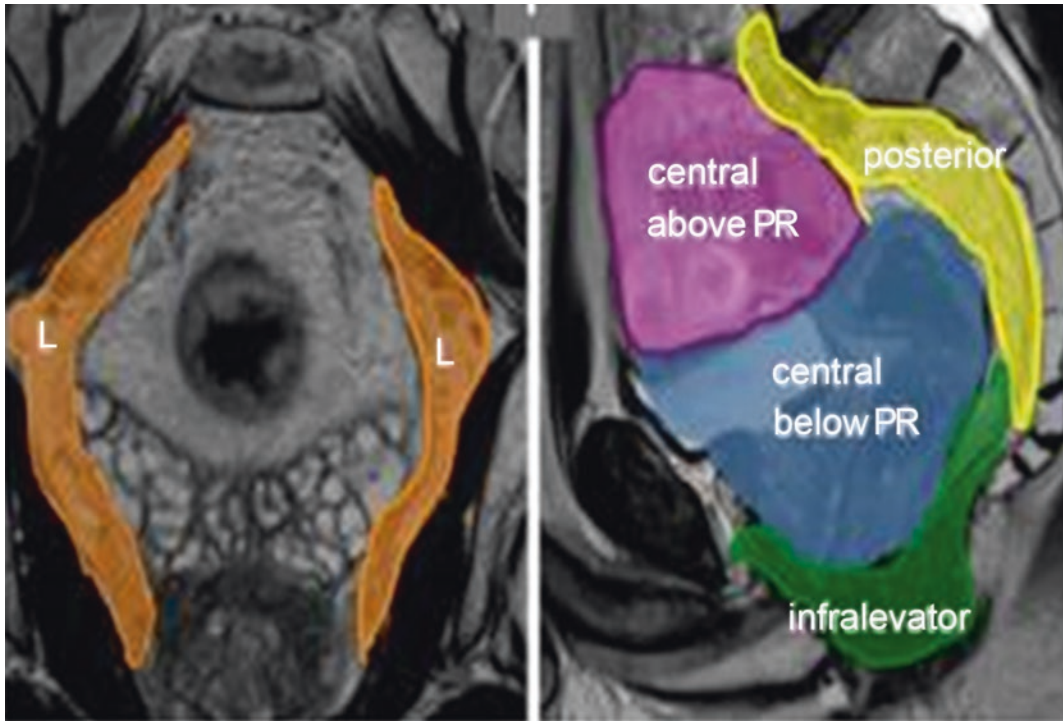


Fig. 21.10 Compartmental pelvic staging for 'Beyond TME' surgery using high resolution MRI. Six distinct anatomical compartments are shown: Lateral (L); central above peritoneal reflection (PR); central below peritoneal reflection (PR); posterior; infralevator. Adapted and modified from [117], which also includes a description of the individual organs in each compartment

this system in a larger study is warranted, and this is currently underway in a multi-centre trial whereby the pelvis is divided into six surgical compartments as shown in Fig. 21.10 [117].

MRI Staging to Guide Neo-Adjuvant Treatment in Rectal Cancer

Neo-adjuvant radiotherapy, either alone or in combination with chemotherapy as a long course regimen has been shown to reduce local recurrence rates [118–121], without any significant improvement in overall survival. But pelvic irradiation is in itself not without consequence, with genitourinary impairment, bowel dysfunction following restorative surgery [122], perineal wound morbidity in patients undergoing an APE [123], and the risks of a secondary malignancy [124] all reported in the literature. The unstanderdised routine use of neo-adjuvant treatment for rectal cancer, as evidenced by the wide variation in its worldwide use [14, 125–127], is detrimental to the patient and of little clinical benefit when optimal TME surgery is performed for operable rectal cancer with no high risk features [58, 128, 129]. A selective, risk stratifying policy that spares patients from the long term toxic effects of neo-adjuvant treatment, without necessarily compromising local control, is therefore highly desirable [130].

In North America, the National Comprehensive Cancer Network (NCCN) recommends neo-adjuvant treatment for all stage II [T3/4; N0] and stage III [T1-T4; N1/2] [131] rectal cancers, a policy also adopted by several other international guidelines [14]. However, up to 80% of all rectal cancers are stage II or III at presentation, and the heterogeneity in this broad group means that some patients will inevitably be over treated, reflecting a recent debate about multimodality treatment in the intermediate risk cancers within

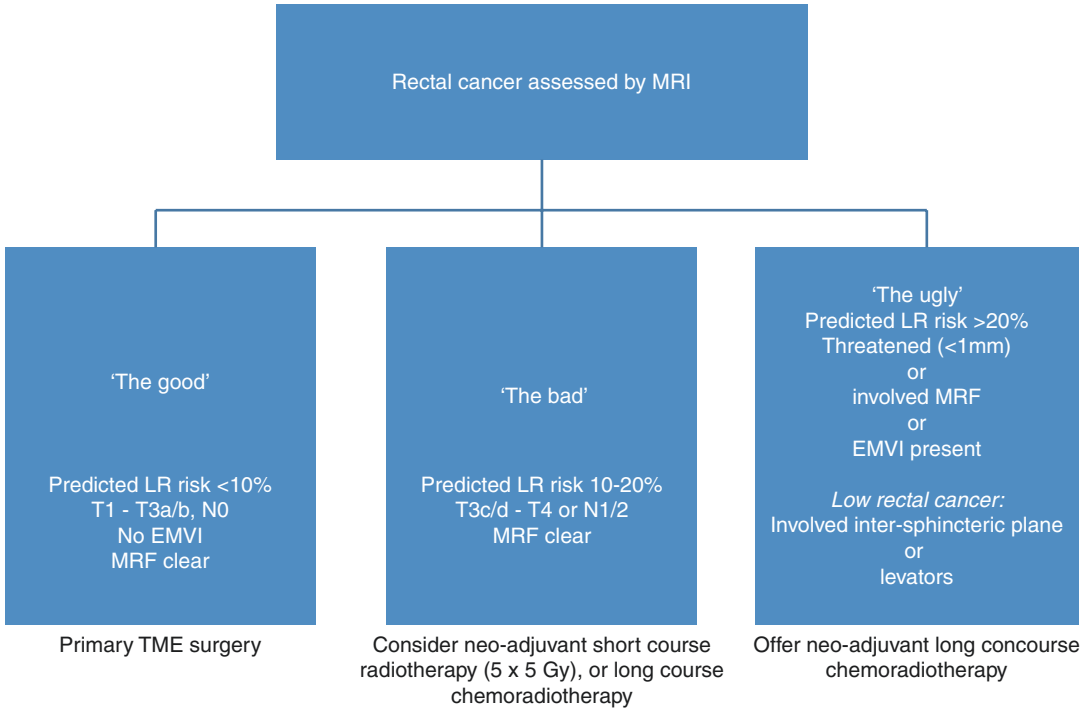


Fig. 21.11 MRI-based risk stratification of local recurrence in rectal cancer, with subsequent recommendation of treatment (Adapted and modified from [129–131])

this prognostically diverse group [128, 132, 133]. Consequently, one approach being adopted in the U.K and some of the Northern European countries has been a shift from the TNM based preoperative evaluation, to MRI based risk stratification in order to guide rectal cancer management, and in particular, the use of neo-adjuvant treatment (Fig. 21.11). [134, 135].

The distinction between 'good', 'bad' and 'ugly' tumours depending on MRI based risk factors of local recurrence has started to be incorporated into clinical guidelines for rectal cancer management, most notably in the U.K [136] and by the European Society of Medical Oncology (ESMO) [137]. By selecting patients for neo-adjuvant treatment based on these highly discriminative MRI features, rectal cancer management can be personalised to achieve maximal benefit in clinical practice, whilst minimising the risks of over- or under treatment. This strategy is also increasingly being implemented in the design of clinical trials such as the the joint Dutch/Nordic RAPIDO trial [99], and has the advantage of eliminating the sampling biases inherent in selecting patients from a progonostically heterogeneous stage II/III population, which may mask the true effect of a given treatment.

Assessment of Response to Neo-Adjuvant Treatment

Over the last decade, the indications for neo-adjuvant treatment in rectal cancer have extended beyond the aim of minimising local recurrence rates following surgery. Today, long course chemoradiotherapy followed by delayed surgery is recommended for locally advanced rectal cancers that threaten the surgical CRM, with the intention that downstaging of the tumour will allow for a curative resection [138]. This may facilitate a surgical procedure less radical than was initially necessary to achieve a complete resection, with the added benefit of sphincter, or even organ preservation through a transanal local

excision in the select few. Moreover, in a prognostically favourable subset, sufficient tumour regression takes place such that there is no clinical evidence of a viable cancer, with the advantage that patients may be able to avoid surgery and its associated morbidity altogether. These decisions are challenging, contentious, and high risk for both patients and clinicians, and are only possible in the context of restaging the rectal cancer to evaluate its response to neo-adjuvant treatment.

Whilst the importance of restaging is undisputed, questions remain unanswered about the optimal time interval between completion of neo-adjuvant treatment and surgical resection [139], the timing of restaging the tumour in this hiatus, the imaging modality that best assesses response to treatment [140], and the safety of recommending a change in the surgical strategy [141], or in the presence of a clinical complete response (cCR), advocating organ preservation under a Watch-and-Wait surveillance programme [142, 143].

Evaluating Tumour Response

Imaging the assessment of response to neo-adjuvant treatment is vital, albeit challenging, despite attempts to standardise the reporting criteria. The RECIST (response evaluation criteria in solid tumours) criteria [144] have been widely adopted and are based on changes of the tumour size in its longest diameter, which is an objectively measurable and reproducible parameter. Response can be categorised as complete if there has been a total disappearance of the tumour, partial or progressive depending on percentage change from baseline diameter, or stable disease in case of no appreciable change in measurement. However, pelvic irradiation results in a combination of tissue oedema, inflammation, necrosis and fibrosis of the tumour bed [145], all of which can be difficult to distinguish from residual tumour when evaluating the response to neo-adjuvant treatment. For example, extensive tumour necrosis in solid organ cancers has been shown take place without any corresponding tumour shrinkage [146]. Moreover, the definition of more than a 30% reduction in tumour diameter to indicate a partial response is arbitrary, and is unvalidated against outcome data [145]. Finally, the RECIST criteria do not account for treatment response in non-tumoural malignant deposits such as EMVI, or the involvement of vital anatomical structures such as the CRM, which remains the most important determinant of local recurrence in rectal cancer.

The other issue in restaging rectal cancer after neo-adjuvant treatment is the choice of imaging modality, with MRI and ERUS being the preferred options [140], and Computed Tomography (CT) largely reserved for extra-pelvic disease assessment. Both MRI and ERUS are subject to the same limitations discussed previously, with the added difficulty that the post-chemoradiation effects compromise accurate re-staging (denoted by the prefix "y") even further. It is therefore unsurprising that a meta-analysis reported the average accuracy of predicting ypT with MRI was 52%, and for ERUS at 65% [140], with overstaging of early tumours a particular issue for both modalities [147]. The accuracy of predicting ypN status was modest, with both MRI and ERUS having an estimated average of 72% [140, 148].

But whilst the absolute prediction of the various ypTN stages is desirable, what is perhaps more valuable from a therapeutic perspective for a tumour that has partially responded to neo-adjuvant treatment is its relationship to the MRF or the intersphincteric plane, because of the possibility of a more conservative curative resection than was initially possible.

Assessment of CRM Following Neo-Adjuvant Treatment

MRI retains a good accuracy of predicting CRM involvement after neo-adjuvant treatment, with reported averages of between 70% and 92% [140]. Whilst the specificity and negative predictive values have been shown to be consistently high, the main compromising factor is of overstaging, such that the risk of over-treatment is increased with a higher number false positive predictions. This arises mainly because of the uncertainty in differentiating fibrotic tissues from residual tumour, especially if there has been a concurrent

retraction of the MRF along with the tumour [149], leading to a cautious overcall at re-staging.

In the case of low rectal cancer, the MERCURY II study reported on 92 patients who had sphincter involvement and were deemed to require an ELAPE to achieve a clear pCRM according to the baseline MRI staging. Following neo-adjuvant treatment and a re-staging MRI, 33 (36%) of the cases were downstaged with a clear intersphincteric plane, out of which 7 (21%) avoided a stoma by undergoing a less radical operation than the initially planned ELAPE; all 33 patients had a clear pCRM [103].

A change in the operative strategy based on the re-staging MRI scan is not without contention, with concerns about the safety of dissecting through a 'sterile' plane which may still harbour cancer cells [150].

Assessment of EMVI Following Neo-Adjuvant Treatment

There is a paucity of data regarding assessment of the ymrEMVI status, and its effect on oncological outcomes. There is only one study of 188 rectal cancer patients by Chand et al. [151] which showed that patients who had persistent mrEMVI following neo-adjuvant treatment had a worse disease-free survival at 3 years (43%) compared to those who were mrEMVI negative on re-staging (80%). The stratification was based on a novel tumour regression grade in which a greater than 50% fibrosis in the mrEMVI was taken as a substantial response and re-staged as ymrEMVI negative [152].

Tumour Regression Grade and Complete Response to Neo-Adjuvant Treatment

A proportion of rectal cancer patients who receive neo-adjuvant treatment will go on to have what is termed as a pathological complete response (pCR)—no evidence of a residual cancer at histopathological analysis of the surgical specimen. For the commonly used regimens of chemoradiotherapy, the average proportion of those who achieve a pCR is estimated at 15–30% [142]. The benefits of being able to predict a pCR and avoid potentially mutilating surgery are immense and obvious, and increasing focus has therefore turned to the concept of a clinical complete response (cCR) as a surrogate for the former entity.

A cCR is defined when there is no clinical evidence of a tumour on imaging, endoluminal visualisation, or digital palpation where this is possible [153]. Patients who exhibit a cCR on re-assessment following neo-adjuvant treatment may be offered the option of non-operative management under a careful 'Watch-and-Wait' surveillance programme to monitor their progress. This strategy was initially met with scepticism when first introduced by Habr-Gama's group [142, 154], because of concerns about oncological compromise and the success of salvage surgery for tumour regrowths, but has since been reported to be both feasible and safe by several groups internationally [155–158].

In addition, the value of imaging assessment in determining a cCR is increasingly being recognised. In a prospective cohort study with pCR as the reference endpoint, the addition of MRI assessment to clinical evaluation alone (digital rectal examination and endoscopy) increased the post-test probability of detecting a complete response from 90% to 98% [159]. Moreover, pCR prediction by MRI assessment of tumour response has been shown to be tenfold higher than clinical assessment, which has a lower sensitivity because of persistent mucosal abnormalities [160]. In the latter study, the MRI criteria for evaluating response to neo-adjuvant treatment are based on the 5-grade Mandard scoring system for assessing pathological tumour regression, which is dependent on the relative proportions of fibrosis and residual tumour in the treated cancer [161]. Radiologically, fibrosis manifests on high resolution T2-weighted images as low signal intensity, whilst tumour is indicated by an intermediate signal (Table 21.4).

The mrTRG score has been retrospectively validated in the MERCURY trial patients, which found it to be an important prognostic determinant. Good response tumours (mrTRG 1–3) had a significantly better disease-free survival and overall 5-year survival than poor response tumours (mrTRG 4–5) [162]. Moreover, mrTRG 1 and 2

patients had a similar survival outcome to those with a pCR, and may therefore be optimal candidates for a Watch-and-Wait strategy. These findings have now been used to apply mrTRG as an imaging biomarker to stratify rectal cancer patients following neo-adjuvant treatment in the multi-centre randomised controlled trial called TRIGGER (Eudract No.: 2015-003009-40). Rectal cancer patients receiving neo-adjuvant therapy as part of their treatment will be randomised to standard TME surgery which is the current standard of care, or mrTRG directed management where 'good response' patients (mrTRG1) are offered intensive follow-up in a Watch-and-Wait protocol, whilst the 'poor response' group is recommended intensified additional chemotherapy (Fig. 21.12a, b).

There is also a growing interest in the use of functional imaging, particularly diffusion weighted MRI (DWI-MRI) and ^{18}F-fluorodeoxyglucose positron emission tomography (^{18}F-FDG PET) with the combination of CT (PET/CT) to assess tumour response following neo-adjuvant treatment. However, the evidence for these modalities is suboptimal according to a recent systematic review [163], given that most studies comprise of small retrospective cohorts that are not validated against established markers of response or long-term outcomes data. Additionally, the uptake of FDG by metabolically active benign tissue is well a recognised issue, and in the context of radiotherapy induced inflammation, may be a significant confounder in accurately assessing post-treatment tumour response. This is compounded by a lack of consensus on the optimal cut off values for SUV that predict for a pCR [163].

Table 21.4 The MRI based tumour regression grade (mrTRG)

mrTRG 1—complete radiological response (linear low signal intensity scar only)
mrTRG 2—good response (dense fibrosis, no obvious tumour signal)
mrTRG 3—moderate response (>50% fibrosis and visible intermediate signal)
mrTRG 4—slight response (mostly tumour)
mrTRG 5—no response (intermediate signal comparable to baseline MRI scan)

Evaluation of Extra-Pelvic Disease

The importance of imaging beyond the primary rectal tumour is evidenced by the high risk of synchronous metastatic disease, currently estimated in up to 30% of colorectal cancer patients at presentation [164]. This has obvious implications for the multimodality management, prognosis, and most importantly, counselling of the patient. The liver is the commonest site for synchronous metastasis, with a reported incidence of 15% [165], followed by lung and peritoneal involvement in up to 10% of patients [166, 167]. The main focus of evaluating extra-pelvic compartments is therefore the detection of concurrent disease at these sites.

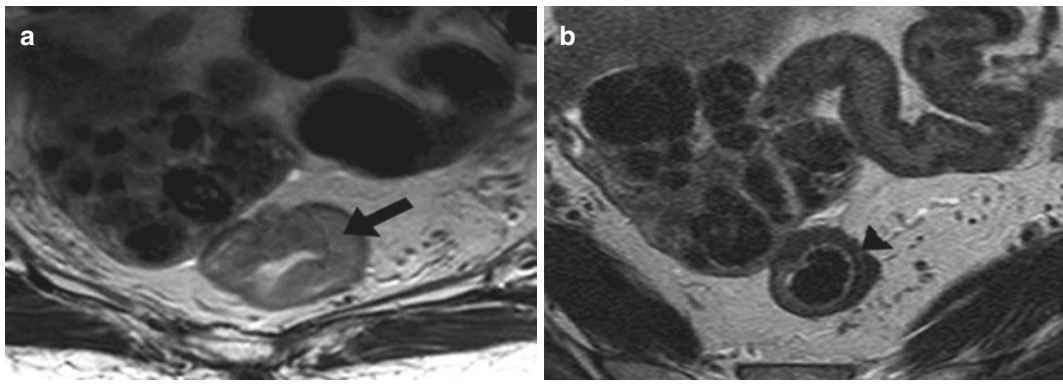


Fig. 21.12 (**a**) Axial image of a pre-treatment rectal cancer. (**b**) Axial MRI image of post-treatment rectal cancer showing good response (mrTRG1)

Hepatic Metastases

Computed tomography (CT) represents the most preferred choice of primary imaging modality for detecting distant metastatic disease, and supersedes other imaging modality because of its widespread availability, reproducibility and lower cost. However, in a meta-analysis of prospective trials, the sensitivity of contrast enhanced CT for diagnosing colorectal liver metastases was reported to be 83.6% in patient who had no previous treatment, compared to 88.2% and 94.1% for MRI and ^{18}F-FDG PET, respectively [168]; there was little variation in the specificity of each modality (93–96%). Furthermore, in lesions measuring less than 10 mm in size, MRI outperforms CT in being able to characterise a metastatic deposit. The higher accuracy of MRI is because of the enhanced soft tissue resolution, with further gains in interpretation reported with the use of diffusion weighted, or contrast enhanced liver specific MRI [169]. Most hepatobiliary units that treat colorectal liver metastases now mandate pre-operative imaging with multiparametric MRI because of this accuracy.

Pulmonary Metastases

In most instances, a CT of the thorax is performed as part of the extra-pelvic staging of primary rectal cancer, and is recommended in the American College of Radiology guidelines [170]. The rationale for routine imaging of the thorax is haematogenous spread of cancer directly to the lungs via the haemorrhoidal plexus which drain into the vena cava, bypassing the portal circulation altogether. Indeed, isolated pulmonary metastases arising from a primary rectal cancer are not uncommon [171]. Moreover, rectal cancer metastases to the lung are more common than colon cancer. Whilst the importance of detecting pulmonary metastases cannot be overstated, CT imaging frequently identifies small indeterminate lesions because of its low specificity, with a variable incidence of between 4 and 42% reported in the literature. Of these, only 1% are eventually confirmed as metastases [172], and there are considerable costs of follow-up imaging, radiation exposure, additional tests which may include invasive diagnostics, and patient anxiety which all have to be addressed in the decision making process.

The addition of ^{18}F-FDG PET to CT staging of the thorax has also been shown to be of sub-optimal diagnostic value, with a sensitivity of 57.1% [173] in diagnosing pulmonary metastases. This is because of the lower resolution of ^{18}F-FDG PET in characterising lesions <10 mm in size compared with thin slice CT scanning, which remains the first choice of investigation for pulmonary staging. Thus, current indications for the routine use of ^{18}F-FDG PET/CT in primary rectal cancer staging are limited, and it may be advocated in a patient being considered for curative hepatic or pulmonary metastectomy to rule out an occult metastasis, where conventional CT or MRI imaging may not have been informative.

Peritoneal Metastases

Pre-operative diagnosis of peritoneal carcinomatosis remains a major challenge, and is frequently identified for the first time at operation for the primary tumour. Contrast enhanced multi-slice CT is the principal imaging modality despite a modest accuracy of between 60% and 88% [174, 175], with underestimation of the true extent of peritoneal involvement. The main limitation of all available imaging modalities is the small size of peritoneal nodules, typically less than 1 cm in size, which frequently spread along the normal anatomical planes in the abdomen, thus compromising the sensitivity even further. Direct visualisation of the peritoneal surfaces remains the most accurate way of establishing the tumour burden, and is increasingly becoming a common staging modality in patients presenting with metachronous disease and being considered for surgery [176]. But unlike primary staging in hepatopancreaticobiliary and gastroesophageal cancers, its role in the detection of synchronous colorectal peritoneal metastases is unknown at present.

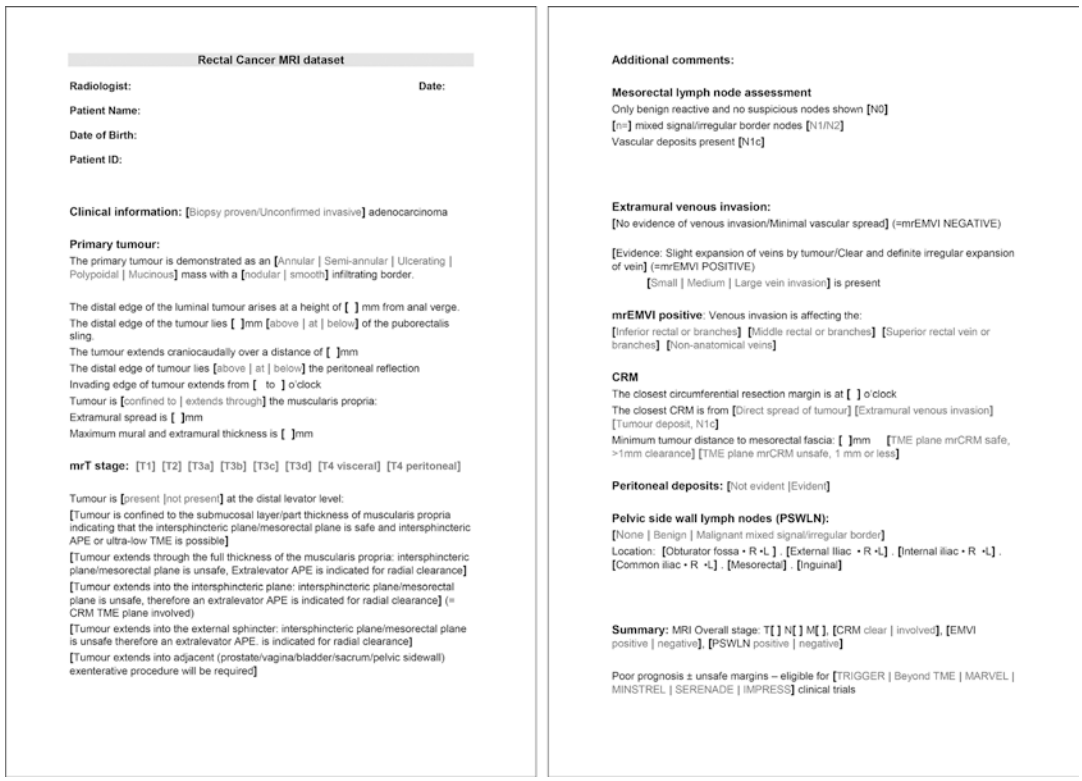
Synoptic Reporting in Rectal Cancer Staging

A key component of the pre-operative evaluation of rectal cancer is the accurate reporting and

communication of radiological findings that determine patient treatment pathways, in particular the selection of patients for neo-adjuvant therapies. Traditionally, radiology reports have been issued in 'free-form' and unstanderdised text, based on the radiologist's opinion of pertinent staging features. However, this form of unstructured reporting has been associated with the omission of crucial prognostic information such as CRM involvement, both in histopathology and radiology reports [177, 178]. One solution of enhancing the completeness and consistency of radiology reports is the use of synoptic templates that provide summarised information which various members of the multidisciplinary team can access and interpret easily [179]. An example of a MRI based synoptic reporting proforma with individually itemised prognostic features, and the option of additional free text is shown in Fig. 21.13. The implementation of a such a reporting system at a population level reported a 39% improvement in the completeness of pre-operative MRI staging reports [180]. The use of a synoptic report is one of the required standards of the new American College of Surgeons Commission on Cancer National Accreditation Program for Rectal Cancer [181]. The American College of Radiology has been very supportive of this program and has made available a very high quality educational module about both rectal cancer MRI staging and the use of synoptic reports [182].

Summary

Advances in imaging technology have revolutionised the way in which rectal cancer is managed. The remit of accurate pre-operative staging goes wider than the traditional prognostic stratification of patients. With a complex range of treatment options available, multidisciplinary teams integrate vital information from radiological staging with clinical evalua-



Rectal Cancer MRI dataset

Radiologist: **Date:**

Patient Name:

Date of Birth:

Patient ID:

Clinical information: [Biopsy proven/Unconfirmed invasive] adenocarcinoma

Primary tumour:
The primary tumour is demonstrated as an [Annular | Semi-annular | Ulcerating | Polypoidal | Mucinous] mass with a [nodular | smooth] infiltrating border.

The distal edge of the luminal tumour arises at a height of [ ] mm from anal verge.
The distal edge of the tumour lies [ ]mm [above | at | below] of the puborectalis sling.
The tumour extends craniocaudally over a distance of [ ]mm
The distal edge of tumour lies [above | at | below] the peritoneal reflection
Invading edge of tumour extends from [to] o'clock
Tumour is [confined to | extends through] the muscularis propria:
Extramural spread is [ ]mm
Maximum mural and extramural thickness is [ ]mm

mrT stage: [T1] [T2] [T3a] [T3b] [T3c] [T3d] [T4 visceral] [T4 peritoneal]

Tumour is [present |not present] at the distal levator level:
[Tumour is confined to the submucosal layer/part thickness of muscularis propria indicating that the intersphincteric plane/mesorectal plane is safe and intersphincteric APE or ultra-low TME is possible]
[Tumour extends through the full thickness of the muscularis propria: intersphincteric plane/mesorectal plane is unsafe, Extralevator APE is indicated for radial clearance]
[Tumour extends into the intersphincteric plane: intersphincteric plane/mesorectal plane is unsafe, therefore an extralevator APE is indicated for radial clearance] (= CRM TME plane involved)
[Tumour extends into the external sphincter: intersphincteric plane/mesorectal plane is unsafe therefore an extralevator APE. is indicated for radial clearance]
[Tumour extends into adjacent (prostate/vagina/bladder/sacrum/pelvic sidewall) exenterative procedure will be required]

Additional comments:

Mesorectal lymph node assessment
Only benign reactive and no suspicious nodes shown [N0]
[n=] mixed signal/irregular border nodes [N1/N2]
Vascular deposits present [N1c]

Extramural venous invasion:
[No evidence of venous invasion/Minimal vascular spread] (=mrEMVI NEGATIVE)

[Evidence: Slight expansion of veins by tumour/Clear and definite irregular expansion of vein] (=mrEMVI POSITIVE)
[Small | Medium | Large vein invasion] is present

mrEMVI positive: Venous invasion is affecting the:
[Inferior rectal or branches] [Middle rectal or branches] [Superior rectal vein or branches] [Non-anatomical veins]

CRM
The closest circumferential resection margin is at [ ] o'clock
The closest CRM is from [Direct spread of tumour] [Extramural venous invasion] [Tumour deposit, N1c]
Minimum tumour distance to mesorectal fascia: [ ]mm [TME plane mrCRM safe, >1mm clearance] [TME plane mrCRM unsafe, 1 mm or less]

Peritoneal deposits: [Not evident |Evident]

Pelvic side wall lymph nodes (PSWLN):
[None | Benign | Malignant mixed signal/irregular border]
Location: [Obturator fossa • R •L] . [External Iliac • R •L] . [Internal iliac • R •L] . [Common iliac • R •L] . [Mesorectal] . [Inguinal]

Summary: MRI Overall stage: T[ ] N[ ] M[ ], [CRM clear | involved], [EMVI positive | negative], [PSWLN positive | negative]

Poor prognosis ± unsafe margins – eligible for [TRIGGER | Beyond TME | MARVEL | MINSTREL | SERENADE | IMPRESS] clinical trials

Fig. 21.13 Proforma for MRI database

tion to personalise management plans for rectal cancer patients. MRI remains at the mainstay of this process; local staging with high resolution images provides critical information about the tumour and its relation to key anatomical landmarks, which determine the need or otherwise for neo-adjuvant treatment, the plane and radicality of curative surgery, and lately, the possibility of avoiding surgery by assessing the downstaging response.

Along with emerging technologies, the improvements in speed and spatial resolution, development of functional imaging, and the recognition of novel imaging biomarkers are at the frontiers of pre-operative rectal cancer evaluation.

References

1. Wild JJ, Reid JM. Further pilot echographic studies on the histologic structure of tumors of the living intact human breast. Am J Pathol. 1952;28(5):839–61.
2. Dragsted J, Gammelgaard J. Endoluminal ultrasonic scanning in the evaluation of rectal cancer: a preliminary report of 13 cases. Gastrointest Radiol. 1983;8(1):367–9.
3. Hildebrandt U, Feifel G. Preoperative staging of rectal cancer by intrarectal ultrasound. Dis Colon Rectum. 1958;28(1):42–6.
4. Beynon J, Foy DMA, Temple LN, Channer JL, Virjee J, Mortensen NJMC. The endosonic appearances of normal colon and rectum. Dis Colon Rectum. 1986;29(12):810–3.
5. Skandarajah AR, Tjandra JJ. Preoperative locoregional imaging in rectal cancer. ANZ J Surg. 2006;76(6):497–504.
6. Harewood GC. Assessment of publication bias in the reporting of EUS performance in staging rectal cancer. Am J Gastroenterol. 2005;100(4):808–16.
7. Puli SR, Bechtold ML, Reddy JBK, Choudhary A, Antillon MR, Brugge WR. How good is endoscopic ultrasound in differentiating various T stages of rectal cancer? Meta-analysis and systematic review. Ann Surg Oncol. 2008;16(2):254–65.
8. Bipat S, Glas AS, Slors FJ, Zwinderman AH, Bossuyt PM, Stoker J. Rectal cancer: local staging and assessment of lymph node involvement with endoluminal US, CT, and MR imaging–a meta-analysis. Radiology. 2004;232(3):773–83.
9. Edelman BR, Weiser MR. Endorectal ultrasound: its role in the diagnosis and treatment of rectal cancer. Clin Colon Rectal Surg. 2008;21(3):167–77.
10. Hulsmans FJ, Tio TL, Fockens P, Bosma A, Tytgat GN. Assessment of tumor infiltration depth in rectal cancer with transrectal sonography: caution is necessary. Radiology. 1994;190(3):715–20.
11. Mackay SG, Pager CK, Joseph D, Stewart PJ, Solomon MJ. Assessment of the accuracy of transrectal ultrasonography in anorectal neoplasia. Br J Surg. 2003;90(3):346–50.
12. Brown G, Radcliffe AG, Newcombe RG, Dallimore NS, Bourne MW, Williams GT. Preoperative assessment of prognostic factors in rectal cancer using high-resolution magnetic resonance imaging. Br J Surg. 2003;90(3):355–64.
13. Merkel S, Mansmann U, Siassi M, Papadopoulos T, Hohenberger W, Hermanek P. The prognostic inhomogeneity in pT3 rectal carcinomas. Int J Color Dis. 2001;16(5):298–304.
14. Nielsen LBJ, Wille-Jørgensen P. National and international guidelines for rectal cancer. Color Dis. 2014;16(11):854–65.
15. Akasu T, Kondo H, Moriya Y, Sugihara K, Gotoda T, Fujita S, et al. Endorectal ultrasonography and treatment of early stage rectal cancer. World J Surg. 2000;24(9):1061–8.
16. Garcia-Aguilar J, Pollack J, Lee SH, Hernandez de Anda E, Mellgren A, Wong WD, et al. Accuracy of endorectal ultrasonography in preoperative staging of rectal tumors. Dis Colon Rectum. 2002;45(1):10–5.
17. Marusch F, Koch A, Schmidt U, Zippel R, Kuhn R, Wolff S, et al. Routine use of transrectal ultrasound in rectal carcinoma: results of a prospective multicenter study. Endoscopy. 2002;34(5):385–90.
18. Manger T, Stroh C. Accuracy of endorectal ultrasonography in the preoperative staging of rectal cancer. Tech Coloproctol. 2004;8(1):s14–s5.
19. Kauer WK, Prantl L, Dittler HJ, Siewert JR. The value of endosonographic rectal carcinoma staging in routine diagnostics: a 10-year analysis. Surg Endosc. 2004;18(7):1075–8.
20. Zammit M, Jenkins JT, Urie A, O'Dwyer PJ, Molloy RG. A technically difficult endorectal ultrasound is more likely to be inaccurate. Color Dis. 2005;7(5):486–91.
21. Ptok H, Marusch F, Meyer F, Wendling P, Wenisch HJ, Sendt W, et al. Feasibility and accuracy of TRUS in the pre-treatment staging for rectal carcinoma in general practice. Eur J Surg Oncol. 2006;32(4):420–5.
22. Badger SA, Devlin PB, Neilly PJ, Gilliland R. Preoperative staging of rectal carcinoma by endorectal ultrasound: is there a learning curve? Int J Color Dis. 2007;22(10):1261–8.
23. Goertz RS, Fein M, Sailer M. Impact of biopsy on the accuracy of endorectal ultrasound staging of rectal tumors. Dis Colon Rectum. 2008;51(7):1125–9.
24. Morris OJ, Draganic B, Smith S. Does a learning curve exist in endorectal two-dimensional ultrasound accuracy? Tech Coloproctol. 2011;15(3):301–11.
25. Marusch F, Ptok H, Sahm M, Schmidt U, Ridwelski K, Gastinger I, et al. Endorectal ultrasound in rectal carcinoma--do the literature results really correspond to the realities of routine clinical care? Endoscopy. 2011;43(5):425–31.

26. Ashraf S, Hompes R, Slater A, Lindsey I, Bach S, Mortensen NJ, et al. A critical appraisal of endorectal ultrasound and transanal endoscopic microsurgery and decision-making in early rectal cancer. Color Dis. 2012;14(7):821–6.
27. Restivo A, Zorcolo L, Marongiu L, Scintu F, Casula G. Limits of endorectal ultrasound in tailoring treatment of patients with rectal cancer. Dig Surg. 2015;32(2):129–34.
28. Orrom WJ, Wong WD, Rothenberger DA, Jensen LL, Goldberg SM. Endorectal ultrasound in the preoperative staging of rectal tumors. A learning experience. Dis Colon Rectum. 1990;33(8):654–9.
29. Li XT, Sun YS, Tang L, Cao K, Zhang XY. Evaluating local lymph node metastasis with magnetic resonance imaging, endoluminal ultrasound and computed tomography in rectal cancer: a meta-analysis. Color Dis. 2015;17(6):O129–O35.
30. Kim JC, Kim HC, Yu CS, Han KR, Kim JR, Lee KH, et al. Efficacy of 3-dimensional endorectal ultrasonography compared with conventional ultrasonography and computed tomography in preoperative rectal cancer staging. Am J Surg. 2006;192(1):89–97.
31. Gleeson FC, Clain JE, Papachristou GI, Rajan E, Topazian MD, Wang KK, et al. Prospective assessment of EUS criteria for lymphadenopathy associated with rectal cancer. Gastrointest Endosc. 2009;69(4):896–903.
32. Catalano MF, Sivak MV Jr, Rice T, Gragg LA, Van Dam J. Endosonographic features predictive of lymph node metastasis. Gastrointest Endosc. 1994;40(4):442–6.
33. Harewood GC, Wiersema MJ, Nelson H, Maccarty RL, Olson JE, Clain JE, et al. A prospective, blinded assessment of the impact of preoperative staging on the management of rectal cancer. Gastroenterology. 2002;123(1):24–32.
34. Sailer M, Leppert R, Bussen D, Fuchs KH, Thiede A. Influence of tumor position on accuracy of endorectal ultrasound staging. Dis Colon Rectum. 1997;40(10):1180–6.
35. Taylor FG, Quirke P, Heald RJ, Moran BJ, Blomqvist L, Swift IR, et al. Preoperative magnetic resonance imaging assessment of circumferential resection margin predicts disease-free survival and local recurrence: 5-year follow-up results of the MERCURY study. J Clin Oncol. 2014;32(1):34–43.
36. Hurlstone DP, Brown S, Cross SS, Shorthouse AJ, Sanders DS. Endoscopic ultrasound miniprobe staging of colorectal cancer: can management be modified? Endoscopy. 2005;37(08):710–4.
37. Waage JER, Leh S, Røsler C, Pfeffer F, Bach SP, Havre RF, et al. Endorectal ultrasonography, strain elastography and MRI differentiation of rectal adenomas and adenocarcinomas. Color Dis. 2015;17(2):124–31.
38. Vliegen RF, Beets GL, von Meyenfeldt MF, Kessels AG, Lemaire EE, van Engelshoven JM, et al. Rectal cancer: MR imaging in local staging--is gadolinium-based contrast material helpful? Radiology. 2005;234(1):179–88.
39. Zand KR, Reinhold C, Haider MA, Nakai A, Rohoman L, Maheshwari S. Artifacts and pitfalls in MR imaging of the pelvis. J Magn Reson Imaging. 2007;26(3):480–97.
40. Brown G, Richards CJ, Newcombe RG, Dallimore NS, Radcliffe AG, Carey DP, et al. Rectal carcinoma: thin-section mr imaging for staging in 28 patients. Radiology. 1999;211(1):215–22.
41. Al-Sukhni E, Milot L, Fruitman M, Beyene J, Victor JC, Schmocker S, et al. Diagnostic accuracy of MRI for assessment of T category, lymph node metastases, and circumferential resection margin involvement in patients with rectal cancer: a systematic review and meta-analysis. Ann Surg Oncol. 2012;19(7):2212–23.
42. Hermanek P, Henson DE, Hutter RV, Sobin LH. UICC TNM supplement: a commentary on uniform use. Berlin: Springer; 1993.
43. MERCURY Study Group. Extramural depth of tumor invasion at thin-section MR in patients with rectal cancer: results of the MERCURY study. Radiology. 2007;243(1):132–9.
44. Taylor FG, Quirke P, Heald RJ, Moran B, Blomqvist L, Swift I, et al. Preoperative high-resolution magnetic resonance imaging can identify good prognosis stage I, II, and III rectal cancer best managed by surgery alone: a prospective, multicenter, European study. Ann Surg. 2011;253(4):711–9.
45. Dworak O. Morphology of lymph nodes in the resected rectum of patients with rectal carcinoma. Pathol Res Pract. 1991;187(8):1020–4.
46. Vogl TJ, Pegios W, Mack MG, Hünerbein M, Hintze R, Adler A, et al. Accuracy of staging rectal tumors with contrast-enhanced transrectal MR imaging. Am J Roentgenol. 1997;168(6):1427–34.
47. Blomqvist L, Machado M, Rubio C, Gabrielsson N, Granqvist S, Goldman S, et al. Rectal tumour staging: MR imaging using pelvic phased-array and endorectal coils vs endoscopic ultrasonography. Eur Radiol. 2000;10(4):653–60.
48. Kim NK, Kim MJ, Park JK, Park SI, Min JS. Preoperative staging of rectal cancer with MRI: accuracy and clinical usefulness. Ann Surg Oncol. 2000;7(10):732–7.
49. Kim JH, Beets GL, Kim M-J, Kessels AGH, Beets-Tan RGH. High-resolution MR imaging for nodal staging in rectal cancer: are there any criteria in addition to the size? Eur J Radiol. 2004;52(1):78–83.
50. Brown G, Richards CJ, Bourne MW, Newcombe RG, Radcliffe AG, Dallimore NS, et al. Morphologic predictors of lymph node status in rectal cancer with use of high-spatial-resolution MR imaging with histopathologic comparison. Radiology. 2003;227(2):371–7.
51. Akasu T, Iinuma G, Takawa M, Yamamoto S, Muramatsu Y, Moriyama N. Accuracy of high-resolution magnetic resonance imaging in preop-

erative staging of rectal cancer. Ann Surg Oncol. 2009;16(10):2787–94.
52. Halefoglu AM, Yildirim S, Avlanmis O, Sakiz D, Baykan A. Endorectal ultrasonography versus phased-array magnetic resonance imaging for preoperative staging of rectal cancer. World J Gastroenterol. 2008;14(22):3504–10.
53. Koh D-M, Brown G, Temple L, Raja A, Toomey P, Bett N, et al. Rectal cancer: mesorectal lymph nodes at MR imaging with USPIO versus histopathologic findings—initial observations. Radiology. 2004;231(1):91–9.
54. Koh DM, George C, Temple L, Collins DJ, Toomey P, Raja A, et al. Diagnostic accuracy of nodal enhancement pattern of rectal cancer at MRI enhanced with ultrasmall superparamagnetic iron oxide: findings in pathologically matched mesorectal lymph nodes. AJR Am J Roentgenol. 2010;194(6):W505–13.
55. Lahaye MJ, Engelen SME, Kessels AGH, Bruïne APD, MFv M, Engelshoven JMAV, et al. USPIO-enhanced MR imaging for nodal staging in patients with primary rectal cancer: predictive criteria. Radiology. 2008;246(3):804–11.
56. Chand M, Moran BJ, Jones RG, Heald RJ, Brown G. Lymph node status does not predict local recurrence in the total mesorectal excision era. Dis Colon Rectum. 2014;57(1):127–9.
57. Kosinski LA, Greene FL. Perfect treatment in an imperfect world: surgery alone or radiation for node positive rectal cancer? Dis Colon Rectum. 2014;57(1):130–2.
58. Quirke P, Steele R, Monson J, Grieve R, Khanna S, Couture J, et al. Effect of the plane of surgery achieved on local recurrence in patients with operable rectal cancer: a prospective study using data from the MRC CR07 and NCIC-CTG CO16 randomised clinical trial. Lancet. 2009;373(9666):821–8.
59. Quirke P, Durdey P, Dixon MF, Williams NS. Local recurrence of rectal adenocarcinoma due to inadequate surgical resection. Histopathological study of lateral tumour spread and surgical excision. Lancet. 1986;2(8514):996–9.
60. Wibe A, Rendedal PR, Svensson E, Norstein J, Eide TJ, Myrvold HE, et al. Prognostic significance of the circumferential resection margin following total mesorectal excision for rectal cancer. Br J Surg. 2002;89(3):327–34.
61. Nagtegaal ID, Marijnen CA, Kranenbarg EK, van de Velde CJ, van Krieken JH. Circumferential margin involvement is still an important predictor of local recurrence in rectal carcinoma: not one millimeter but two millimeters is the limit. Am J Surg Pathol. 2002;26(3):350–7.
62. Birbeck KF, Macklin CP, Tiffin NJ, Parsons W, Dixon MF, Mapstone NP, et al. Rates of circumferential resection margin involvement vary between surgeons and predict outcomes in rectal cancer surgery. Ann Surg. 2002;235(4):449–57.
63. Nagtegaal ID, Quirke P. What is the role for the circumferential margin in the modern treatment of rectal cancer? J Clin Oncol. 2008;26(2):303–12.
64. Glimelius B, Beets-Tan R, Blomqvist L, Brown G, Nagtegaal I, Pahlman L, et al. Mesorectal fascia instead of circumferential resection margin in preoperative staging of rectal cancer. J Clin Oncol. 2011;29(16):2142–3.
65. Park MJ, Kim SH, Lee SJ, Jang KM, Rhim H. Locally advanced rectal cancer: added value of diffusion-weighted MR imaging for predicting tumor clearance of the mesorectal fascia after neoadjuvant chemotherapy and radiation therapy. Radiology. 2011;260(3):771–80.
66. Beets-Tan RG, Beets GL, Vliegen RF, Kessels AG, Van Boven H, De Bruine A, et al. Accuracy of magnetic resonance imaging in prediction of tumour-free resection margin in rectal cancer surgery. Lancet. 2001;357(9255):497–504.
67. Xie H, Zhou X, Zhuo Z, Che S, Xie L, Fu W. Effectiveness of MRI for the assessment of mesorectal fascia involvement in patients with rectal cancer: a systematic review and meta-analysis. Dig Surg. 2014;31(2):123–34.
68. Taylor FGM, Quirke P, Heald RJ, Moran B, Blomqvist L, Swift I, et al. One millimetre is the safe cut-off for magnetic resonance imaging prediction of surgical margin status in rectal cancer. Br J Surg. 2011;98(6):872–9.
69. Group MS. Diagnostic accuracy of preoperative magnetic resonance imaging in predicting curative resection of rectal cancer: prospective observational study. Br Med J. 2006;333(7572):779.
70. Moriya Y. Treatment of lateral pelvic nodes metastases from rectal cancer: the future prospective. G Chir. 2013;34(9-10):245–8.
71. Bell S, Sasaki J, Sinclair G, Chapuis PH, Bokey EL. Understanding the anatomy of lymphatic drainage and the use of blue-dye mapping to determine the extent of lymphadenectomy in rectal cancer surgery: unresolved issues. Color Dis. 2009;11(5):443–9.
72. Yano H, Moran BJ. The incidence of lateral pelvic side-wall nodal involvement in low rectal cancer may be similar in Japan and the West. Br J Surg. 2008;95(1):33–49.
73. Sugihara K, Kobayashi H, Kato T, Mori T, Mochizuki H, Kameoka S, et al. Indication and benefit of pelvic sidewall dissection for rectal cancer. Dis Colon Rectum. 2006;49(11):1663–72.
74. Fujita S, Akasu T, Mizusawa J, Saito N, Kinugasa Y, Kanemitsu Y, et al. Postoperative morbidity and mortality after mesorectal excision with and without lateral lymph node dissection for clinical stage II or stage III lower rectal cancer (JCOG0212): results from a multicentre, randomised controlled, non-inferiority trial. Lancet Oncol. 2012;13(6):616–21.
75. Georgiou P, Tan E, Gouvas N, Antoniou A, Brown G, Nicholls RJ, et al. Extended lymphadenectomy versus conventional surgery for rectal cancer: a meta-analysis. Lancet Oncol. 2009;10(11):1053–62.
76. Kim TH, Jeong S-Y, Choi DH, Kim DY, Jung KH, Moon SH, et al. Lateral lymph node metastasis is

a major cause of locoregional recurrence in rectal cancer treated with preoperative chemoradiotherapy and curative resection. Ann Surg Oncol. 2007;15(3):729–37.
77. Otowa Y, Yamashita K, Kanemitsu K, Sumi Y, Yamamoto M, Kanaji S, et al. Treating patients with advanced rectal cancer and lateral pelvic lymph nodes with preoperative chemoradiotherapy based on pretreatment imaging. OncoTargets Ther. 2015;8:3169–73.
78. Shihab OC, Taylor F, Bees N, Blake H, Jeyadevan N, Bleehen R, et al. Relevance of magnetic resonance imaging-detected pelvic sidewall lymph node involvement in rectal cancer. Br J Surg. 2011;98(12):1798–804.
79. Freedman LS, Macaskill P, Smith AN. Multivariate analysis of prognostic factors for operable rectal cancer. Lancet. 1984;2(8405):733–6.
80. Horn A, Dahl O, Morild I. Venous and neural invasion as predictors of recurrence in rectal adenocarcinoma. Dis Colon Rectum. 1991;34(9):798–804.
81. Talbot IC, Ritchie S, Leighton MH, Hughes AO, Bussey HJ, Morson BC. The clinical significance of invasion of veins by rectal cancer. Br J Surg. 1980;67(6):439–42.
82. Thomson E, Scott N, Tolan D. Re: the prognostic significance of MRI-detected extramural venous invasion in rectal carcinoma. Clin Radiol. 2015;70(1):111–2.
83. Bokey EL, Öjerskog B, Chapuis PH, Dent OF, Newland RC, Sinclair G. Local recurrence after curative excision of the rectum for cancer without adjuvant therapy: role of total anatomical dissection. Br J Surg. 1999;86(9):1164–70.
84. Rich T, Gunderson LL, Lew R, Galdibini JJ, Cohen AM, Donaldson G. Patterns of recurrence of rectal cancer after potentially curative surgery. Cancer. 1983;52(7):1317–29.
85. Courtney ED, West NJ, Kaur C, Ho J, Kalber B, Hagger R, et al. Extramural vascular invasion is an adverse prognostic indicator of survival in patients with colorectal cancer. Color Dis. 2009;11(2):150–6.
86. Betge J, Pollheimer MJ, Lindtner RA, Kornprat P, Schlemmer A, Rehak P, et al. Intramural and extramural vascular invasion in colorectal cancer. Cancer. 2012;118(3):628–38.
87. Petersen VC, Baxter KJ, Love SB, Shepherd NA. Identification of objective pathological prognostic determinants and models of prognosis in Dukes' B colon cancer. Gut. 2002;51(1):65–9.
88. Chand M, Bhangu A, Wotherspoon A, Stamp GWH, Swift RI, Chau I, et al. EMVI-positive stage II rectal cancer has similar clinical outcomes as stage III disease following pre-operative chemoradiotherapy. Ann Oncol. 2014;25(4):858–63.
89. Chand M, Siddiqui MRS, Swift I, Brown G. Systematic review of prognostic importance of extramural venous invasion in rectal cancer. World J Gastroenterol. 2016;22(4):1721–6.
90. Littleford SE, Baird A, Rotimi O, Verbeke CS, Scott N. Interobserver variation in the reporting of local peritoneal involvement and extramural venous invasion in colonic cancer. Histopathology. 2009;55(4):407–13.
91. Messenger DE, Driman DK, Kirsch R. Developments in the assessment of venous invasion in colorectal cancer: implications for future practice and patient outcome. Hum Pathol. 2012;43(7):965–73.
92. Messenger DE, Driman DK, McLeod RS, Riddell RH, Kirsch R. Current practice patterns among pathologists in the assessment of venous invasion in colorectal cancer. J Clin Pathol. 2011;64(11):983–9.
93. Sternberg A, Amar M, Alfici R, Groisman G. Conclusions from a study of venous invasion in stage IV colorectal adenocarcinoma. J Clin Pathol. 2002;55(1):17–21.
94. Smith NJ, Shihab O, Arnaout A, Swift RI. Brown G. MRI for detection of extramural vascular invasion in rectal cancer. AJR Am J Roentgenol. 2008;191(5):1517–22.
95. Smith NJ, Barbachano Y, Norman AR, Swift RI, Abulafi AM, Brown G. Prognostic significance of magnetic resonance imaging-detected extramural vascular invasion in rectal cancer. Br J Surg. 2008;95(2):229–36.
96. Jhaveri KS, Hosseini-Nik H, Thipphavong S, Assarzadegan N, Menezes RJ, Kennedy ED, et al. MRI detection of extramural venous invasion in rectal cancer: correlation with histopathology using elastin stain. Am J Roentgenol. 2016;206:1–9.
97. Sohn B, J-s L, Kim H, Myoung S, Choi J, Kim NK, et al. MRI-detected extramural vascular invasion is an independent prognostic factor for synchronous metastasis in patients with rectal cancer. Eur Radiol. 2014;25(5):1347–55.
98. Bugg WG, Andreou AK, Biswas D, Toms AP, Williams SM. The prognostic significance of MRI-detected extramural venous invasion in rectal carcinoma. Clin Radiol. 2014;69(6):619–23.
99. Nilsson PJ, van Etten B, Hospers GAP, Påhlman L, van de Velde CJH, Beets-Tan RGH, et al. Short-course radiotherapy followed by neo-adjuvant chemotherapy in locally advanced rectal cancer – the RAPIDO trial. BMC Cancer. 2013;13:279.
100. Salerno G, Sinnatamby C, Branagan G, Daniels IR, Heald RJ, Moran BJ. Defining the rectum: surgically, radiologically and anatomically. Color Dis. 2006;8:5–9.
101. Moran BJ, Holm T, Brannagan G, Chave H, Quirke P, West N, et al. The English National Low Rectal Cancer Development Programme: key messages and future perspectives. Color Dis. 2014;16(3):173–8.
102. Shihab OC, Moran BJ, Heald RJ, Quirke P, Brown G. MRI staging of low rectal cancer. Eur Radiol. 2009;19(3):643–50.
103. Battersby NJ, How P, Moran B, Stelzner S, West NP, Branagan G, et al. Prospective validation of a low rectal cancer magnetic resonance imaging staging system and development of a local recurrence risk

stratification model: The MERCURY II study. Ann Surg. 2016;263(4):751–60.
104. Marr R, Birbeck K, Garvican J, Macklin CP, Tiffin NJ, Parsons WJ, et al. The modern abdominoperineal excision: the next challenge after total mesorectal excision. Ann Surg. 2005;242(1):74–82.
105. den Dulk M, Putter H, Collette L, Marijnen CA, Folkesson J, Bosset JF, et al. The abdominoperineal resection itself is associated with an adverse outcome: the European experience based on a pooled analysis of five European randomised clinical trials on rectal cancer. Eur J Cancer. 2009;45(7):1175–83.
106. Nagtegaal ID, van de Velde CJ, Marijnen CA, van Krieken JH, Quirke P. Low rectal cancer: a call for a change of approach in abdominoperineal resection. J Clin Oncol. 2005;23(36):9257–64.
107. Eriksen MT, Wibe A, Syse A, Haffner J, Wiig JN. Inadvertent perforation during rectal cancer resection in Norway. Br J Surg. 2004;91(2):210–6.
108. Holm T, Ljung A, Häggmark T, Jurell G, Lagergren J. Extended abdominoperineal resection with gluteus maximus flap reconstruction of the pelvic floor for rectal cancer. Br J Surg. 2007;94(2):232–8.
109. Foster JD, Pathak S, Smart NJ, Branagan G, Longman RJ, Thomas MG, et al. Reconstruction of the perineum following extralevator abdominoperineal excision for carcinoma of the lower rectum: a systematic review. Color Dis. 2012;14(9):1052–9.
110. West NP, Anderin C, Smith KJ, Holm T, Quirke P. Multicentre experience with extralevator abdominoperineal excision for low rectal cancer. Br J Surg. 2010;97(4):588–99.
111. Salerno G, Daniels I, Heald RJ, Brown G, Moran BJ. Management and imaging of low rectal carcinoma. Surg Oncol. 2004;13(2–3):55–61.
112. Shihab OC, Heald RJ, Rullier E, Brown G, Holm T, Quirke P, et al. Defining the surgical planes on MRI improves surgery for cancer of the low rectum. Lancet Oncol. 2009;10(12):1207–11.
113. Salerno GV, Daniels IR, Moran BJ, Heald RJ, Thomas K, Brown G. Magnetic resonance imaging prediction of an involved surgical resection margin in low rectal cancer. Dis Colon Rectum. 2009;52(4):632–9.
114. Beyond TME Collaborative. Consensus statement on the multidisciplinary management of patients with recurrent and primary rectal cancer beyond total mesorectal excision planes. Br J Surg. 2013;100(8):1009–14.
115. Bhangu A, Ali SM, Brown G, Nicholls RJ, Tekkis P. Indications and outcome of pelvic exenteration for locally advanced primary and recurrent rectal cancer. Ann Surg. 2014;259(2):315–22.
116. Georgiou PA, Tekkis PP, Constantinides VA, Patel U, Goldin RD, Darzi AW, et al. Diagnostic accuracy and value of magnetic resonance imaging (MRI) in planning exenterative pelvic surgery for advanced colorectal cancer. Eur J Cancer. 2013;49(1):72–81.
117. Balyasnikova S, Brown G. Imaging advances in colorectal cancer. Curr Colorectal Cancer Rep. 2016;12:162–9.
118. Sebag-Montefiore D, Stephens RJ, Steele R, Monson J, Grieve R, Khanna S, et al. Preoperative radiotherapy versus selective postoperative chemoradiotherapy in patients with rectal cancer (MRC CR07 and NCIC-CTG C016): a multicentre, randomised trial. Lancet. 2009;373(9666):811–20.
119. van Gijn W, Marijnen CA, Nagtegaal ID, Kranenbarg EM, Putter H, Wiggers T, et al. Preoperative radiotherapy combined with total mesorectal excision for resectable rectal cancer: 12-year follow-up of the multicentre, randomised controlled TME trial. Lancet Oncol. 2011;12(6):575–82.
120. Bosset J-F, Collette L, Calais G, Mineur L, Maingon P, Radosevic-Jelic L, et al. Chemotherapy with preoperative radiotherapy in rectal cancer. N Engl J Med. 2006;355(11):1114–23.
121. Gérard J-P, Conroy T, Bonnetain F, Bouché O, Chapet O, Closon-Dejardin M-T, et al. Preoperative radiotherapy with or without concurrent fluorouracil and leucovorin in T3-4 rectal cancers: results of FFCD 9203. J Clin Oncol. 2006;24(28):4620–5.
122. Battersby NJ, Juul T, Christensen P, Janjua AZ, Branagan G, Emmertsen KJ, et al. Predicting the risk of bowel-related quality-of-life impairment after restorative resection for rectal cancer: a multicenter cross-sectional study. Dis Colon Rectum. 2016;59(4):270–80.
123. Marijnen CA, Kapiteijn E, van de Velde CJ, Martijn H, Steup WH, Wiggers T, et al. Acute side effects and complications after short-term preoperative radiotherapy combined with total mesorectal excision in primary rectal cancer: report of a multicenter randomized trial. J Clin. 2002;20(3):817–25.
124. Birgisson H, Pahlman L, Gunnarsson U, Glimelius B. Occurrence of second cancers in patients treated with radiotherapy for rectal cancer. J Clin Oncol. 2005;23(25):6126–31.
125. Morris EJ, Finan PJ, Spencer K, Geh I, Crellin A, Quirke P, et al. Wide variation in the use of radiotherapy in the management of surgically treated rectal cancer across the English National Health Service. Clin Oncol. 2016;22:522–31.
126. Fitzgerald TL, Zervos E, Wong JH. Patterns of pelvic radiotherapy in patients with stage II/III rectal cancer. J Cancer Epidemiol. 2013;2013:408460.
127. van Leersum NJ, Snijders HS, Wouters MWJM, Henneman D, Marijnen CAM, Rutten HR, et al. Evaluating national practice of preoperative radiotherapy for rectal cancer based on clinical auditing. Eur J Surg Oncol. 2013;39(9):1000–6.
128. Gunderson LL, Sargent DJ, Tepper JE, Wolmark N, O'Connell MJ, Begovic M, et al. Impact of T and N stage and treatment on survival and relapse in adjuvant rectal cancer: a pooled analysis. J Clin Oncol. 2004;22(10):1785–96.

129. Lai LL, Fuller CD, Kachnic LA, Thomas CR Jr. Can pelvic radiotherapy be omitted in select patients with rectal cancer? Semin Oncol. 2006;33(6 Suppl 11):S70–4.
130. Glynne-Jones R, Tan D, Goh V. Pelvic MRI for guiding treatment decisions in rectal cancer. Oncology. 2014;28(8):667–77.
131. Benson AB, Bekaii-Saab T, Chan E, Chen Y-J, Choti MA, Cooper HS, et al. Rectal cancer. J Natl Compr Cancer Netw. 2012;10(12):1528–64.
132. Guillem JG, Díaz-González JA, Minsky BD, Valentini V, Jeong S-Y, Rodriguez-Bigas MA, et al. cT3N0 rectal cancer: potential overtreatment with preoperative chemoradiotherapy is warranted. J Clin Oncol. 2008;26(3):368–73.
133. Sautter-Bihl M-L, Hohenberger W, Fietkau R, Roedel C, Schmidberger H, Sauer R. MRI-based treatment of rectal cancer: is prognostication of the recurrence risk solid enough to render radiation redundant? Ann Surg Oncol. 2014;21(1):197–204.
134. Smith N, Brown G. Preoperative staging of rectal cancer. Acta Oncol. 2008;47(1):20–31.
135. Blomqvist L, Glimelius B. The 'good', the 'bad', and the 'ugly' rectal cancers. Acta Oncol. 2008;47(1):5–8.
136. Colorectal cancer: diagnosis and management [CG131]. National Institute for Health and Clinical Excellence. 2011(November).
137. Glimelius B, Tiret E, Cervantes A, Arnold D, Group obotEGW. Rectal cancer: ESMO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2013;24(suppl 6):vi81–8.
138. Valentini V, Glimelius B, Haustermans K, Marijnen CAM, Rödel C, Gambacorta MA, et al. EURECCA consensus conference highlights about rectal cancer clinical management: The radiation oncologist's expert review. Radiother Oncol. 2014;110(1):195–8.
139. Glimelius B. Optimal time intervals between preoperative radiotherapy or chemoradiotherapy and surgery in rectal cancer? Front Oncol. 2014;4:50.
140. Memon S, Lynch AC, Bressel M, Wise AG, Heriot AG. Systematic review and meta-analysis of the accuracy of MRI and endorectal ultrasound in the restaging and response assessment of rectal cancer following neoadjuvant therapy. Color Dis. 2015;17(9):748–61.
141. Hanly AM, Ryan EM, Rogers AC, McNamara DA, Madoff RD, Winter DC. Multicenter evaluation of rectal cancer reimaging post neoadjuvant (MERRION) therapy. Ann Surg. 2014;259(4):723–7.
142. Glynne-Jones R, Wallace M, Livingstone JIL, Meyrick-Thomas J. Complete clinical response after preoperative chemoradiation in rectal cancer: is a "wait and see" policy justified? Dis Colon Rectum. 2007;51(1):10–20.
143. Marijnen CAM. Organ preservation in rectal cancer: have all questions been answered? Lancet Oncol. 2015;16(1):e13–22.
144. Eisenhauer EA, Therasse P, Bogaerts J, Schwartz LH, Sargent D, Ford R, et al. New response evaluation criteria in solid tumours: revised RECIST guideline (version 1.1). Eur J Cancer. 2009;45(2):228–47.
145. Evans J, Patel U, Brown G. Rectal cancer: primary staging and assessment after chemoradiotherapy. Semin Radiat Oncol. 2011;21(3):169–77.
146. Minocha J, Lewandowski RJ. Assessing imaging response to therapy. Radiol Clin N Am. 2015;53(5):1077–88.
147. Zhao RS, Wang H, Zhou ZY, Zhou Q, Mulholland MW. Restaging of locally advanced rectal cancer with magnetic resonance imaging and endoluminal ultrasound after preoperative chemoradiotherapy: a systemic review and meta-analysis. Dis Colon Rectum. 2014;57(3):388–95.
148. de Jong EA, ten Berge JCEM, Dwarkasing RS, Rijkers AP, van Eijck CHJ. The accuracy of MRI, endorectal ultrasonography, and computed tomography in predicting the response of locally advanced rectal cancer after preoperative therapy: a metaanalysis. Surgery. 2016;159(3):688–99.
149. Pierredon-Foulongne MA, Nougaret S, Bibeau F, Rouanet P, Delhom E, Lonjon J, et al. Utility of reassessment after neoadjuvant therapy and difficulties in interpretation. Diagn Interv Imaging. 2014;95(5):495–503.
150. Tanaka S, Martling A, Lindholm J, Holm T, Palmer G. Remaining cancer cells within the fibrosis after neo-adjuvant treatment for locally advanced rectal cancer. Eur J Surg Oncol. 2015;41(9):1204–9.
151. Chand M, Evans J, Swift RI, Tekkis PP, West NP, Stamp G, et al. The prognostic significance of post-chemoradiotherapy high-resolution MRI and histopathology detected extramural venous invasion in rectal cancer. Ann Surg. 2015;261(3):473–9.
152. Chand M, Swift RI, Tekkis PP, Chau I, Brown G. Extramural venous invasion is a potential imaging predictive biomarker of neoadjuvant treatment in rectal cancer. Br J Cancer. 2014;110(1):19–25.
153. Dattani M, Moran BJ. Watch and wait after neoadjuvant therapy for rectal cancer. Br J Surg. 2016;103:629–31.
154. Habr-Gama A, Perez RO, Nadalin W, Sabbaga J, Ribeiro U, Silva e Sousa AH, et al. Operative versus nonoperative treatment for stage 0 distal rectal cancer following chemoradiation therapy: long-term results. Ann Surg. 2004;240(4):711–8.
155. Smith JD, Ruby JA, Goodman KA, Saltz LB, Guillem JG, Weiser MR, et al. Nonoperative management of rectal cancer with complete clinical response after neoadjuvant therapy. Ann Surg. 2012;256(6):965–72.
156. Renehan AG, Malcomson L, Emsley R, Gollins S, Maw A, Myint AS, et al. Watch-and-wait approach versus surgical resection after chemoradiotherapy for patients with rectal cancer (the OnCoRe project):

a propensity-score matched cohort analysis. Lancet Oncol. 2015;17:174–83.
157. Appelt AL, Pløen J, Harling H, Jensen FS, Jensen LH, Jørgensen JCR, et al. High-dose chemoradiotherapy and watchful waiting for distal rectal cancer: a prospective observational study. Lancet Oncol. 2015;16(8):919–27.
158. Martens MH, Maas M, Heijnen LA, Lambregts DM, Leijtens JW, Stassen LP, et al. Long-term outcome of an organ preservation program after neoadjuvant treatment for rectal cancer. J Natl Cancer Inst. 2016;108(12):djw171.
159. Maas M, Lambregts DMJ, Nelemans PJ, Heijnen LA, Martens MH, Leijtens JWA, et al. Assessment of clinical complete response after chemoradiation for rectal cancer with digital rectal examination, endoscopy, and MRI: selection for organ-saving treatment. Ann Surg Oncol. 2015;22(12):3873–80.
160. Bhoday J, Smith F, Siddiqui MR, Balyasnikova S, Swift RI, Perez R, et al. Magnetic resonance tumor regression grade and residual mucosal abnormality as predictors for pathological complete response in rectal cancer postneoadjuvant chemoradiotherapy. Dis Colon Rectum. 2016;59(10):925–33.
161. Mandard AM, Dalibard F, Mandard JC, Marnay J, Henry-Amar M, Petiot JF, et al. Pathologic assessment of tumor regression after preoperative chemoradiotherapy of esophageal carcinoma. Clinicopathologic correlations. Cancer. 1994;73(11):2680–6.
162. Patel UB, Taylor F, Blomqvist L, George C, Evans H, Tekkis P, et al. Magnetic resonance imaging–detected tumor response for locally advanced rectal cancer predicts survival outcomes: MERCURY experience. J Clin Oncol. 2011;29(28):3753–60.
163. Joye I, Deroose CM, Vandecaveye V, Haustermans K. The role of diffusion-weighted MRI and (18) F-FDG PET/CT in the prediction of pathologic complete response after radiochemotherapy for rectal cancer: a systematic review. Radiother Oncol. 2014;113(2):158–65.
164. Cunningham D, Atkin W, Lenz HJ, Lynch HT, Minsky B, Nordlinger B, et al. Colorectal cancer. Lancet. 2010;375(9719):1030–47.
165. Mantke R, Schmidt U, Wolff S, Kube R, Lippert H. Incidence of synchronous liver metastases in patients with colorectal cancer in relationship to clinico-pathologic characteristics. Results of a German prospective multicentre observational study. Eur J Surg Oncol. 2012;38(3):259–65.
166. Mitry E, Guiu B, Cosconea S, Jooste V, Faivre J, Bouvier AM. Epidemiology, management and prognosis of colorectal cancer with lung metastases: a 30-year population-based study. Gut. 2010;59(10):1383–8.
167. Mirnezami R, Mehta AM, Chandrakumaran K, Cecil T, Moran BJ, Carr N, et al. Cytoreductive surgery in combination with hyperthermic intraperitoneal chemotherapy improves survival in patients with colorectal peritoneal metastases compared with systemic chemotherapy alone. Br J Cancer. 2014;111(8):1500–8.
168. Niekel MC, Bipat S, Stoker J. Diagnostic imaging of colorectal liver metastases with CT, MR imaging, FDG PET, and/or FDG PET/CT: a meta-analysis of prospective studies including patients who have not previously undergone treatment. Radiology. 2010;257(3):674–84.
169. Knowles B, Welsh FK, Chandrakumaran K, John TG, Rees M. Detailed liver-specific imaging prior to preoperative chemotherapy for colorectal liver metastases reduces intra-hepatic recurrence and the need for a repeat hepatectomy. HPB. 2012;14(5):298–309.
170. Dewhurst C, Rosen MP, Blake MA, Baker ME, Cash BD, Fidler JL, et al. ACR appropriateness criteria pretreatment staging of colorectal cancer. J Am Coll Radiol. 2012;9(11):775–81.
171. Vatandoust S, Price TJ, Karapetis CS. Colorectal cancer: metastases to a single organ. World J Gastroenterol. 2015;21(41):11767–76.
172. Nordholm-Carstensen A, Wille-Jorgensen PA, Jorgensen LN, Harling H. Indeterminate pulmonary nodules at colorectal cancer staging: a systematic review of predictive parameters for malignancy. Ann Surg Oncol. 2013;20(12):4022–30.
173. Bamba Y, Itabashi M, Kameoka S. Value of PET/CT imaging for diagnosing pulmonary metastasis of colorectal cancer. Hepato-Gastroenterology. 2011;58(112):1972–4.
174. Koh J-L, Yan TD, Glenn D, Morris DL. Evaluation of preoperative computed tomography in estimating peritoneal cancer index in colorectal peritoneal carcinomatosis. Ann Surg Oncol. 2009;16(2):327–33.
175. Esquivel J, Chua TC, Stojadinovic A, Melero JT, Levine EA, Gutman M, et al. Accuracy and clinical relevance of computed tomography scan interpretation of peritoneal cancer index in colorectal cancer peritoneal carcinomatosis: a multi-institutional study. J Surg Oncol. 2010;102(6):565–70.
176. Iversen LH, Rasmussen PC, Laurberg S. Value of laparoscopy before cytoreductive surgery and hyperthermic intraperitoneal chemotherapy for peritoneal carcinomatosis. Br J Surg. 2013;100(2):285–92.
177. Bull AD, Biffin AH, Mella J, Radcliffe AG, Stamatakis JD, Steele RJ, et al. Colorectal cancer pathology reporting: a regional audit. J Clin Pathol. 1997;50(2):138–42.
178. Taylor F, Mangat N, Swift IR, Brown G. Proforma-based reporting in rectal cancer. Cancer Imaging. 2010;10:S142–50.
179. Spiegle G, Leon-Carlyle M, Schmocker S, Fruitman M, Milot L, Gagliardi AR, et al. Development of

a synoptic MRI report for primary rectal cancer. Implement Sci. 2009;4:79.
180. Kennedy ED, Milot L, Fruitman M, Al-Sukhni E, Heine G, Schmocker S, et al. Development and implementation of a synoptic MRI report for preoperative staging of rectal cancer on a population-based level. Dis Colon Rectum. 2014;57(6):700–8.
181. National Accreditation Program for Rectal Cancer, American College of Surgeons, https://www.facs.org/quality-programs/cancer/naprc.
182. ACR Catalog, Rectal Cancer Staging, https://shop.acr.org/Default.aspx?TabID=55&ProductId=1753677070.

Rectal Carcinoma: Operative Treatment, Transanal

22

Cora Ianiro, Mark H. Whiteford, and Patricia Sylla

Local Approaches to Rectal Cancer

The history of rectal cancer surgery is intertwined with both radical transabdominal approaches and non-radical local approaches. In 1886, Kraske described the transsacral approach to low and mid rectal cancers [1]. This procedure was able to access tumors that were either too large or beyond the of reach for transanal approaches and permitted adequate visability for both disc excisions and more extensive sleeve resections. The procedure was initially performed as a two-step process with a midline to left gluteal skin incision with distal sacrococcygectomy and division of the levator muscles in the right lateral decubitus position, followed by the rectal excision in lithotomy position [2]. Unfortunately, when applied to all comers, this operation suffered from unacceptably high incidence of local recurrence (~90%), fecal fistula (~70%). The transsacral approach evolved to a single stage prone jack-knife procedure, and when applied to a more select population of early rectal cancers and polyps, had a lower, but still significant fecal fistula rate of approximately 20% [2]. A second dorsal approach was popularized by Mason. Through a similar posterior incision, the sacrum and coccyx are spared, but rectal access was facilitated by careful division of the sphincter complex in the midline to fully lay open the rectum from anus up [3]. This was followed by careful reapproximation of the sphincter during closure. Concerns over increased fecal incontinence and fecal fistulas halted enthusiasm for this technique. The successes of local excision via transanal surgery and TME with stapled or hand sewn anastomosis have supplanted the routine need for dorsal approaches for rectal polyps and cancer. The dorsal approaches are still utilized for less common indications such as removal of distal presacral tumors and to repair iatrogenic rectourinary fistulas [4, 5].

Prior to adoption of low pelvic stapling devices, dorsal approaches, in conjunction with a synchronous abdominal approach, was utilized for the radical treatment of mid rectal tumors with sphincter preservation. Patients were positioned in a right lateral [6, 7]. These techniques had acceptable oncological and functional results and a fecal fistula rate of 10%, which usually resolved spontaneously or with temporary fecal diversion.

C. Ianiro
Department of Surgery, Division of Colorectal Surgery, Mount Sinai Hospital, New York, NY, USA
e-mail: cora.ianiro@mountsinai.org

M. H. Whiteford
Oregon Health and Science University, Portland, OR, USA
e-mail: mwhiteford@orclinic.com

P. Sylla (✉)
Department of Surgery, Division of Colorectal Surgery, Mount Sinai Hospital, New York, NY, USA

Icahn School Medicine, New York, NY, USA
e-mail: patricia.sylla@mountsinai.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_22

Popularized by Professor Bill Heald and colleagues in 1982, total mesorectal excision (TME) is currently the gold standard for the surgical management of rectal cancer [8]. The TME technique calls for radical en-bloc sharp dissection of the rectum and mesorectum along the mesorectal fascia. The application of the TME technique, in conjunction with stage-appropriate neoadjuvant chemoradiation (CRT), has been shown to considerably reduce local recurrence rates in resectable rectal cancer when compared to surgery alone [9, 10]. TME may be performed with sphincter-preserving low anterior resection (LAR) or for tumors with threatened circumferential margins (CRM) and/or involving the anal sphincter muscles, abdominoperineal resection (APR). Regardless of the approach (open, laparoscopic or robotic), TME is associated with a 2–5% mortality rate, morbidity ranging 18–55%, and frequent use of a temporary ostomy [11–14]. Related TME-morbidities include, but are not limited to, infectious, anastomotic, and wound-related complications, as well as urogenital dysfunction and defecatory disturbances [11–16]. Long-term complications associated with ileostomy and colostomy includes parastomal hernia and stomal prolapse. These complications yield significant morbidity, often require surgical correction, and have significant psychological and psychosocial impact. Even when sphincter-preserving LAR for low rectal tumors can be achieved, functional disturbances linked with low anterior syndrome and coloanal reconstruction are often reported and can be particularly problematic in radiated patients [17, 18].

Due to the high morbidity and mortality rates related to TME, new avenues in the surgical treatment of rectal carcinomas were investigated in order to offer patients less radical and invasive options. It is in this context that local excision techniques emerged as an alternate option to radical resection.

Transanal Excision (TAE)

The earliest report of transanal excision (TAE or Park's operation) of a rectal tumor is credited to Dr. Jacques Lisfranc in the early 1800s. In this initial report there was no mention of anesthesia, no defect closure was attempted, and hemostasis was maintained with serial intrarectal packing [17]. The modern era of TAE was popularized by Sir Alan Parks in the 1960s, whereby the technique employed anesthesia, a self-retaining rectal retractor, epinephrine injection, a submucosal section plane, use of stay sutures and primary closure of the defect [19, 20].

TAE was further developed to include full-thickness excision of distal lesions. The distal lesion is visualized and accessed through the anus, and a full-thickness excision can be performed, thus eliminating the need for radical resection and stoma creation. Procedures are performed using conventional anoscopes to expose the rectum and circumferentially resect lesions and full-thickness through the rectal wall, followed by suture closure of the rectal defects. The morbidity rates of TAE are considerably lower than previously mentioned resection techniques, ranging from 10 to 17%, and mostly consisting of bleeding, transient urinary retention and fecal incontinence [21–23]. However, due to the limited exposure, lighting, and visualization of the surgical field through standard anoscopes, TAE is limited to lesions in the distal 6–8 cm of the rectum. These limitations increase the incidence of specimen fragmentation and positive resection margins [24].

Another historic perspective for transanal treatment of rectal cancer includes electrocoagulation of rectal cancer. First published by Strauss in 1935 [25]. The goal is to use electrocautery to destroy the tumor along with clear deep and radial margins, ofter requiring multiple sessions [26]. One obvious criticism of this technique is the lack of a specimen with which to provide proper T staging and histologic evaluation for prognostication. In keeping with other transanal techniques, this approach was primarily utilized in frail, elderly patients or for palliation. Complications included bleeding, strictures, urinary retention, and occasional fistulas. Local recurrence rates were much higher for lesions >4 cm in size or ulcerated, than for lesions <4 cm in size and exophytic [26, 27]. Palliative procedures were often inadequate to stop bleeding and tenesmus.

Transanal Endoscopic Surgery

Transanal endoscopic microsurgery (TEM, Richard Wolf Company, Knittlingen, Germany) (Fig. 22.1a) was developed by Buess in 1983 to perform endoscopic resection of rectal polyps deemed too proximal for access by TAE, too large or distal for access by standard colonoscopy, and would otherwise be managed with proctectomy [28]. The original beveled rigid TEM metal multiport platform represents a substantial technological improvement over TAE and flexible endoscopy by providing magnified 3D stereoscopic visualization of rectal lesions, stable rectal distention with CO_2, and angled rigid instruments for dissection and suture closure of rectal defects within the narrow confines of the 4 cm-wide platform. Other ergonomic benefits include an anchoring arm that locks the platform onto the operating table, stabilizing the operating platform and permitting a single operator to perform either submucosal

Fig. 22.1 Transanal endoscopic surgery platforms. (**a**) TEM (transanal endoscopic microsurgery, Richard Wolf Medical). (**b**) TEO (transanal endoscopic operation, Karl Storz). (**c**) SILS (single incision laparosocpic surgery, Covidien). (**d**) Gelpoint path (Applied Medical)

or full-thickness rectal dissection with hemostasis achieved with electrocautery, bipolar energy, or clips. Superficial rectal defects can be left open, or be closed in a fashion similar to full-thickness defects using laparoscopic suturing instruments. In 2012 one of the editors (SDW) proposed the generic term transanal endoscopic surgery (TES) to replace the myriad of proprietary trade names used prior to that time. The technology has remained largely unaltered over the last 30 years, a testament to its effectiveness. The second TES technique and platform was developed for reusable use with conventional laparoscopic equipment and a 3 mm 2D laparoscopic camera, termed the transanal endoscopic operation (TEO, Karl Storz GmbH, Tuttlingen, Germany) (Fig. 22.1b). It should be noted that because of the similarity between TEM and TEO rigid metal platforms, many series do not necessarily distinguish between the two rigid platforms, and may use the terms TEM and TEO interchangeably, or refer to them as TEM or TES rigid platforms.

TES was originally designed as an alternative minimally invasive endoscopic approach for rectal adenomas, and is currently the preferred approach to resect large flat carpeting villous lesions that are unresectable by standard polypectomy, and out of the reach by TAE [21, 29–31]. Although TES was initially developed to treat benign disease, indications for TES have expanded over the last 30 years to include the curative treatment of rectal adenocarcinoma via full thickness endoscopic excision in select cases. TES has also been employed for a variety of other tumors such as early-stage rectal carcinoid, GIST tumors, and presacral tumors and other benign conditions. Lastly, in medically unfit patients, locally advanced and symptomatic rectal cancer, a multimodal approach combining TES and neoadjuvant treatment, or TES without CRT, can be used in the palliative treatment of advanced rectal tumors and in patients who refuse radical surgery that would otherwise require a permanent colostomy.

Until recently, adoption of TES was limited to a few high-volume and referral centers. Wider adoption was limited by the high costs of the rigid TEM and TEO platforms, scarcity of training centers, limitations on registrant participation, and perceived long learning curve required to achieve technical proficiency. However, in 2009, an alternate transanal endoscopic set-up using a single-incision laparoscopic disposable transanal ports was described. The use of disposable single-incision multiport platforms for TES was termed transanal minimally invasive surgery (TAMIS) [24, 28]. TAMIS overcomes many of the difficulties of TEM that led to limited adoption, namely the need for specialized and costly towers and instruments. TAMIS is compatible with standard laparoscopic equipment, thus leveling the steep learning curve of the procedure. TAMIS platforms consist in shorter, and more pliable multiport platform [SILS Port, Covidien, Mansfield, MA (Fig. 22.1c); GelPOINT Path, Applied Medical, Rancho Santa Margarita, CA (Fig. 22.1d)] thereby increasing the freedom of motion and reducing instrument collision during the procedure. TAMIS has its own limitations (Fig. 22.2). The devices seat themselves through the anal canal an into the distal rectum, thereby obscuring upper anal canal and distal rectal lesions, mandating a combined TAMIS-TAE technique for these low lesions. The shorter length of the TAMIS platform also limits the extent of proximal rectal wall retraction and exposure, specifically beyond the 2nd or 3rd Haustral valves. Because there is no stabilizing arm to anchor the platform to the operating table and a standard laparoscopic camera and scope is used, TAMIS procedures require 2 operators, a camera holder and an operating surgeon. While a number of TAMIS series have demonstrated the procedural and short-term oncologic safety of TAMIS, these TAMIS experience is still relatively small and data regarding long-term oncologic results, functional outcomes, or comparisons to rigid platforms is still lacking (Table 22.1) [32–50].

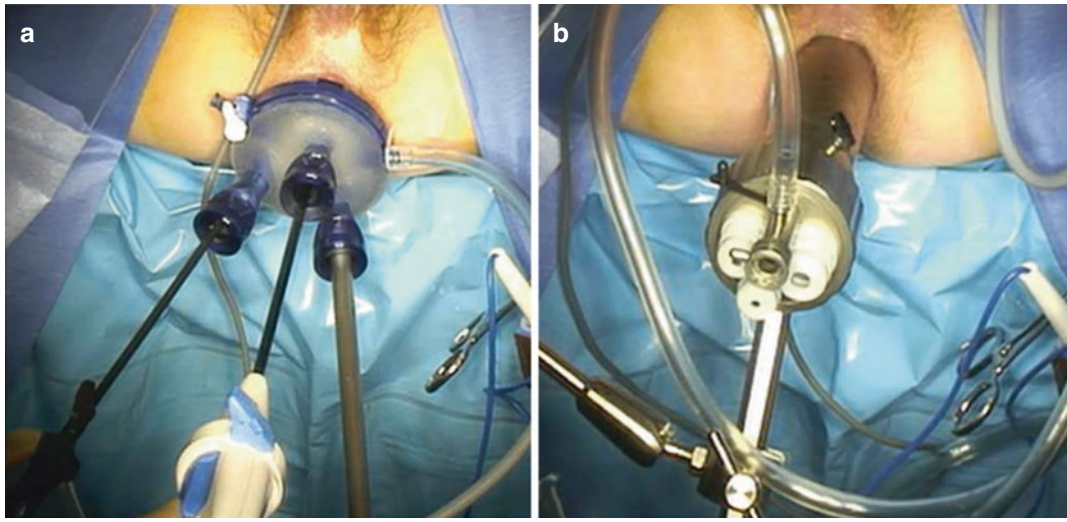


Fig. 22.2 Operative set up for TAMIS and TEO. Patients are positioned in lithotomy position and the platform is insert transanally. TAMIS procedures are performed by an operator and camera assistant (**a**). TEO and TEM procedures are performed by a single operator and platforms are secured to the OR table by a U-shaped arm holder (**b**)

Transanal Excision for Rectal Cancer

Local excision, rather than radical resection, for the surgical treatment of rectal cancer is controversial [29, 30, 51, 52]. As interest and popularity increased in locoregional management of early rectal cancer (T1 and T2), so did concerns regarding the oncologic adequacy of local excision relative to radical resection. These concerns arose due to unacceptably high rates of local recurrence reported in early series of local excision using TAE and TEM compared to TME. In a retrospective series of 260 patients who underwent either TAE or TME for T1 rectal tumors, 5-year local recurrence rates were 18% vs. 0%, respectively [53]. Several other early series reported similar high local recurrence rates following local excision for stage I rectal cancers [52, 54, 55]. It is important to note that none of these early retrospective studies included tumor selection criteria based on size or histological features, patient age, or comorbidities, therefore introducing significant heterogeneity in the histopathological features of the tumors studied and local recurrence rates observed following local excision. It has since been established that the risk of locoregional recurrence following resection of rectal cancer, which relates to the risk of lymph node metastasis, is directly correlated not only with tumor depth and size, but also with several high-risk histological features that can be identified preoperatively [56–58]. More contemporary published series, have demonstrated that with careful preoperative staging to rule out locally advanced tumors and distant disease, and when T1 rectal tumors are carefully sub-analyzed based on histopathologic features that are now known to be of prognostic significance for lymph node metastasis and local recurrence, a select subgroup of T1 lesions are amenable candidates for local excision by TES with acceptable long-term oncologic outcomes. In these more recent studies, careful review of histopathological features can help predict patients with very low risk of occult nodal disease who would likely be over-treated by radical surgery, thus incurring avoidable morbidity. These carefully selected T1 rectal tumors can be safely offered

Table 22.1 Outcomes of published TAMIS series with >12 patients

Author	Platform	Total patients (n)	B:M:O	Median distance from AV (cm)	Median OR Time (min)	+ve margins (n)	Complications (n)	Recurrence (n)	Follow up (months)
Lorenz et al. [41]	SILS	13	0:13:0	6.5	NR	0	0	NR	0.5
van den Boezem et al. [40]	SILS	12	9:3:0	7	55	0	2	NR	NR
Lim et al. [39]	SILS	16	0:11:5	7.5	86	0	0	NR	3
Hompes et al. [99]	Glove	14	7:6:1	5	93	2	2	1	5.7
Ragupathi et al. [37]	SILS	20	14:6:0	10.6	80	1	1	1	NR
Barendse et al. [36]	SSL	15	9:4:2	6	57	0	2	NR	NR
Albert et al. [48]	SILS/ Gelpoint	50	25:23:2	8.1 (mean)	74.9 (mean)	3	4	2	20
Lee et al. [50]	SILS	25	6:9:10	9	45	0	1	0	9.8
Gorgun et al. [35]	Gelpoint	12	10:1:1	8.4	79	NR	3	NR	NR
McLemore et al. [46]	Gelpoint/ SILS	32	13:16:3	4	123	0	5	0	8
Maglio et al. [44]	GelPoint	15	5:10:0	7	86	0	0	0	6
Hahnloser et al. [49]	SILS	75	38:37:0	6.6	77	3	23	0	12.7
Schiphorst et al. [43]	SILS	37 (1 converted to LAR)	23:13:1	<4	64	6	3	2	11
Gill et al. [34]	Gelpoint	32	11:16:5	7.5	131	0	16	1 (distant)	NR
Sumrien et al. [32]	SILS/ Gelpoint	28	17:11:0	NR	NR	6	7	2	3
Verseveld et al. [33]	SSL	24	20:4:0	8	32	0	1	0	NR
Quaresima et al. [42]	SILS/ Gelpoint	31	10:17:4	9.5 (mean)	NR	1	8	1	30

B:M:O benign: malignant: other, *SSL* single site laparoscopic access system, *SILS* single incision laparoscopic surgery port, *Gelpoint* GelPOINT path transanal access platform, *NR* not reported

TES alone as curative therapy. Moreover, there is mounting evidence demonstrating acceptable oncologic outcomes with the use of TES in combination with adjuvant or neoadjuvant chemoradiotherapy for more advanced lesions [59, 60].

TES for Early Rectal Cancer

Early rectal cancer (ERC) consists of T1 invasive adenocarcinoma extending into but not beyond the submucosa, i.e. staged as T1, and is typically found within a pedunculated or sessile adenoma or an ulcerated lesion. The extent of invasion can be further characterized by the depth of penetration of the carcinoma into the polyp stalk for pedunculated lesions, or submucosa for sessile lesions [61]. Haggitt was the first to subclassify submucosal invasion by depth. A low-risk ERC contained in a pedunculated polyp is defined as Haggitt level 1, 2 or 3, where the carcinoma invades through the muscularis mucosa into the submucosa but is confined to the head, neck or stalk respectively. Routine snare polypectomy is an acceptable curative strategy for the latter, which are typically incidentally identified on pathologic review [62].

For ERC contained in small flat rectal polyps and ulcerated lesions, the depth of T1 invasion into the submucosal layer needs to be further characterized based on the more recent Kikuchi classification where Sm1 represents invasion into the upper third, Sm2 into the middle third, and Sm3 into the deepest third [63]. Deeper submucosal invasion correlates with increased risk of lymphovascular invasion (LVI). Polypectomy alone for Sm3 and high-risk Sm2 lesions is associated with higher risk of lymph node metastasis and local recurrence [63]. Kikuchi and Nascimbeni independently determined from large samples of T1 colorectal cancers undergoing radical resection that Sm1, Sm2 and Sm3 depth of tumor invasion was associated with a 0–3%, 8–10% and 23–25% risk of lymph node metastasis respectively [63, 64]. Therefore, complete polypectomy or endoscopic mucosal resection (EMR) of a low-risk ERC i.e. <3 cm sessile or ulcerated Sm1 pT1 well or moderately well differentiated adenocarcinoma with no LVI, does not require further treatment [62]. For larger and more distal ERC, TAE and TES provide improved transanal access, exposure and opportunity to achieve negative margins. In addition, when polypectomy or EMR results in positive or indeterminate resection margins for otherwise low-risk ERC, TAE and TES with full-thickness excision of the polypectomy site is particularly suited to complete the excision, achieve a cure or identify an unsuspected deeper invasive component. Histopathological risk factors for local recurrence following local excision of T1 tumors, by either submucosal dissection (ESD) or full-thickness TES or TAE have been extensively studied.

In addition to Kikuchi depth of submucosal invasion, other important histopathologic risk factors for lymph node metastasis include tumor size, positive resection margins (R1 resection), poor histologic differentiation grade, LVI, and the presence of tumor budding [63, 65–67]. In a retrospective review of 353 patients who underwent TME for sessile T1 rectal lesions, Nascimbeni et al. reported a 13% overall incidence of lymph node metastasis [64]. By multivariate analysis, independent predictors of metastasis included Sm3 involvement ($p = 0.001$), LVI ($p = 0.005$) and lesions in the lower third of the rectum ($p = 0.007$). Two additional studies reviewing large prospectively collected databases have also identified LVI, poor differentiation and depth of invasion (T2) to be significantly related to nodal involvement [63, 68, 69].

Tumor budding is a histologic feature that refers to the presence of a small discrete cluster of cells at the invasive tumor edge [70]. Tumor budding is a strong prognostic factor for locoregional and distant metastasis in colorectal cancer, and is associated with worse overall and disease-free survival [71]. In a series of 251 T1 colorectal tumors that underwent radical resection, high tumor grade, LVI and tumor budding were independently associated with lymph node metastasis [72]. Relative to patients without any of the above risk factors, patients with one, two or three risk factors had significantly higher rates of nodal involvement (1% versus 21% versus 36%). These results suggest that local excision with polypec-

tomy, EMR, ESD or TES with R0 resection margins would be oncologically adequate for T1 colorectal carcinoma with no evidence of LVI, tumor budding or poor differentiation [72, 73].

With regards to tumor size, TES excision for rectal tumors greater than 4 cm in diameter is usually considered a risk factor for local recurrence. In a series of 62 T1 rectal tumors, Doornebosch et al. reported a 31% local recurrence rate at 3 years following TEM, with significantly higher local recurrence for tumors >3 cm relative to tumors <3 cm (39% versus 11%). Local recurrence was lowest in the subgroup of tumors <3 cm with no evidence of Sm3 submucosal invasion (7%). In addition, the 3-year local recurrence for tumors <3 cm without budding was 10% vs. 38% in tumors >3 cm and with tumor budding [74].

Early rectal cancers that are under evaluation for TES should be staged as per standard of care, which include carcinoembryonic antigen (CEA), CT scans of the chest, abdomen and pelvis to rule out distant disease, and a pelvic MRI and/or endorectal ultrasound (ERUS) for local staging. Since the T-stage accuracy of ERUS is largely operator-dependent, ERUS is limited in its accuracy in assessing nodal status, with accuracy rates ranging 65% to 81%. The accuracy reported in multi-institutional studies is usually lower than that reported in single-institution or single-operator studies, which may relate to variations in equipment as well as the learning curve and operator-dependent expertise required to achieve consistency in performance and interpretation of ERUS. Overall, ERUS is relatively less accurate at differentiating between T1 and T2 lesions, with one multi-institutional study reporting only 57% accuracy, as compared with individual studies reporting up to 88% accuracy in identifying T1 lesions with this modality [75, 76].

Pelvic MRI has replaced ERUS as the preferred modality for rectal cancer staging. Although standard MRI imaging has comparably low sensitivity and specificity as ERUS for lymph node assessment, it provides critical assessment of circumferential radial margin (CRM), tumor location in relation to anal sphincters, prostate, vagina, and even the peritoneal reflection, all essential for accurate local staging [77].

Based on the recent published data on local recurrence rates following TEM for low-risk T1 rectal cancers approaching that following radical resection, the 2012 NCCN guidelines, stipulate that TES is recommended as an alternative curative approach for the management of carefully selected T1 cancer (Table 22.3) [78]. Tumors eligible for TES resection should have no radiographic evidence of lymph node involvement based on preoperative ERUS and/or pelvic MRI, be less than 3 cm in diameter and less than 30% of the rectal circumference, well to moderately well differentiated, and be within 8 cm of the anal verge. Despite these recommendations, there still remains considerable controversy as to whether TEM is a valid alternative to TME for T1 cancer. In a review of 11 national or international guidelines on management of rectal cancer, only 8 recommended the use of TES in the treatment of low risk early rectal cancer [79]. This debate is particularly relevant given the increased adoption of EMR and ESD for en-bloc resection of superficial colorectal cancer (intramucosal adenocarcinoma or T1 Sm1 cancers), which has been demonstrated to result in acceptable short and long-term oncologic outcomes [30, 80, 81]. In a recent European Association for Endoscopic Surgery (EAES) consensus statement regarding management of early rectal cancer, full thickness excision down to the mesorectum was considered the procedure of choice in order to achieve R0 en-bloc resection for T1 tumors determined preoperatively to be well to moderately differentiated, without lymphovascular and perineural invasion, less than 4 cm in diameters and involving <30% of the rectal wall circumference [82]. The EAES consensus quoted two recent ESD studies, including the largest one that retrospectively compared 30 patients treated with ESD and 33 patients treated with TEM for non-polypoid rectal mucosal adenocarcinomas or submucosally invasive adenocarcinomas. No significant differences in en-bloc resection rates or R0 resection rates (96.7 vs. 97%), procedural or postoperative complications, or need for additional treatment such as radical resection or adjuvant

treatment, were observed between the groups. ESD was associated with shorter operative time and length of hospital stay, and no local recurrence or distant metastases were noted over the study period [80].

TES is also commonly used in the setting of incomplete resection by piecemeal polypectomy or EMR, when a focus of high-grade dysplasia or intramucosal adenocarcinoma with unascertainable or positive deep margins of resection is discovered upon pathology review. In such cases, full-thickness excision of the polypectomy scar by TEM, TEO or TAMIS is not only diagnostic of any residual tumor or more advanced disease, but also curative, as it achieves definitive resection of the lesion [83].

TES for High-Risk T1 And T2, and More Advanced Rectal Cancer

TES excision of high-risk pT1 rectal cancer, those that harbor high-risk histopathological factors, has been associated with local recurrence rates as high as 33% [56, 84]. With respect to T2 rectal tumors, in a recent retrospective review of T1 and T2 rectal cancers treated with TAE or TEM (N = 74) vs. TME (N = 79) without the use of adjuvant therapy, no statistically significant difference in local recurrence (18.4% vs. 5.1%) or 3-year DFS (84.2% vs. 94.9%) was noted between local excision vs. TME groups for pT1 tumors. However, local recurrence was significantly higher for pT2 treated with LE vs. RR (42.3% vs. 7.5%) with significantly worse 3-year DFS (61.5% vs. 87.5%) but no difference in overall survival between the groups [85].

Among series reporting strictly on oncologic outcomes following TEM, 5-year local recurrence rates following TEM excision for T2 lesions not treated with neoadjuvant or adjuvant therapy ranges from 19.5% to as high as 36% [53, 86]. In a series of 17 vs. 83 pT2 rectal tumors resected with TEM vs. TME without adjuvant therapy, local recurrence was 19.5% vs. 9.4% in the TEM vs. TME group ($p = 0.035$) but the 3-year DFS was similar between the two groups [86]. In another series of 40 T2 rectal tumors treated with TEM alone without adjuvant therapy, at a median follow-up of 59 months, the local and distant recurrence rate was 35% and 30% respectively [56]. Among patients with high-risk histopathological features such as poorly differentiated or LVI, the local recurrence rate was as high as 50% [56]. Overall, although local recurrence rates in series where T2 tumors were strictly resected using TEM with full-thickness dissection were substantially lower than those reported in mixed TAE and TEM series, local control achieved with local excision alone without neoaduvant or adjuvant therapy remain unacceptably poor relative to gold standard radical resection.

The role of neoadjuvant CRT has been increasingly explored both in combination with local excision of T2 and T3 tumors, and more recently, in the non-operative management of rectal cancer. Lezoche et al. reported their group's long-term outcomes from a randomized trial of 100 preoperatively staged T2N0 rectal cancers treated with neoadjuvant CRT and subsequently randomized to TEM vs. laparoscopic TME [60]. At a median follow-up of 9.6 years, the local recurrence was 6% vs. 8% in the TEM vs. RR group [60]. Moreover, the surgical morbidity was lower in the TEM group.

The prospective multicenter ACOSOG Z6041 phase II trial recently reported the 3-year oncologic outcome from 72 patients with preoperative staged T2N0 cancers located within the distal 8 cm of the rectum and treated with FOLFOX and 54 Gy of radiation followed by local excision using TAE or TES [59, 87]. Complete pathologic response was noted in 44% and 64% of tumors were downstaged (ypT0-1) with 39% incidence of CRT related toxicity [59]. The 3-year DFS for the intention-to-treat group was 88.2% and 86.9% for the per-protocol group. Overall organ preservation could be achieved in 91% patients, and the authors concluded that neoadjuvant treatment followed by local excision should be reserved for those with cT2N0 lesions that are not otherwise amenable to sphincter-preserving anterior resection [87].

The CARTS study recently investigated the pathologic response of 51 cT1-3N0 rectal tumors treated with capecitabine and 50–54 Gy of radiation followed TEM resection [88]. Among the 47 tumors that were downstaged enough to be eligible for TEM (ycT0-2), 30 were staged ypT0-1 with R0 resection and were subsequently followed. Patients with ypT2-T3 tumors following TEM were advised to undergo complete TME. At a median follow- up 17 months, 4 local recurrences occurred, one patient with ypT1 and 3 patients with ypT2 tumors who declined radical resection. Overall, organ-sparing could be achieved in 55% of patients with CRT [88]. Of note, there was a 42% incidence of toxicity and 3.6% mortality rate related to CRT. In addition to the toxicity incurred by increasingly aggressive neoadjvuant treatment of cT1-3 tumors, several groups have also cautioned about the relatively high incidence of TES rectal wound-related complications in radiated patients, ranging 0–60.9% and which dehiscence is associated with severe and refractory pain for 1–2 months [89–91].

Most recently, other advocates of organ-preserving strategies have investigated the outcomes of non-operative management for rectal tumors that have demonstrated complete clinical regression following neoadjuvant therapy. This "watch-and-wait" approach has been most extensively evaluated by Habr-Gama et al. in a cohort of 69 patients with cT2-T4, N0–N2 tumors treated with intensive CRT regimens, achieving a 68% rate of complete clinical response when assessed 10–12 weeks following completion of treatment based on imaging, endoscopy and DRE confirming the absence of residual tumor or other mucosal irregularity [92]. These 47 patients were subsequently observed and a sustained complete clinical response was observed in 51% of the entire cohort at 3 years post-treatment. The remaining 49% with evidence of recurrent disease underwent immediate or salvage surgery with either TEM or TME. Several European series have corroborated the findings from the Habr-Gama group [93, 94]. With more aggressive CRT regimens, the rates of complete clinical response have exceeded the historical 20–30% rate; although this occurs at the expense of increase toxicity and possibly over-treatment early rectal tumors that ultimately require salvage radical resection.

Ultimately, the oncologic adequacy of TES with or without neoadjuvant treatment is dependent on accurate tumor staging, careful patient selection, and intensive postoperative surveillance in order to promptly identify local recurrences and salvage patients with radical resection, particularly in patients receiving neoadjuvant treatment. There is no consensus on neoadjuvant treatment regimen or surveillance protocols following TES or following neoadjuvant CRT with complete clinical response. Another challenge is posed by the accuracy of post-radiation imaging in detecting residual or recurrent disease, which is notoriously difficult to interpret due to radiation-induced fibrosis and inflammation. While the evidence in support of the role of TEM as part of a multimodal organ-sparing strategy for T2N0 rectal cancer, current NCCN guidelines recommend that treatment with neoadjuvant treatment with or without local excision be used only in the experimental setting [78].

TES for Palliation

Locally advanced and symptomatic rectal cancer often requires palliation through fecal diversion, stenting, surgical debulking, cryosurgery, embolization and radiotherapy in medically unfit patients. Multimodal approach combining TEM and neoadjuvant treatment, or TEM without CRT, can be used in the palliative treatment of advanced rectal tumors and in patients who refuse radical surgery that would most often require a permanent colostomy. In a series of 29 patients with unresectable bleeding or obstructing rectal cancers, TES was successfully used to control bleeding by coagulation or suturing, and relieve obstruction by complete or near complete excision of the mass [95]. One procedure was complicated by intra-abdominal perforation, and the overall morbidity was 14%. Thirteen patients died from their disease within 3-58 months of TEM procedures, and 8 patients remained without recurrence during postoperative surveillance [95].

Therefore, TES is a viable alternative in the palliation of for rectal cancer in patients who are not candidates for surgery or CRT.

Proctectomy Following TES and Salvage Surgery

In cases where rectal tumors are upstaged following local excision or when procedures are complicated by positive resection margins, multiple studies have found no significant difference in oncologic outcomes when local excision is followed by completion radical resection TME compared to performing TME as initial therapy [96]. This scenario is not uncommon and usually results from inaccurate preoperative staging, incomplete assessment of prognostic histopathologic features in tumor samples, and/or suboptimal surgical technique. In cases of suspected early rectal cancers where the alternative to local excision would entail APR, TES has been increasingly used as an excisional biopsy strategy to help guide further therapy. It is imperative to prepare patients for the implications of uncovering more advanced pathology, which would mandate completion radical resection in order to optimize oncologic outcomes.

There is some evidence that interval TME following full-thickness TES may be more technically challenging, morbid, and may decrease the likelihood of achieving sphincter preservation relative to primary therapy with TME, however oncologic outcomes are similar, particularly in the setting of adjuvant treatment [97–99]. Conversely, when radical resection is undertaken later as salvage therapy for local recurrence following local excision, outcomes are generally poor [100, 101]. In the setting of the increasing use of organ-preserving strategies in the management of locally advanced low rectal tumors that would otherwise require APR, oncologic outcomes of patients with complete clinical response following CRT confirmed on local excision and subsequently observed, in a prospective series by Pucciarelli the overall organ salvage rate was 90.5% and the estimated cumulative 3-year OS, DFS and local disease-free survival was 91.5%, 91% and 96.5% respectively [102]. In the Habr-Gama watch-an-wait study mentioned earlier, among the 33 patients who failed the watch-and-wait protocol, 22 with an incomplete response underwent immediate TME, while 8 patients with initial clinical complete response developed local recurrence. Seven recurrences were amenable to salvage surgery but 3 developed local or systemic recurrence of systemic recurrences only, with a 3-year OS and DFS of 90% and 72% respectively. Four additional patients developed late recurrences, 100% of which could be salvaged with R0 resection with no evidence of disease at a median follow-up of 25.5 months [92].

Cumulatively, these studies demonstrate that in the setting of the watch-and wait approach which incorporate aggressive surveillance protocol to ensure early detection of locoregional recurrence, salvage resection for early and late recurrences is associated with acceptable oncologic outcomes.

TES Preparation, Operative Set-Up, and Technique

In addition to standard rectal cancer staging and detailed histopathological review of biopsy specimens, patients that are eligible for TES should undergo tumor localization by the surgeon. Preoperative evaluation should include digital rectal examination to assess baseline anal sphincter tone, location of the tumor in relation to the anal sphincter muscles and anorectal ring, and fixity of the lesion. Patients under evaluation for TES should have resting anal sphincter tone and squeeze assessed on DRE. Patients with anal sphincter dysfunction at baseline, in particular patients treated with neoadjuvant therapy, may develop further deterioration in fecal continence following TES, and the risks vs. benefits of TES in that setting should be carefully reviewed with patients during preoperative discussions. Flexible or rigid sigmoidoscopy should also be performed to assess the exact orientation of the tumor along the rectal wall, distance from the anal verge (AV), and estimate its size and circumferential extent. In addition to standard preoperative evaluation,

full mechanical bowel preparation, with or without enemas is also recommended to keep the endoluminal surgical field free of fecal debris. In the US, TES procedures are typically performed as ambulatory surgery cases, and patients are admitted for observation if and when complex peritoneal entry was noted and repaired. Procedures are usually performed under general anesthesia, although there have been reports of TAMIS performed under spinal anesthesia [50]. Patients are typically positioned in lithotomy position regardless of tumor orientation. However in case of high-risk anterior and lateral rectal tumors, namely located ≥8 cm from the AV, with high probability of peritoneal entry during full-thickness dissection, patients are usually placed in prone position using a split-leg table.

Following insertion and set up of the rigid TEO, TEM or TAMIS platform, the rectum is distended to 12–15 mmHg with CO_2. After achieving adequate pneumorectum and visualization, the rectal lesion is scored circumferentially with electocautery mark with a 0.5–1 cm circumferential margin (Fig. 22.3a). The lesion is then dissected full-thickness using monopolar cautery and/or bipolar energy, until the perirectal fat or mesorectum is reached (Fig. 22.3b). Of note, dissection can be greatly facilitated by the use of angled and flexible-tip laparoscopic instruments, which help reduce instrument crossing and collision. Another important recent addition to the TES armentarium has been the use of specialized high-flow insufflation and smoke evacuation systems that help maintain a stable pneumorectum and clear field of view in the face of heavy smoke and fluctuations in CO_2 pressures. The TEM platform is equipped with its own integrated automatic pressure-controlled CO_2 insufflation system, and the Airseal insufflation system (SurgiQuestInc, Milford, CT, USA), which provides a continuous flow circuit that evacuates CO_2 and smoke and quickly recirculates filtered and high-pressure CO_2, helps main a stable pneumorectum at all time and has become the most commonly platform during TAMIS.

Following dissection, the lesion is then extracted transanally, oriented with sutures on a flat surface for pathologic assessment, and the rectal defect is closed with sutures (Fig. 22.3c–f). In addition to standard intracorporeal suturing with a laparoscopic needle holder, there are several suturing devices and materials commercially available to facilitate endoluminal suture closure such as the Endo Stich™ device (Medtronic, Mansfield, MA), and the Cor-Knot device (LSI Solutions, Victor, NY) Air-tight closure can be achieved using continuous and/or interrupted absorbable monofilament sutures or permanent sutures, with or without the assistance of clips, silver bullets (Richard Wolf), or self-locking barbed sutures (V-loc, Medtronic).

Mean operative time in large TEM and TEO series typically range from 70 to 95 min [103–105] with variations primarily related to size of lesions, depth of resection (submucosal vs. full-thickness), distance from the anal verge, complexity of the suture closure, and the learning curve effect. Although one of the quoted advantages of TAMIS was shorter operative set-up and OR time relative to TEM/TEO, among published TAMIS series (N = 12–75), the mean OR time ranges from 45 to 123 min, with the largest series reporting OR time of 76 and 77 min respectively (Table 22.1) [32–50]. There has not been any prospective comparative trial of TEM, TEO and TAMIS published to date.

Intraoperative Complications

Intraoperative complications of TES are fairly uncommon but include bleeding, adjacent organ injury, complicated peritoneal entry and conversion. The most common intraoperative challenges, particularly for the novice, are related to technical difficulties establishing, or maintaining adequate pneumorectum during the case. CO_2 leakage during TES results in suboptimal rectal distention and exposure, the sources of which must be sought then corrected. Typical causes of CO_2 leakage include dislocation or malpositioning of the transanal platform, leakage around the platform, which necessitates either suture fixation to the perianal skin (TAMIS) or repositioning of the platform (TEM/TEO). It is also important to verify that the platform has been

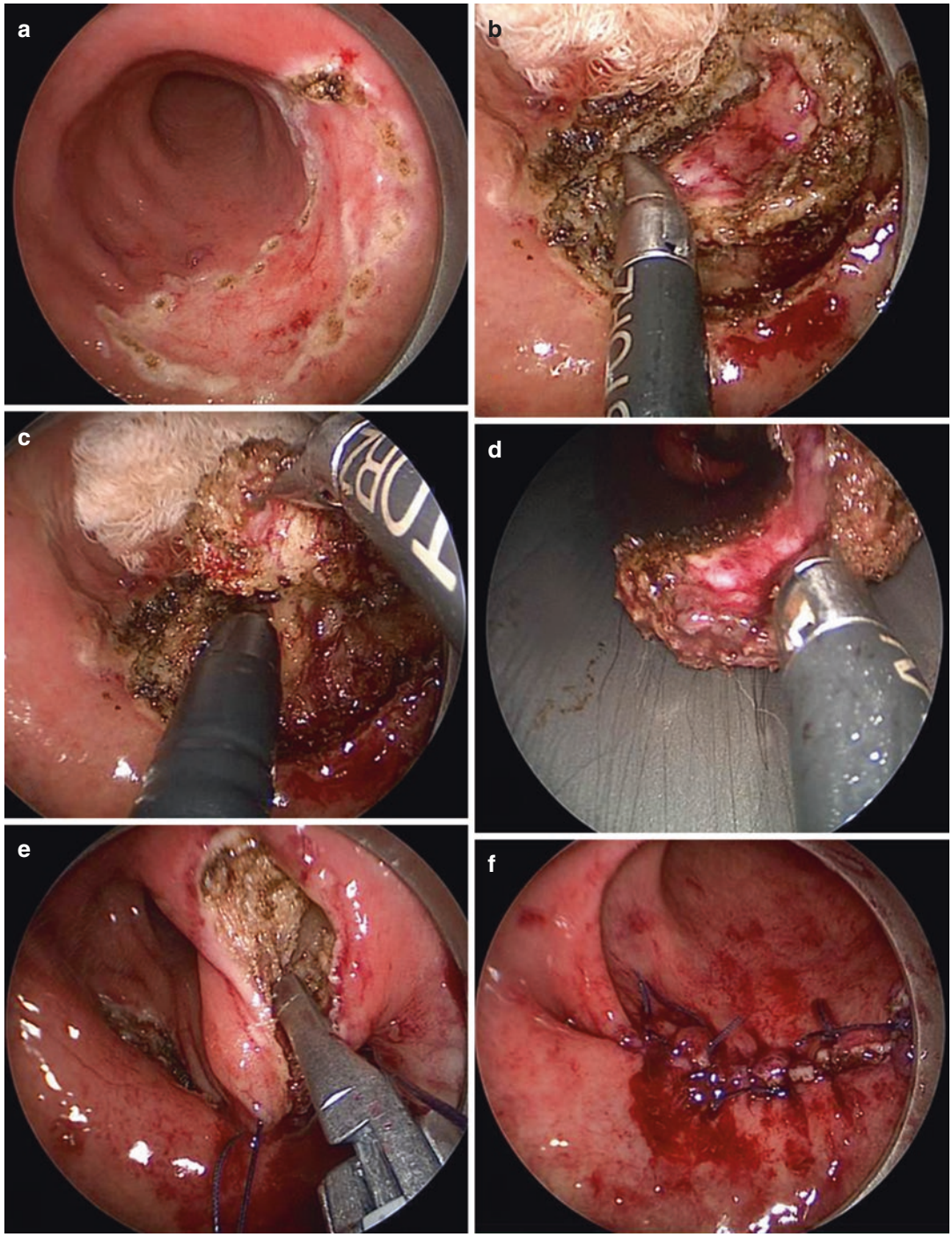


Fig. 22.3 Procedural steps of transanal endoscopic surgery. The lesion is marked circumferentially with monopolar cautery (**a**). The lesion is dissected full-thickness through the rectal wall down to the mesorectum or perirectal fat (**b**). The lesion is resected en-bloc (**c**) and passed off the field (**d**). Full thickness rectal defects are closured using sutures or a suturing device (**e**). Additional sutures are placed as needed until complete air-tight closure is achieved (**f**)

correctly assembled, and that inner and outer rubber TEM/TEO ports have not been damaged or displaced. Finally, the patient should remain completely paralyzed until completion of the case, as patient movement causes impairment of pneumorectum and exposure. In the event of sudden loss of pneumorectum during the case, it is important to ensure that there hadn't been leakage of CO_2 from an unrecognized rectal defect into the peritoneal cavity which would require prompt closure.

Bleeding during full-thickness rectal dissection can usually be controlled with monopolar cautery or bipolar energy. Laparoscopic clips and sutures can also be used to control bleeding vessels. Adjuncts such as gauze and laparoscopic suction tip are essential to avoid rapid accumulation of blood in an already narrow field.

Although rare, TES can result in visceral organ injury, including injury to structures anterior to the rectum including the vagina, prostate, bladder, and urethra, which, if not recognized and repaired promptly, often results in pelvic or perirectal abscesses and delayed rectovisceral fistulas. In addition, peritoneal entry can result in inadvertent injury to the colon and small bowel during attempted suture closure of the rectal defect. In their series of 402 TEM cases, Guerrieri et al. have reported 2 cases of urethral injury during TEM resection of anterior-based rectal lesions [106]. Among one of the largest TAMIS series published to date (N = 15), Keller et al. reported one occurrence of a rectovaginal fistula resulting from a cautery injury, which was managed non-operatively [107].

Peritoneal Entry

The management of peritoneal entry (PE) during TES, either unplanned or anticipated based on location and/or extent of the rectal lesion, remains controversial. Earlier TEM reports considered PE to be a complication requiring conversion to abdominal procedure with abdominal lavage, radical resection with or without fecal diversion due to concern of peritonitis from bacterial contamination [108, 109]. From an oncologic standpoint, PE during TEM for rectal cancer was also feared to increase the risk of tumor cell spillage and thus the risk of peritoneal tumor implants [69]. With further experience, however, these concerns have not been realized. Recent TEM/TEO series have reported an incidence of PE ranging from 0 to as high as 32.5%, but across larger TEM series from experienced centers ($N \geq 300$), the rate of PE ranges 5–10.7% [110, 111]. The studies have highlighted risks factors for PE which include full-thickness resection of lesions located in the upper rectum, anteriorly or laterally along the rectal wall, and during resection of circumferential or near-circumferential rectal lesions [112, 113]. With regards to the morbidity associated with PE, several studies have reported no differences in the incidence of infectious complications or other adverse events in TEM cases with vs. without PE [114–116]. Finally, several studies have demonstrated no adverse short or long-term oncologic outcomes in patients in whom peritoneal entry occurred during TEM excision of rectal tumors [70, 104]. Morino et al. followed 13 patients with rectal adenocarcinoma in whom peritoneal perforation occurred during TEM [115]. At a median follow-up of 48 months (range 12–150), there were no reports of distant metastasis. Two patients with T2 and T3 tumors developed local recurrences and subsequently died from disease progression. Based on these studies, TES experts do not consider tumor location 10 cm or more from the anal verge to a contraindication to TEM, as long as full-thickness suture closure of rectal defects can be achieved transanally by experienced operators [112–114, 117, 118].

It is important to note however that entry into the peritoneal cavity, with subsequent difficulty maintaining adequate pneumorectum and visualization due to leakage of CO_2 into the abdominal cavity, presents a considerable technical challenge to the surgeon. This occurrence, which is commonly referred to as complicated PE [118], is associated with a higher risk of conversion to an abdominal procedure and/or fecal diversion. For lesions that are at high-risk for PE during full-thickness dissection, patients should preemptively be placed in prone position to help

mitigate the loss of pneumorectum resulting from leakage of CO_2 into the peritoneal cavity [115]. This maneuver permits the surgeon to maintain a stable pneumorectum and facilitate adequate closure of the rectal wall defect. Other strategies to compensate for loss of pneumorectum into the peritoneal cavity include decompressing the pneumoperitoneum with a veress needle or trocar. Over time, and in experienced centers as demonstrated in the largest TEM and TEO series, conversion rates following peritoneal entry have steadily decreased, with conversion rates ranging from 0 to 40% but averaging 10% or less [115].

Loss of pneumorectum and rectal luminal collapse, which occurs with PE is greatly mitigated when using the rigid TEM and TEO platforms. With regards to the occurrence and management of PE during TAMIS, which lack the rectal stenting ability of rigid platforms, a review of 390 TAMIS procedures for rectal lesions located at an average of 7.6 cm from the AV, reported inadvertent PE in only 4 cases (1.025%) [119]. All 4 cases of PE occurred during dissection of upper rectal lesions and 2 (50%) could be closed transanally while the others required abdominal conversion. Only four TAMIS series that include 32–75 patients, have reported an incidence of PE ranging from 2 to 9.4% [32, 34, 49, 107]. Among the 10 cases of PE during TAMIS across all 4 studies, 6 required conversion to laparoscopy or laparotomy from inability to effectively close the rectal wall defect, and while in 2 cases, the defect could be closed transanally, patients were diverted with a loop ileostomy [107] This relatively high incidence of conversion and/or diversion following PE during TAMIS may reflect the long learning curve required for managing these complex rectal lesions, and the currently small experience with TAMIS to date. But it may also reflect technical limitations of shorter TAMIS platforms, which do not always permit adequate retraction and exposure of the proximal rectum [118]. Molina et al. reviewed their experience with incidence of PE among various TES modalities including 51 TEO, 21 TEM and 6 TAMIS cases. PE occurred in 28.2% of cases involving high-risk anterior/lateral lesions located an average of 13.1 cm from the anal verge. Interestingly, PE occurred in 4/6 of TAMIS cases compared to 18/72 of TEM/TEO cases. Although transanal suture closure of PE defects could be performed in 90.9% of cases, this could be accomplished with TEM and TEO platforms, but not with TAMIS platforms. All 4 TAMIS cases with PE were converted to TEO for suture closure, due to the inability to maintain adequate exposure through the shorter TAMIS platforms. Conversion to laparoscopic LAR and Hartmann's procedure was required in 2/18 TEM/TEO cases (11.1%) TEM/TEO cases with PE, which is consistent with previously reported TEM conversion rates [118].

Conversion

Conversion to TAE or LAR may be required in cases where adequate exposure of rectal lesions cannot be achieved or maintained, full-thickness rectal wall defect closure cannot be completed, when unexpected advanced pathology is encountered, or in cases of major intraoperative complication such as major bleeding or organ injury. Abdominal conversion is more likely to occur with proximal and circumferential rectal lesions, and is strongly related to the operator's learning curve with advanced TES techniques. In the largest multicenter TEM/TEO series published to date, among 693 cases, conversion to TAE or abdominal procedures was required in 4.3% [110], which is consistent with the 0–5.3% conversion rates reported in large TEM/TEO series from experienced centers [104, 116, 120, 121]. Low rectal lesions, which are obscured by the TAMIS platform, will need to remove the TAMIS platform to complete the distal dissection and defect closure using TAE technique, partially detracting from the benefits of TES.

Positive Margins

Positive resection margins are an important predictor of local recurrence for malignant rectal lesions and, along with specimen fragmentation, constitute an important metric of the quality and efficacy of local excision including TAE and

TEM. Positive resection margins strongly correlate with local recurrence of rectal adenomas. With respect to rectal cancers resected using TEM, positive margin rates range across TEM and TEO series from less than 2% to as high as 8.8% [57, 96, 104, 105, 111]. Across TAMIS series, rates of positive margins also vary but have generally been 6% or less for larger series that typically include both benign and malignant pathologies (Table 22.1) [32–50]. In a meta-analysis of 6 studies that compared perioperative and oncologic outcomes following TAE vs. TEM for rectal neoplasms (adenomas and cancer), TEM was associated with a higher rate of negative resection margins (OR 5.28), reduced incidence of specimen fragmentation (OR 0.10), and lower rate of local recurrence (OR 0.25) relative to TAE [24]. While this meta-analysis was limited by the retrospective design of the studies, heterogeneity in tumor type, size and stage, and lack of standardized follow-up schedule for assessment of LR, it confirms the superiority of TES over TAE for the local excision of rectal neoplasms with improved local control achieved through the use of transanal endoscopic platforms [24].

Postoperative Complications

A major advantage of TES is the exceedingly low morbidity and mortality rates achieved relative to TME. Mortality across TEM, TEO and TAMIS series remains <1% with 30-day morbidity rates ranging 6–23% in the largest TEM/TEO series (N = 262 to 693 patients) relative to historical 30-day mortality and morbidity rates of 2–5% and 18–55% respectively for TME (Tables 22.1, 22.2, and 22.3). In additional, the majority of TES-related complications are relatively minor and transient and major complications are noted in 10% or less of cases [104, 108, 121–123].

The most common postoperative surgical complication following TES is hemorrhage, which is reported in 1 to 13% of patients, and is usually managed conservatively. The most common non-surgical complication is urinary retention, which occurs in 5–10% of patients [104, 111, 121, 124]. With regards to TAMIS, the published rate of perioperative complications range 0–25%, with bleeding and urinary retention being the most common complications as well [29, 104, 111, 121]. In a review of published TAMIS series between 2010 and 2013, a total of 29 complications were reported among 367 patients (7.9%) [47]. The incidence of bleeding and suture dehiscence was 2.7% and 0.5% respectively, and conversion to TAE, TEM or laparoscopic abdominal approach was required in 2.3%. There were no deaths reported following TAMIS, and the average length of hospital stay was 1.9 days.

Functional Outcomes

Several studies have demonstrated that patients without pre-existing anal sphincter dysfunction, can experience a transient decrease in resting anal and contractile pressures following TEM/TEO, with no impact on long term anorectal function. Multiple small TEM studies have documented a transient decrease in sphincter resting pressures on anal manometry

Table 22.2 Outcomes after TEM for T1 rectal cancer vs. TME

Author	TEM:TME (n)	Morbidity TEM:TME (n)	Mortality TEM:TME (n)	5 year LR TEM:TME (n)	5 year survival TEM:TME (%)
Heintz et al. [84]	58:45	2:8	0:2	6:1	75.5:78.1
Lee et al. [86]	74 (T1 52, T22): 100 (T1 17, T2 83)	4.1%:48%	TEM<TME	(T1 only) 2:0	(T1 only) 100:92.9
Ptok et al. [159]	120 (TAE 85, TEM 35):359	11:82	0:0	6:2	83.6:91.5
De Graaf et al. [122]	80:75	5:48	0:3	15:0	75:77
Palma et al. [158]	34:17	5:12	0:1	2:0	82.3:82.3

Table 22.3 NCCN guidelines for transanal excision of rectal cancer [68]

T1 lesion
Well to moderately differentiated adenocarcinoma
No lymphovascular invasion
No perineural invasion
Less than 3 cm in diameter
Occupying less than 1/3 circumference of the lumen
Mobile, non-fixed
Within 8 cm of the anal verge
Anticipated clear Margin (>3 mm)

that was proportional to the duration of the procedure, with resting pressures returning to baseline 12 months postoperatively [124–127]. Alterations in resting anal sphincter pressures did not translate into any detrimental effects on continence. In a study of 41 TEM cases, Cataldo et al. found no significant changes in the Fecal Incontinence Severity Index (FISI) or Fecal Incontinence Quality of Life (FIQL) scores 6 weeks postoperatively relative to preoperative scores [128]. A recent study that longitudinally assessed anorectal function and quality of life in 102 TEM patients preoperatively and at 6, 12, 26 and 52 weeks postoperatively, found that the general quality of life scores (EQ-5D) were significantly lower at 6 and 12 weeks, but returned to baseline at 26 weeks. Similar to prior studies, anorectal function as assessed by colorectal functional outcome (COREFO) was worse at 6 weeks postoperatively, but returned to baseline at 12 weeks postoperatively [129]. However, two TEM series reported persistent sphincter dysfunction following TEM in on long term assessment using either St. Mark's fecal incontinence score or Wexner and Kamm incontinence scores [130, 131]. Dafnis et al. reported a 37% rate of various degrees of fecal incontinence in 48 patients at a median follow-up of 22 months following TEM, and found a correlation with OR time [131]. Restivo et al. also reported a 28% incidence of variable degrees of fecal incontinence at a median follow-up of 40 months among a cohort of 89 patients who underwent TEM. Preoperative radiotherapy and perioperative complications were found to be independent risk factor for functional disturbances [130]. In a small prospective study conducted by Schiphorst et al., functional outcomes following TAMIS were assessed in 37 patients using FISI score preoperatively and at 3, 6, 9 and 12 months postoperatively [43]. Among 17 patients with decreased preoperative fecal continence at baseline, improved FISI scores were noted in 88%, while among 18 patients with normal continence at baseline, no change in FISI scores were found in 83%, suggesting preserved long-term anorectal function following TAMIS procedures.

Future Directions: Transanal TME (TATME)

One of the most exciting advances in transanal endoscopic surgery has been the evolution of transanal Natural Orifice Transluminal Endoscopic Surgery (NOTES). The transanal approach offers the possibility of "incisionless" colorectal resection, whereby rectal and/or colon dissection followed by specimen extraction is performed primarily through the anus. Transanal TME has evolved from the "open" transanal transabdominal approach (TATA). The addition of a transanal endoscopic surgery platform significantly expanded the proximal reach of the distal TME dissection. Low rectal tumors abutting the anorectal ring and that are eligible for sphincter-preserving LAR can be extraordinarily difficult to resect with negative distal and circumferential margins and intact mesorectal fascia, particularly in patients with visceral obesity. This is largely due to difficulties with effective tissue traction and counter-traction and optimal positioning of the linear stapler in the deep and narrow male pelvis. These difficulties that have not been entirely overcome by the use of a laparoscopy as reflected by CRM positivity rates persistently nearing 10% and conversion rates ranging 8–29% in the most recently large randomized trials of open vs. laparoscopic TME for rectal cancer [12–14].

As in TATA, transanal dissection in taTME is initiated by delineating the planned distal resection margin and placing a purse string suture to occlude the rectum 1cm below the tumor. When the tumor is near the dentate line, intersphincteric resection, either partial or complete, is carried out first, followed by full-thickness dissection of the rectum and mesorectum (Fig. 22.4). This "bottom-up" approach has several advantages over traditional abdominal procedures, particularly when used for mid-and low rectal tumors. In addition to improved tissue retraction and exposure relative to traditional anal retractors using during TATA, transanal platforms are equipped with HD and even 3D optics, which, in combination with CO_2 distention and effective

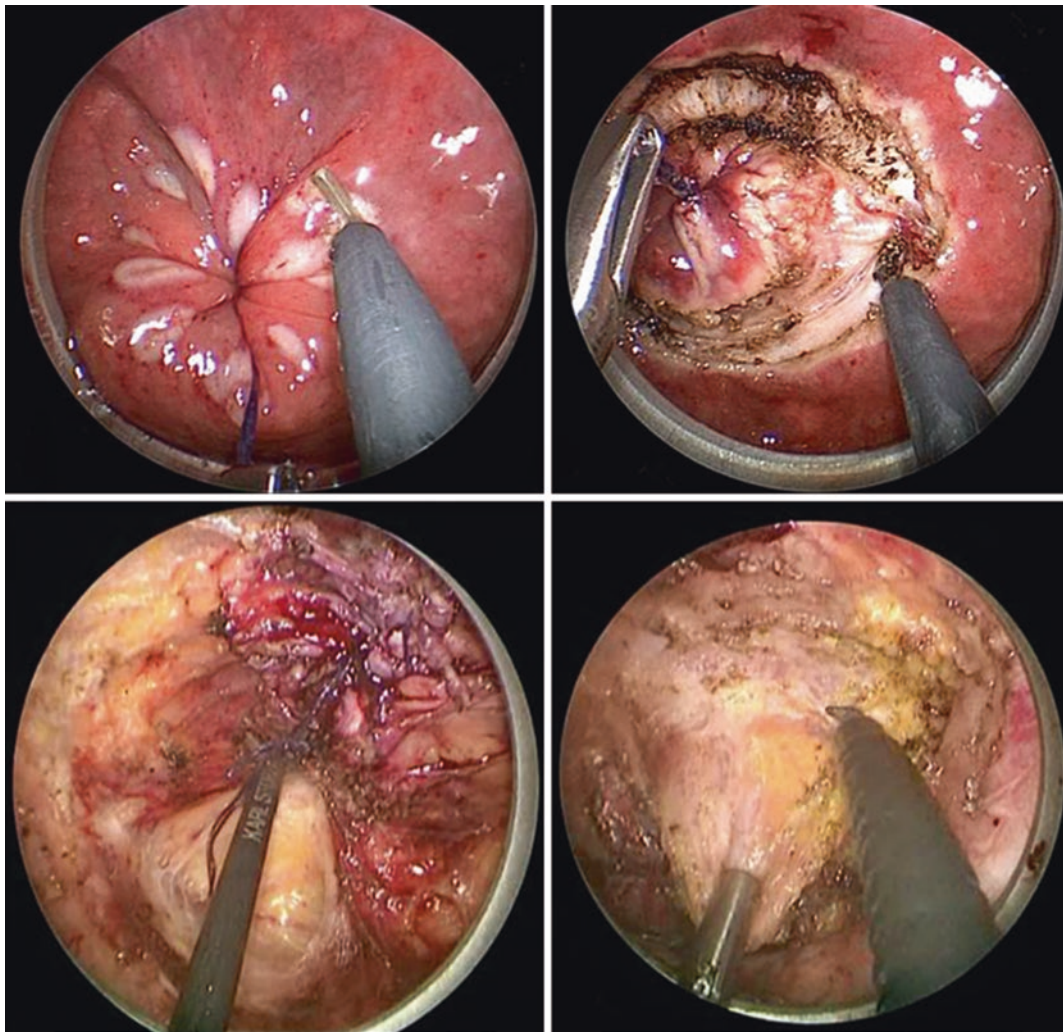


Fig. 22.4 Procedural steps of transanal TME. Following distention of the rectum with CO_2 through the TES platform, the rectum is occluded with a suture below the rectal tumor and the rectal mucosal is scored circumferentially with monopolar cautery (**a**). Full-thickness rectal dissection is carried out circumferentially (**b**) and extended cephalad. The mesorectum is dissected posteriorly along the plane between the mesorectal fascia and the endopelvic fascia (**c**). Anterior and lateral mobilization of the rectum is extended cephalad, making sure not to injure the posterior vaginal wall, prostate and pelvic sidewall nerves (**d**). Dissection is extended cephalad until the peritoneal reflection is reached and divided anteriorly (**e**). taTME specimen following completion of laparoscopic-assisted transanal TME dissection

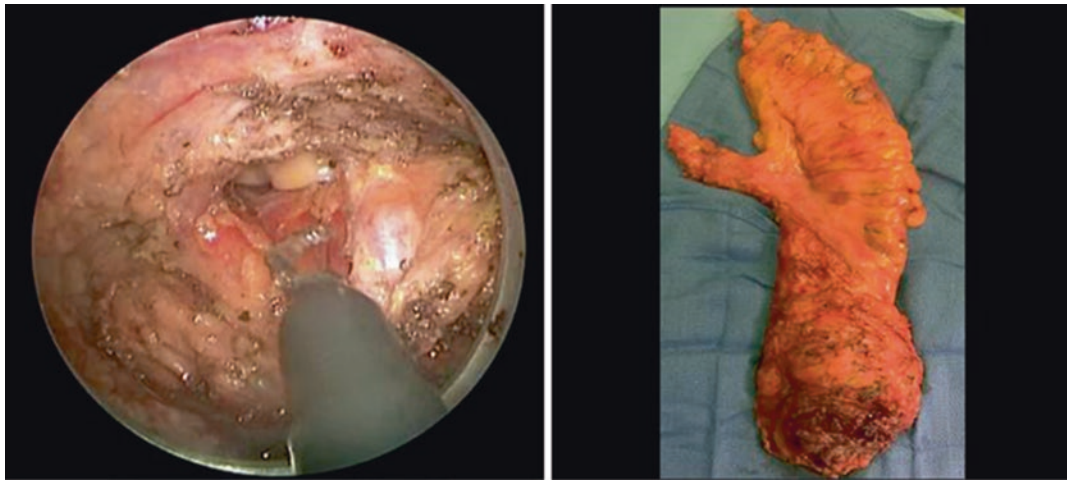


Fig. 22.4 (continued)

smoke evacuation, greatly enhance visualization of tissue planes. Multiple dissecting instruments can be inserted through the multiport platform and optimally positioned to carry out mesorectal dissection with significantly less encumbrance from anterior structures such as the bladder, or uterus, and unobstructed access to the rectoprostatic/rectovaginal plane, and lateral pelvic sidewalls. While taTME dissection can be performed prior to or following abdominal left colonic mobilization and vessel transection, it can also be performed with a 2-team approach, i.e. simultaneously with the abdominal procedure, with the advantage of combined input and guidance with dissection along the correct planes, and a potentially shorter operative time. Finally, when transanal specimen extraction is feasible, the abdominal extraction site can be eliminated, and standard coloanal or colorectal reconstruction can be carried out.

Since the first case report of laparoscopic-assisted transanal TME for rectal cancer in 2010, over 600 cases reports and series of pure and hybrid transanal TME with LAR or APR for benign and malignant indications have been published to date, with the largest series by Lacy et al. from 2015 which included 140 consecutive patients (Table 22.4) [43, 132–150] Although these clinical series include substantial variations in patient selection, surgical techniques, duration of follow-up and outcome measures, review of the cumulative results from the largest taTME series demonstrate favorable outcomes with respect to procedural safety and preliminary oncologic and functional outcomes in carefully selected patients (Table 22.4) [142–150]. Two recently published systematic reviews of 510 and 449 taTME cases by Similis et al. and Arunachalam et al. respectively, reported an overall morbidity of 34%, 30-day mortality rate <1%, mean OR time ranging 143–450 min, a 2.3% conversion rate to open surgery [151, 152]. Conversion was attributed to unfavourable rectal tumors, severe abdominal adhesions, difficulties related to visceral obesity, and organ injury. Intraoperative complications during transanal dissection include bleeding and organ injury namely three cases of urethral injuries, as well as rectal, bladder and ureteral injury. Anastomotic leak rates ranged 6.1–9.1% [143, 153] and reoperation was needed in 3.7–9.1% for pelvic abscess, anastomotic leaks, small bowel obstruction and ischemic conduit. The mean LOS ranged 4.3–16.6 days. With respect to oncologic outcomes, among the 510 cumulative taTME cases reported by Similis et al., the mesorectum was graded as complete or nearly complete in 88% and 6% respectively with a negative CRM in 95% and negative distal margins in 99.7%.

Table 22.4 Short-term outcomes for published taTME series with >30 patients

Author	Patients (n)	Abdominal approach	Platform	LAR:APR:P:IAPR:HAR	IntraOp complication rate (n)	Morbidity rate	Rate of +ve DM (n)	Rate of +ve CRM (n)	LR (n)	DR (n)	Follow up (months)
Rounet et al. [143]	30	LA	TEO	30:0:0:0	Urethral injury (2), air embolism (1)	30.0%	0	4	12 (not specified)	12 (not specified)	21
Tuech et al. [144]	56	LA (41), SILS (8), open (4), RA (1)	Endorec Trochar, SILS port, GelPoint path	52:4:0:0	0	26.0%	0	3	1	2	29
Lacy et al. [142]	140	LA	GelPoint	138:0:2:0	0	34.3%	NR	9	1	8	15
De'Angelis et al. [149]	32	LA, SILS	GelPoint	32:0:0:0	0	25.0%	2	1	1	1	36
Veltcamp Helbach et al. [145]	80	LA, SILS	SILS port, GelPoint path	65:15:0:0	Bleeding (2), perforation (3)	39.0%	0	2	2	0	<24
Serra-Aracil et al. [146]	32	LA	TEO	32:0:0:0	0	31.0%	0	0	NR	NR	1
Burke et al. [147]	50	Open (4), LA (14), HA (19), RA (10)	GelPoint	43:6:1:0	Urethral injury (1), ureteral injury (1), iliac vessel injury (1)	36.0%	1	2	2	8	15.1
Chen et al. [148]	50	LA, SILS	GelPoint	50:0:0:0	Presacral bleeding (2), vaginal injury (1)	20.0%	0	2	NR	NR	NR
Penna et al. [150]	720 (cancer: 634, benign: 86)	Open (21), LA (553), SILS (93), robotic (4), missing (49)	NR	(Cancer cases) 537:14:0:42:30	Urethral injury (5), bladder injury (2), vaginal perforation (1), unilateral resection of hypogastric nerves (1), rectal perforation anastomosis (2)	32.6%	2	14	NR	NR	1

LA laparoscopic assisted, *HA* hand assisted, *RA* robotic assisted, *TEO* transanal endoscopic operation, *SILS* single incision laparoscopic surgery port, *Gelpoint* GelPOINT path transanal access platform, *NR* not reported, *LAR* low anterior resection, *APR* abdominoperineal excision, *P* proctocolectomy, *IAPR* intersphincteric *APR, HAR* high anterior resection, *LR* local recurrence, *DR* distant recurrence

These published results were corroborated in the recently published first international taTME registry that included 720 taTME cases, 634 of which were performed for rectal cancers [150]. The majority of patients were male (68%) with a mean age of 62.4 years and BMI of 26.5 kg/m^2. The median tumor height from anorectal junction on MRI was 3 cm and 57% received neoadjuvant therapy. The overall morbidity and mortality rates at 30-days were 32.6% and 0.5% respectively which are similar to those reported in previous TME trials and other large taTME studies [12–14, 154]. Abdominal conversion was noted in 6.3%, 5 cases of urethral injuries were reported, and the anastomotic leak rate was 6.7%. With respect to oncologic outcomes, R0 resection was achieved in 97.3% and the mesorectum was graded as complete or near complete in 96% [150], which compares favourably with the 7–12.1% rate of positive CRM reported in the previous randomized trials of laparoscopic vs. open TME [12–14, 154].

Overall, while short-term oncologic results from taTME series compare favorably to historical laparoscopic and open TME outcomes, long-term oncologic outcomes remain scarce. In one series of 30 taTME performed for locally advanced low rectal tumors, at a median follow-up period up of 29 months (range, 18–52), Tuech et al. reported an OS of 96.4%, DFS of 94.2%, and local recurrence rate of 1.7% [144]. Likewise, data on functional results following taTME are limited with only 4 studies reporting Wexner scores 3–12 months post-taTME [143, 155–159].

While no prospective comparative study or randomized controlled trial of transanal vs. laparoscopic TME has yet been published, the cumulative published evidence thus far suggests that when performed by well-trained and experienced surgeons, and offered to appropriately selected patients, taTME with laparoscopic assistance is equivalent to laparoscopic TME and may become the procedure of choice for low rectal tumors in order to minimize the risk of conversion, incomplete TME and R1 resection. Currently, two prospective, randomized trials (Us taTME and COLOR III) comparing taTME to other minimally invasive approaches are ongoing (https://www.clinicaltrials.gov/ct2/show/NCT03144765?term=PATRICIA+SYLLA&rank=1 and https://www.clinicaltrials.gov/ct2/show/NCT02736942?term=COLOR+III&rank=1).

Proposed Training Pathways for TATME

TaTME is emerging as a useful technique to overcome many of the limitations of traditional TME from an abdominal approach. Early experience has revealed that a new skill set is required to gain an understanding of the novel anatomical landmarks from an inverted approach [160], the fundamental steps of the procedure, and the increased complexity of laparoscopic surgery in the most challenging of conditions with patients that are morbidly obese, male, have large prostates, and have irradiated, low rectal cancers. Add to this the more extensive nature of the full thickness and circumferential transanal dissection and significantly increased risk of technical misadventures during taTME which is considerably more difficult that typical TES excision of a rectal polyp. It is for these reasons and reports of complications in early case series [143] that international consensus panels have expressed patience and caution in adopting taTME into clinical practice through structured and supervised training [161]. McLemore proposed six prerequisite skills for the potential taTME surgeon to possess: (1) expertise in TME for rectal cancer, (2) expertise in minimally invasive TME from the abdominal approach, (3) expertise in transanal endoscopic surgery (TEM or TAMIS), (4) expertise in intersphincteric (transanal transabdominal/TATA) dissection for very low rectal invasive neoplasms, (5) practice in taTME techniques in human cadaver models, and (6) IRB approved data collection with publication of outcomes and/or participation in a clinical registry. European (http://www.lorec.nhs.uk or https://tatme.medicaldata.eu/) and United States (https://tatme.ostrichconsortium.org) registries are currently available.

Mirroring the design and success of laparoscopic colectomy training curricula [161–165], taTME workshops should include interactive didactics and video presentations, dry lab practice of endoluminal purse string suturing, and hands on male cadaver dissection [166, 167]. TaTME is in a state of dynamic knowledge growth and technical evolution. As such, training courses will need to adapt to incorporate new evidence, advances, and educational paradigms.

Summary

TES was originally developed as a minimally invasive alternative to proctectomy for benign and early malignant rectal tumors. Over the last 3 decades, by virtue of their superior optics and improved local control achieved, TES has progressively supplanted TAE as the preferred option in the treatment of rectal early rectal cancers, with acceptable oncological outcomes and a considerably improved safety relative to radical resection. Novel TAMIS platforms have recently enabled wider implementation and adoption of TES, and accelerated the trend towards application of TES for more complex colorectal pathologies. Although TES is only indicated for local excision of ERCs, there is growing evidence in support of TES as an adjunct in the non-operative organ-sparing strategy for advanced rectal cancers treated with chemoradiation. TES has recently enabled the newest development in minimally invasive surgery for rectal cancer, namely transanal TME. This approach offers the future prospect of an "incision-less" colorectal resection whereby rectal and mesorectal dissection followed by specimen extraction is achieved primarily through TES platforms. The cumulative evidence published to date indicates that in experienced hands and in appropriately selected patients, taTME with laparoscopic assistance is associated equivalent postoperative and short-term oncologic outcomes relative to laparoscopic TME. Based on exceedingly low published rates of conversion to open surgery and high rates of TME completion, taTME may soon upstage other surgical strategies and become the procedure of choice for low rectal tumors. Prospective randomized controlled trials are underway to better define perioperative, oncologic and functional outcomes of taTME relative to laparoscopic TME for low and mid rectal tumors.

References

1. Kraske P. Zur extirpation hochsitzenden mastdarmkrebs verhandl deutch gesellsch. Verh Otsch Gs Chir. 1885;14:464–74.
2. Onaitis M, Ludwig K, Perez-Tamayo A, Gottfried M, Russell L, Shadduck P, Pappas T, Seigler HF, Tyler DS. The Kraske procedure: a critical analysis of a surgical approach for mid-rectal lesions. J Surg Oncol. 2006;94(3):194–202.
3. Mason AY. Surgical access to the rectum--a transsphincteric exposure. Proc R Soc Med. 1970;63(Suppl):91–4.
4. Hadley DA, Southwick A, Middleton RG. York-Mason procedure for repair of recto-urinary fistulae: a 40-year experience. BJU Int. 2012;109(7):1095–8.
5. Toh JW, Morgan M. Management approach and surgical strategies for retrorectal tumours:a systematic review. Color Dis. 2016;18(4):337–50.
6. Localio SA, Eng K, Coppa GF. Abdominosacral resection for midrectal cancer. A fifteen-year experience. Ann Surg. 1983 Sep;198(3):320–4.
7. Localio SA, Baron B. Abdomino-transsacral resection and anastomosis for mid-rectal cancer. Ann Surg. 1973;178(4):540–6.
8. Heald RJ, Husband EM, Ryall RD. The mesorectum in rectal cancer surgery--the clue to pelvic recurrence? Br J Surg. 1982;69:613–6.
9. MacFarlane JK, Ryall RD, Heald RJ. Mesorectal excision for rectal cancer. Lancet. 1993;341:457–60.
10. Marijnen CAM, Kapiteijn E, van de Velde CJH, Martijn H, Steup WH, Wiggers T, et al. Acute side effects and complications after short-term preoperative radiotherapy combined with total mesorectal excision in primary rectal cancer: report of a multicenter randomized trial. J Clin Oncol. 2002;20:817–25.
11. Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AMH, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. Lancet. 2005;365:1718–26.
12. van der Pas MH, Haglind E, Cuesta MA, Fürst A, Lacy AM, Hop WC, et al. Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. Lancet Oncol. 2013;14:210–8.
13. Fleshman J, Branda M, Sargent DJ, Boller AM, George V, Abbas M, et al. Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the

ACOSOG Z6051 randomized clinical trial. JAMA. 2015;314:1346–55.
14. Stevenson ARL, Solomon MJ, Lumley JW, Hewett P, Clouston AD, Gebski VJ, et al. Effect of laparoscopic-assisted resection vs open resection on pathological outcomes in rectal cancer: the ALaCaRT randomized clinical trial. JAMA. 2015;314:1356–63.
15. Kang S-B, Park JW, Jeong S-Y, Nam BH, Choi HS, Kim D-W, et al. Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): short-term outcomes of an open-label randomised controlled trial. Lancet Oncol. 2010;11:637–45.
16. Kneist W, Junginger T. Residual urine volume after total mesorectal excision: an indicator of pelvic autonomic nerve preservation? Results of a case-control study. Color Dis. 2004;6:432–7.
17. Corman ML. Jacques Lisfranc 1790–1847. Dis Colon Rectum. 1983;26(10):694–5.
18. Snijders HS, Wouters MWJM, van Leersum NJ, Kolfschoten NE, Henneman D, de Vries AC, et al. Meta-analysis of the risk for anastomotic leakage, the postoperative mortality caused by leakage in relation to the overall postoperative mortality. Eur J Surg Oncol. 2012;38:1013–9.
19. Hendren SK, O'Connor BI, Liu M, Asano T, Cohen Z, Swallow CJ, et al. Prevalence of male and female sexual dysfunction is high following surgery for rectal cancer. Ann Surg. 2005;242:212–23.
20. Parks AG. A technique for excising extensive villous papillomatous change in the lower rectum. Proc R Soc Med. 1968;61(5):441–2.
21. Moore JS, Cataldo PA, Osler T, Hyman NH. Transanal endoscopic microsurgery is more effective than traditional transanal excision for resection of rectal masses. Dis Colon Rectum. 2008;51:1026–30. discussion 1030–1
22. de Graaf EJR, Burger JWA, van Ijsseldijk ALA, Tetteroo GWM, Dawson I, Hop WCJ. Transanal endoscopic microsurgery is superior to transanal excision of rectal adenomas. Color Dis. 2011;13:762–7.
23. Langer C, Liersch T, Markus P, Süss M, Ghadimi M, Füzesi L, et al. Transanal endoscopic microsurgery (TEM) for minimally invasive resection of rectal adenomas and "Low-risk" carcinomas (uT1, G1 - 2). Z Gastroenterol. 2002;40:67–72.
24. Clancy C, Burke JP, Albert MR, O'Connell PR, Winter DC. Transanal endoscopic microsurgery versus standard transanal excision for the removal of rectal neoplasms: a systematic review and meta-analysis. Dis Colon Rectum. 2015;58:254–61.
25. Strauss AA, Strauss SF, Crawford RA, Strauss HA. Surgical diathermy of carcinoma of the rectum: its clinical end results. JAMA. 1935;104:1480–4.
26. Hughes EP Jr, Veidenheimer MC, Corman ML, Coller JA. Electrocoagulation of rectal cancer. Dis Colon Rectum. 1982;25(3):215–8.
27. Eisenstat TE, Oliver GC. Electrocoagulation for adenocarcinoma of the low rectum. World J Surg. 1992;16(3):458–62.
28. Buess G, Theiss R, Hutterer F, Pichlmaier H, Pelz C, Holfeld T, et al. Transanal endoscopic surgery of the rectum - testing a new method in animal experiments. Leber Magen Darm. 1983;13:73–7.
29. Heidary B, Phang TP, Raval MJ, Brown CJ. Transanal endoscopic microsurgery: a review. Can J Surg. 2014;57:127–38.
30. Morino M, Arezzo A, Allaix ME. Transanal endoscopic microsurgery. Tech Coloproctol. 2013;17(Suppl 1):S55–61.
31. Arezzo A, Passera R, Saito Y, Sakamoto T, Kobayashi N, Sakamoto N, et al. Systematic review and meta-analysis of endoscopic submucosal dissection versus transanal endoscopic microsurgery for large noninvasive rectal lesions. Surg Endosc. 2014;28:427–38.
32. Sumrien H, Dadnam C, Hewitt J, McCarthy K. Feasibility of transanal minimally invasive surgery (TAMIS) for rectal tumours and its impact on quality of life: the Bristol Series. Anticancer Res. 2016;36:2005–9.
33. Verseveld M, Barendse RM, Gosselink MP, Verhoef C, de Graaf EJ, Doornebosch PG. Transanal minimally invasive surgery: impact on quality of life and functional outcome. Surg Endosc. 2016;30:1184–7.
34. Gill S, Stetler JL, Patel A, et al. Transanal minimally invasive surgery (TAMIS): standardizing a reproducible procedure. J Gastrointest Surg. 2015;19:1528–36.
35. Gorgun IE, Aytac E, Costedio MM, Erem HH, Valente MA, Stocchi L. Transanal endoscopic surgery using a single access port: a practical tool in the surgeon's toybox. Surg Endosc. 2014;28:1034–8.
36. Barendse RM, Doornebosch PG, Bemelman WA, Fockens P, Dekker E, de Graaf EJ. Transanal employment of single access ports is feasible for rectal surgery. Ann Surg. 2012;256:1030–3.
37. Ragupathi M, Vande Maele D, Nieto J, Pickron TB, Haas EM. Transanal endoscopic video-assisted (TEVA) excision. Surg Endosc. 2012;26:3528–35.
38. Hompes R, Ris F, Cunningham C, Mortensen NJ, Cahill RA. Transanal glove port is a safe and cost-effective alternative for transanal endoscopic microsurgery. Br J Surg. 2012;99:1429–35.
39. Lim SB, Seo SI, Lee JL, et al. Feasibility of transanal minimally invasive surgery for mid-rectal lesions. Surg Endosc. 2012;26:3127–32.
40. van den Boezem PB, Kruyt PM, Stommel MW, Tobon Morales R, Cuesta MA, Sietses C. Transanal single-port surgery for the resection of large polyps. Dig Surg. 2011;28:412–6.
41. Lorenz C, Nimmesgern T, Langwieler TE. Transanal endoscopic surgery using different single-port devices. Surg Technol Int. 2011;21:107–11.
42. Quaresima S, Balla A, Franceschilli L, et al. Transanal minimally invasive surgery for rectal lesions. JSLS. 2016;20(3):2016–00032.
43. Schiphorst AH, Langenhoff BS, Maring J, Pronk A, Zimmerman DD. Transanal minimally invasive surgery: initial experience and short-term functional results. Dis Colon Rectum. 2014;57:927–32.
44. Maglio R, Muzi GM, Massimo MM, Masoni L. Transanal minimally invasive surgery (TAMIS):

new treatment for early rectal cancer and large rectal polyps—experience of an Italian center. Am Surg. 2015;81:273–7.
45. Atallah S, Albert M, Larach S. Transanal minimally invasive surgery: a giant leap forward. Surg Endosc. 2010;24:2200–5.
46. McLemore EC, Weston LA, Coker AM, Jacobsen GR, Talamini MA, Horgan S, et al. Transanal minimally invasive surgery for benign and malignant rectal neoplasia. Am J Surg. 2014;208:372–81.
47. Martin-Perez B, Andrade-Ribeiro GD, Hunter L, Atallah S. A systematic review of transanal minimally invasive surgery (TAMIS) from 2010 to 2013. Tech Coloproctol. 2014;18:775–88.
48. Albert MR, Atallah SB, deBeche-Adams TC, Izfar S, Larach SW. Transanal minimally invasive surgery (TAMIS) for local excision of benign neoplasms and early-stage rectal cancer: efficacy and outcomes in the first 50 patients. Dis Colon Rectum. 2013;56:301–7.
49. Hahnloser D, Cantero R, Salgado G, Dindo D, Rega D, Delrio P. Transanal minimal invasive surgery for rectal lesions: should the defect be closed? Color Dis. 2015;17:397–402.
50. Lee T-G, Lee S-J. Transanal single-port microsurgery for rectal tumors: minimal invasive surgery under spinal anesthesia. Surg Endosc. 2014;28:271–80.
51. Serra-Aracil X, Mora-Lopez L, Alcantara-Moral M, Corredera-Cantarin C, Gomez-Diaz C, Navarro-Soto S. Atypical indications for transanal endoscopic microsurgery to avoid major surgery. Tech Coloproctol. 2014;18:157–64.
52. You YN. Local excision: is it an adequate substitute for radical resection in T1/T2 patients? Semin Radiat Oncol. 2011;21:178–84.
53. Mellgren A, Sirivongs P, Rothenberger DA, Madoff RD, García-Aguilar J. Is local excision adequate therapy for early rectal cancer? Dis Colon Rectum. 2000;43:1064–71.
54. Paty PB, Nash GM, Baron P, Zakowski M, Minsky BD, Blumberg D, et al. Long-term results of local excision for rectal cancer. Ann Surg. 2002;236:522–9.
55. Garcia-Aguilar J, Mellgren A, Sirivongs P, Buie D, Madoff RD, Rothenberger DA. Local excision of rectal cancer without adjuvant therapy. Ann Surg. 2000;231:345–51.
56. Borschitz T, Heintz A, Junginger T. The influence of histopathologic criteria on the long-term prognosis of locally excised pT1 rectal carcinomas: results of local excision (transanal endoscopic microsurgery) and immediate reoperation. Dis Colon Rectum. 2006;49:1492–506. discussion 1500–5
57. Doornebosch PG, Ferenschild FTJ, de Wilt JHW, Dawson I, Tetteroo GWM, de Graaf EJR. Treatment of recurrence after transanal endoscopic microsurgery (TEM) for T1 rectal cancer. Dis Colon Rectum. 2010;53:1234–9.
58. Mentges B, Buess G, Effinger G, Manncke K, Becker HD. Indications and results of local treatment of rectal cancer. Br J Surg. 1997;84:348–51.
59. Garcia-Aguilar J, Shi Q, Thomas CR, Chan E, Cataldo P, Marcet J, et al. A phase II trial of neoadjuvant chemoradiation and local excision for T2N0 rectal cancer: preliminary results of the ACOSOG Z6041 trial. Ann Surg Oncol. 2012;19:384–91.
60. Lezoche E, Baldarelli M, Lezoche G, Paganini AM, Gesuita R, Guerrieri M. Randomized clinical trial of endoluminal locoregional resection versus laparoscopic total mesorectal excision for T2 rectal cancer after neoadjuvant therapy. Br J Surg. 2012;99:1211–8.
61. Haggitt RC, Glotzbach RE, Soffer EE, Wruble LD. Prognostic factors in colorectal carcinomas arising in adenomas: implications for lesions removed by endoscopic polypectomy. Gastroenterology. 1985;89:328–36.
62. Tytherleigh MG, Warren BF, Mortensen NJM. Management of early rectal cancer. Br J Surg. 2008;95:409–23.
63. Kikuchi R, Takano M, Takagi K, Fujimoto N, Nozaki R, Fujiyoshi T, et al. Management of early invasive colorectal cancer. Risk of recurrence and clinical guidelines. Dis Colon Rectum. 1995;38:1286–95.
64. Nascimbeni R, Burgart LJ, Nivatvongs S, Larson DR. Risk of lymph node metastasis in T1 carcinoma of the colon and rectum. Dis Colon Rectum. 2002;45:200–6.
65. Suzuki A, Togashi K, Nokubi M, Koinuma K, Miyakura Y, Horie H, et al. Evaluation of venous invasion by Elastica van Gieson stain and tumor budding predicts local and distant metastases in patients with T1 stage colorectal cancer. Am J Surg Pathol. 2009;33:1601–7.
66. Heafner TA, Glasgow SC. A critical review of the role of local excision in the treatment of early (T1 and T2) rectal tumors. J Gastrointest Oncol. 2014;5:345–52.
67. Morino M, Allaix ME, Caldart M, Scozzari G, Arezzo A. Risk factors for recurrence after transanal endoscopic microsurgery for rectal malignant neoplasm. Surg Endosc. 2011;25:3683–90.
68. Chang HC, Huang SC, Chen JS, Tang R, Changchien CR, Chiang JM, et al. Risk factors for lymph node metastasis in pT1 and pT2 rectal cancer: a single-institute experience in 943 patients and literature review. Ann Surg Oncol. 2012;19:2477–84.
69. Saraste D, Gunnarsson U, Janson M. Predicting lymph node metastases in early rectal cancer. Eur J Cancer. 2013;49:1104–8.
70. Shinto E, Jass JR, Tsuda H, Sato T, Ueno H, Hase K, et al. Differential prognostic significance of morphologic invasive markers in colorectal cancer: tumor budding and cytoplasmic podia. Dis Colon Rectum. 2006;49:1422–30.
71. Syk E, Lenander C, Nilsson PJ, Rubio CA, Glimelius B. Tumour budding correlates with local recurrence of rectal cancer. Color Dis. 2011;13:255–62.
72. Ueno H, Mochizuki H, Hashiguchi Y, Shimazaki H, Aida S, Hase K, et al. Risk factors for an adverse outcome in early invasive colorectal carcinoma. Gastroenterology. 2004;127:385–94.

73. Mitrovic B, Schaeffer DF, Riddell RH, Kirsch R. Tumor budding in colorectal carcinoma: time to take notice. Mod Pathol. 2012;25:1315–25.
74. Doornebosch PG, Zeestraten E, de Graaf EJR, Hermsen P, Dawson I, Tollenaar RAEM, et al. Transanal endoscopic microsurgery for T1 rectal cancer: size matters! Surg Endosc. 2012;26:551–7.
75. Ashraf S, Hompes R, Slater A, Lindsey I, Bach S, Mortensen NJ, et al. A critical appraisal of endorectal ultrasound and transanal endoscopic microsurgery and decision-making in early rectal cancer. Color Dis. 2012;14:821–6.
76. Starck M, Bohe M, Simanaitis M, Valentin L. Rectal endosonography can distinguish benign rectal lesions from invasive early rectal cancers. Color Dis. 2003;5:246–50.
77. Bipat S, Glas AS, Slors FJM, Zwinderman AH, Bossuyt PMM, Stoker J. Rectal cancer: local staging and assessment of lymph node involvement with endoluminal US, CT, and MR imaging--a meta-analysis. Radiology. 2004;232:773–83.
78. Benson AB, Bekaii-Saab T, Chan E, Chen Y-J, Choti MA, Cooper HS, et al. Rectal cancer. J Natl Compr Cancer Netw. 2012;10:1528–64.
79. Nielsen LBJ, Wille-Jørgensen P. National and international guidelines for rectal cancer. Color Dis. 2014;16:854–65.
80. Park SU, Min YW, Shin JU, Choi JH, Kim Y-H, Kim JJ, et al. Endoscopic submucosal dissection or transanal endoscopic microsurgery for nonpolypoid rectal high grade dysplasia and submucosa-invading rectal cancer. Endoscopy. 2012;44:1031–6.
81. Kawaguti FS, Nahas CSR, Marques CFS, Martins B d C, Retes FA, Medeiros RSS, et al. Endoscopic submucosal dissection versus transanal endoscopic microsurgery for the treatment of early rectal cancer. Surg Endosc. 2014;28:1173–9.
82. Morino M, Risio M, Bach S, Beets-Tan R, Bujko K, Panis Y, et al. Early rectal cancer: the European Association for Endoscopic Surgery (EAES) clinical consensus conference. Surg Endosc. 2015;29:755–73.
83. Arolfo S, Allaix ME, Migliore M, Cravero F, Arezzo A, Morino M. Transanal endoscopic microsurgery after endoscopic resection of malignant rectal polyps: a useful technique for indication to radical treatment. Surg Endosc. 2014;28:1136–40.
84. Heintz A, Mörschel M, Junginger T. Comparison of results after transanal endoscopic microsurgery and radical resection for T1 carcinoma of the rectum. Surg Endosc. 1998;12:1145–8.
85. Elmessiry MM, Van Koughnett JA, Maya A, DaSilva G, Wexner SD, Bejarano P, et al. Local excision of T1 and T2 rectal cancer: proceed with caution. Color Dis. 2014;16:703–9.
86. Lee W, Lee D, Choi S, Chun H. Transanal endoscopic microsurgery and radical surgery for T1 and T2 rectal cancer. Surg Endosc. 2003;17:1283–7.
87. Garcia-Aguilar J, Renfro LA, Chow OS, Shi Q, Carrero XW, Lynn PB, et al. Organ preservation for clinical T2N0 distal rectal cancer using neoadjuvant chemoradiotherapy and local excision (ACOSOG Z6041): results of an open-label, single-arm, multi-institutional, phase 2 trial. Lancet Oncol. 2015;16:1537–46.
88. Verseveld M, de Graaf EJ, Verhoef C, van Meerten E, Punt CJ, de Hingh IH, CARTS Study Group, et al. Chemoradiation therapy for rectal cancer in the distal rectum followed by organ-sparing transanal endoscopic microsurgery (CARTS study). Br J Surg. 2015;102:853–60.
89. Allaix ME, Arezzo A, Giraudo G, Morino M. Transanal endoscopic microsurgery vs. laparoscopic total mesorectal excision for T2N0 rectal cancer. J Gastrointest Surg. 2012;16:2280–7.
90. Perez RO, Habr-Gama A, São Julião GP, Proscurshim I, Scanavini Neto A, Gama-Rodrigues J. Transanal endoscopic microsurgery for residual rectal cancer after neoadjuvant chemoradiation therapy is associated with significant immediate pain and hospital readmission rates. Dis Colon Rectum. 2011;54:545–51.
91. Marks JH, Valsdottir EB, DeNittis A, Yarandi SS, Newman DA, Nweze I, et al. Transanal endoscopic microsurgery for the treatment of rectal cancer: comparison of wound complication rates with and without neoadjuvant radiation therapy. Surg Endosc. 2009;23:1081–7.
92. Habr-Gama A, Sabbaga J, Gama-Rodrigues J, São Julião GP, Proscurshim I, Bailão Aguilar P, et al. Watch and wait approach following extended neoadjuvant chemoradiation for distal rectal cancer: are we getting closer to anal cancer management? Dis Colon Rectum. 2013;56:1109–17.
93. Maas M, Beets-Tan RGH, Lambregts DMJ, Lammering G, Nelemans PJ, Engelen SME, et al. Wait-and-see policy for clinical complete responders after chemoradiation for rectal cancer. J Clin Oncol. 2011;29:4633–40.
94. Dalton RSJ, Velineni R, Osborne ME, Thomas R, Harries S, Gee AS, et al. A single-centre experience of chemoradiotherapy for rectal cancer: is there potential for nonoperative management ? Color Dis. 2012;14:567–71.
95. Türler A, Schäfer H, Pichlmaier H. Role of transanal endoscopic microsurgery in the palliative treatment of rectal cancer. Scand J Gastroenterol. 1997;32:58–61.
96. Stipa F, Giaccaglia V, Burza A. Management and outcome of local recurrence following transanal endoscopic microsurgery for rectal cancer. Dis Colon Rectum. 2012;55:262–9.
97. Levic K, Bulut O, Hesselfeldt P, Bülow S. The outcome of rectal cancer after early salvage TME following TEM compared with primary TME: a case-matched study. Tech Coloproctol. 2013;17:397–403.
98. Morino M, Allaix ME, Arolfo S, Arezzo A. Previous transanal endoscopic microsurgery for rectal cancer represents a risk factor for an increased abdominoperineal resection rate. Surg Endosc. 2013;27:3315–21.
99. Hompes R, McDonald R, Buskens C, Lindsey I, Armitage N, Hill J, Scott A, Association of Coloproctology of Great Britain and Ireland Transanal Endoscopic Microsurgery Collaboration,

et al. Completion surgery following transanal endoscopic microsurgery: assessment of quality and short- and long-term outcome. Color Dis. 2013;15:e576–81.
100. Baron PL, Enker WE, Zakowski MF, Urmacher C. Immediate vs. salvage resection after local treatment for early rectal cancer. Dis Colon Rectum. 1995;38:177–81.
101. Weiser MR, Landmann RG, Wong WD, Shia J, Guillem JG, Temple LK, et al. Surgical salvage of recurrent rectal cancer after transanal excision. Dis Colon Rectum. 2005;48:1169–75.
102. Pucciarelli S, De Paoli A, Guerrieri M, La Torre G, Maretto I, De Marchi F, et al. Local excision after preoperative chemoradiotherapy for rectal cancer: results of a multicenter phase II clinical trial. Dis Colon Rectum. 2013;56:1349–56.
103. Guerrieri M, Gesuita R, Ghiselli R, Lezoche G, Budassi A, Baldarelli M. Treatment of rectal cancer by transanal endoscopic microsurgery: experience with 425 patients. World J Gastroenterol. 2014;20:9556–63.
104. Tsai BM, Finne CO, Nordenstam JF, Christoforidis D, Madoff RD, Mellgren A. Transanal endoscopic microsurgery resection of rectal tumors: outcomes and recommendations. Dis Colon Rectum. 2010;53:16–23.
105. Ramirez JM, Aguilella V, Valencia J, Ortego J, Gracia JA, Escudero P, et al. Transanal endoscopic microsurgery for rectal cancer. Long-term oncologic results. Int J Color Dis. 2011;26:437–43.
106. Guerrieri M, Baldarelli M, de Sanctis A, Campagnacci R, Rimini M, Lezoche E. Treatment of rectal adenomas by transanal endoscopic microsurgery: 15 years' experience. Surg Endosc. 2010;24:445–9.
107. Keller DS, Haas EM. Transanal minimally invasive surgery: state of the art. J Gastrointest Surg. 2016;20(2):463–9.
108. Lev-Chelouche D, Margel D, Goldman G, Rabau MJ. Transanal endoscopic microsurgery: experience with 75 rectal neoplasms. Dis Colon Rectum. 2000;43:662–7. discussion 667–8
109. Demartines N, von Flüe MO, Harder FH. Transanal endoscopic microsurgical excision of rectal tumors: indications and results. World J Surg. 2001;25:870–5.
110. Barendse RM, Dijkgraaf MG, Rolf UR, Bijnen AB, Consten ECJ, Hoff C, et al. Colorectal surgeons' learning curve of transanal endoscopic microsurgery. Surg Endosc. 2013;27:3591–602.
111. Allaix ME, Arezzo A, Caldart M, Festa F, Morino M. Transanal endoscopic microsurgery for rectal neoplasms: experience of 300 consecutive cases. Dis Colon Rectum. 2009;52:1831–6.
112. Gavagan JA1, Whiteford MH, Swanstrom LL. Full-thickness intraperitoneal excision by transanal endoscopic microsurgery does not increase short-term complications. Am J Surg. 2004;187:630–4.
113. Marks JH, Frenkel JL, Greenleaf CE, D'Andrea AP. Transanal endoscopic microsurgery with entrance into the peritoneal cavity: is it safe? Dis Colon Rectum. 2014;57:1176–82.
114. Ramwell A, Evans J, Bignell M, Mathias J, Simson J. The creation of a peritoneal defect in transanal endoscopic microsurgery does not increase complications. Color Dis. 2009;11:964–6.
115. Morino M, Allaix ME, Famiglietti F, Caldart M, Arezzo A. Does peritoneal perforation affect short- and long-term outcomes after transanal endoscopic microsurgery? Surg Endosc. 2013;27:181–8.
116. de Graaf EJR, Doornebosch PG, Tetteroo GWM, Geldof H, Hop WCJ. Transanal endoscopic microsurgery is feasible for adenomas throughout the entire rectum: a prospective study. Dis Colon Rectum. 2009;52:1107–13.
117. Baatrup G, Borschitz T, Cunningham C, Qvist N. Perforation into the peritoneal cavity during transanal endoscopic microsurgery for rectal cancer is not associated with major complications or oncological compromise. Surg Endosc. 2009;23:2680–3.
118. Molina G, Bordeianou L, Shellito P, Sylla P. Transanal endoscopic resection with peritoneal entry: a word of caution. Surg Endosc. 2015;30(5):1816–25.
119. Fuchs KH, Breithaupt W, Varga G, Schulz T, Reinisch A, Josipovic N. Transanal hybrid colon resection: from laparoscopy to NOTES. Surg Endosc. 2013;27:746–52.
120. Barker JA, Hill J. Incidence, treatment and outcome of rectal stenosis following transanal endoscopic microsurgery. Tech Coloproctol. 2011;15:281–4.
121. Kumar AS, Coralic J, Kelleher DC, Sidani S, Kolli K, Smith LE. Complications of transanal endoscopic microsurgery are rare and minor: a single institution's analysis and comparison to existing data. Dis Colon Rectum. 2013;56:295–300.
122. de Graaf EJR, Doornebosch PG, Tollenaar RAEM, Meershoek-Klein Kranenbarg E, de Boer AC, Bekkering FC, et al. Transanal endoscopic microsurgery versus total mesorectal excision of T1 rectal adenocarcinomas with curative intention. Eur J Surg Oncol. 2009;35:1280–5.
123. Bignell MB, Ramwell A, Evans JR, Dastur N, Simson JNL. Complications of transanal endoscopic microsurgery (TEMS): a prospective audit. Color Dis. 2010;12:e99–103.
124. Allaix ME, Rebecchi F, Giaccone C, Mistrangelo M, Morino M. Long-term functional results and quality of life after transanal endoscopic microsurgery. Br J Surg. 2011;98:1635–43.
125. Mora López M, Serra Aracil X, Hermoso Bosch J, Rebasa P, Navarro Soto S. Study of anorectal function after transanal endoscopic surgery. Int J Surg. 2015;13:142–7.
126. Kennedy ML, Lubowski DZ, King DW. Transanal endoscopic microsurgery excision: is anorectal function compromised? Dis Colon Rectum. 2002;45:601–4.
127. Bridoux V, Schwarz L, Suaud L, Dazza M, Michot F, Tuech J-J. Transanal minimal invasive surgery with

the Endorec(TM) trocar: a low cost but effective technique. Int J Color Dis. 2014;29:177–81.
128. Cataldo PA, O'Brien S, Osler T. Transanal endoscopic microsurgery: a prospective evaluation of functional results. Dis Colon Rectum. 2005;48:1366–71.
129. Hompes R, Ashraf SQ, Gosselink MP, van Dongen KW, Mortensen NJ, Lindsey I, et al. Evaluation of quality of life and function at 1 year after transanal endoscopic microsurgery. Color Dis. 2015;17:O54–61.
130. Restivo A, Zorcolo L, D'Alia G, Cocco F, Cossu A, Scintu F, et al. Risk of complications and long-term functional alterations after local excision of rectal tumors with transanal endoscopic microsurgery (TEM). Int J Color Dis. 2015;31(2):257–66.
131. Dafnis G, Påhlman L, Raab Y, Gustafsson UM, Graf W. Transanal endoscopic microsurgery: clinical and functional results. Color Dis. 2004;6:336–42.
132. Lee L, Mappin-Kasirer B, Sender Liberman A, et al. High incidence of symptomatic incisional hernia after midline extraction in laparoscopic colon resection. Surg Endosc. 2012;26(11):3180–5.
133. You YN, Baxter NN, Stewart A, Nelson H. Is the increasing rate of local excision for stage I rectal cancer in the United States justified? A nationwide ochort study from the nation cancer database. Ann Surg. 2007;245(5):726–33.
134. Samia H, Lawrence J, Nobel T, et al. Extraction site location and incisional hernias after laparoscopic colorectal surgery: should we be avoiding the midline? Am J Surg. 2013;205(3):264–7.
135. Guillou PJ, Quirke P, Thorpe H, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicenter, randomised controlled trial. Lancet. 2005;365(9472):1718–26.
136. Habr-Gama A, Perez RO, Nadalin W, et al. Operative versus nonoperative treatment for stage 0 distal rectal cancer following chemoradiation therapy: long-term results. Ann Surg. 2004;240(4):711–7. discussion 717-8
137. Masaki T, Matsuoka H, Sugiyama M, et al. Budding as a useful determinant of the optimal treatment for T1 rectal carcinomas. Hepato-Gastroenterology. 2003;50(50):388–91.
138. Guerriert M, Baldarelli M, Morino M, et al. Transanal endoscopic microsurgery in rectal adenomas: experience of six Italian centres. Dig Liver Dis. 2006;38(3):202–7.
139. Martin S, Heneghan H, Winter D. Systematic review of outcomes after intersphincteric resection for low rectal cancer. Br J Surg. 2012;99(5):603–12.
140. Lee GC, Sylla P. Shifting paradigms in minimally invasive surgery: applications of transanal natural orifice transluminal endoscopic surgery in colorectal surgery. Clin Colon Rectal Surg. 2015;28:181–93.
141. Sylla P, Rattner DW, Delgado S, Lacy AM. NOTES transanal rectal cancer resection using transanal endoscopic microsurgery and laparoscopic assistance. Surg Endosc. 2010;24:1205–10.
142. Lacy AM, Tasende MM, Delgado S, Fernandez-Hevia M, Jimenez M, De Lacy B, et al. Transanal total mesorectal excision for rectal cancer: outcomes after 140 patients. J Am Coll Surg. 2015;221:415–23.
143. Rouanet P, Mourregot A, Azar CC, Carrere S, Gutowski M, Quenet F, et al. Transanal endoscopic proctectomy: an innovative procedure for difficult resection of rectal tumors in men with narrow pelvis. Dis Colon Rectum. 2013;56:408–15.
144. Tuech JJ, Karoui M, Lelong B, De Chaisemartin C, Bridoux V, Manceau G, et al. A step toward NOTES total mesorectal excision for rectal cancer: endoscopic transanal proctectomy. Ann Surg. 2015;261:228–33.
145. Veltcamp Helbach M, Deijen CL, Velthuis S, Bonjer HJ, Tuynman JB, et al. Transanal total mesorectal excision for rectal carcinoma: short-term outcomes and experience after 80 cases. Surg Endosc. 2015;30(2):464–70.
146. Serra-Aracil X, Mora-López L, Casalots A, Pericay C, Guerrero R, Navarro-Soto S. Hybrid NOTES: TEO for transanal total mesorectal excision: intracorporeal resection and anastomosis. Surg Endosc. 2016;30:346–54.
147. Burke JP, Martin-Perez B, Khan A, Nassif G, deBeche-Adams T, Larach SW, et al. Transanal total mesorectal excision for rectal cancer: early outcomes in 50 consecutive patients. Color Dis. 2016;18(6):570–7.
148. Chen CC, Lai YL, Jiang JK, et al. Transanal total mesorectal excision versus laparoscopic surgery for rectal cancer receiving neoadjuvant chemoradiation: a matched case-control study. Ann Surg Oncol. 2016;23:1169–76.
149. De'Angelis N, Portigliotti L, et al. Transanal total mesorectal excision for rectal cancer: a single center experience and systematic review of the literature. Langenbeck's Arch Surg. 2015;400:945–59.
150. Penna M, Hompes R, Arnold S, Wynn G, Austin R, Warusavitarne J, Tekkis PP. Transanal total mesorectal excision: international registry results of the first 720 cases. Ann Surg. 2016;266:111–7.
151. Simillis C, Hompes R, Penna M, Rasheed S, Tekkis PP. A systematic review of transanal total mesorectal excision: is this the future of rectal cancer surgery? Color Dis. 2016;18(1):19–36.
152. Arunachalam L, O'Grady H, Hunter IA, Killeen S. A systematic review of outcomes after transanal mesorectal resection for rectal cancer. Dis Colon Rectum. 2016;59:340–50.
153. Schirnhofer J, Brunner E, Mittermair C, et al. Technical issues in transanal minimal invasive surgery: total mesorectal excision (TAMIS-TME). Eur Surg. 2014;46:S58.
154. Green BL, Marshall HC, Collinson F, et al. Long-term follow-up of the Medical Research Council CLASICC trial of conventional versus laparoscopically assisted resection in colorectal cancer. Br J Surg. 2013;100:75–82.

155. Dumont F, Goere D, Honore C, Elias D. Transanal endoscopic total mesorectal excision combined with single-port laparoscopy. Dis Colon Rectum. 2012;55:996–1001.
156. Gómez Ruiz M, Parra IM, Palazuelos CM, Martín JA, Fernández CC, Diego JC, Fleitas MG. Robotic-assisted laparoscopic transanal total mesorectal excision for rectal cancer: a prospective pilot study. Dis Colon Rectum. 2015;58:145–53.
157. Elmore U, Fumagalli Romario U, Vignali A, Sosa MF, Angiolini MR, Rosati R. Laparoscopic anterior resection with transanal total mesorectal excision for rectal cancer: preliminary experience and impact on postoperative bowel function. J Laparoendosc Adv Surg Tech A. 2015;2:364–9.
158. Palma P, Horisberger K, Joos A, et al. Local excision of early rectal cancer: is transanal endoscopic microsurgery an alternative to radical surgery? Rev Esp Enferm Dig. 2009;101:172–8.
159. Ptok H, Marusch F, Meyer F, et al. Oncological outcome of local vs radical resection of low-risk pT1 rectal cancer. Arch Surg. 2007;142:649–55. discussion 656
160. Atallah S, Albert M, Monson JRT. Clinical concepts and important anatomical landmarks encountered during transanal total mesorectal excision (taTME): toward the mastery of a new operation for rectal cancer surgery. Tech Coloproctol. 2016;20(7):483–94.
161. Fleshman J, Marcello P, Stamos MJ, Wexner SD. Focus group on laparoscopic colectomy education as endorsed by The American Society of Colon and Rectal Surgeons (ASCRS) and The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). Dis Colon Rectum. 2006;49(7):945–9.
162. Foster JD, Gash KJ, Carter FJ, et al. Development and evaluation of a cadaveric training curriculum for low rectal cancer surgery in the English LOREC National Development Programme. Color Dis. 2014;16(9):O308–19.
163. McLemore EC, Harnsberger CR, Broderick RC. Transanal total mesorectal excision (taTME) for rectal cancer: a training pathway. Surg Endosc. 2015;30:4130–5.
164. Motson W, Whiteford MH, Hompes R, Albert M, Miles WFA on behalf of the Expert Group. Current status of trans-anal total mesorectal excision (TaTME) following the Second International Consensus Conference. Color Dis. 2015;18:13–8.
165. Penna M, Hompes R, Mackenzie H, Carter F, Francis NK. First international training and assessment consensus workshop on transanal total mesorectal excision (taTME). Tech Coloproctol. 2016;20(6):343–52.
166. Penna M, Whiteford M, Hompes R, Sylla P. Developing and assessing a cadaveric training model for transanal total mesorectal excision: initial experience in the UK and USA. Color Dis. 2016;19(5):476–84.
167. Sylla P, Bordeianou LG, Berger D, et al. A pilot study of natural orifice transanal endoscopic total mesorectal excision with laparoscopic assistance for rectal cancer. Surg Endosc. 2013;27:3396–405.

Rectal Cancer: Operative Treatment Transabdominal

23

Jose G. Guillem and Julio Garcia-Aguilar

Overview

Anatomically, the rectum extends from the point at which the three taenia coli fuse into a single longitudinal smooth muscle layer (rectosigmoid junction) to the top of the anal canal. However, from an oncologic perspective, it corresponds to the distal 12 cm of the large bowel measured from the anal verge. According to this definition, most of the rectum is located below the anterior peritoneal reflection. Cancers that occur proximal to this level in the average patient behave more like colon cancers and are treated accordingly.

This chapter reviews the preoperative evaluation and clinical staging of patients with rectal cancer and management options based on stage of disease, highlighting a multi-disciplinary approach, careful preoperative planning, sequential multimodal therapy, and transabdominal approaches.

J. G. Guillem (✉) · J. Garcia-Aguilar
Department of Surgery, Memorial Sloan Kettering Cancer Center, New York, NY, USA
e-mail: guillemj@mskcc.org

Preoperative Evaluation

History, Physical Examination, and Laboratory Studies

A complete history and physical examination by the surgeon are essential components of the initial evaluation of patients with rectal cancer. The history should document changes in bowel habits, incontinence of stool or flatus, previous colonoscopies, and a detailed family history to assess for the possibility of a hereditary or familial syndrome. In addition, when an ostomy is a consideration, preoperative counseling with an enterostomal therapist should be offered.

A complete physical examination of patients with rectal cancer includes a digital rectal examination (DRE) and proctosigmoidoscopy. The DRE enables assessment of size, degree of fixation, and location of disease relative to the upper part of the anorectal ring. It also allows for evaluation of the sphincter tone both at rest and with squeeze. Proctosigmoidoscopy allows delineation of tumor orientation (anterior, lateral, or posterior), circumferential involvement (evaluated as a percentage of the entire bowel wall circumference), and extent of proximal involvement. A full colonoscopy should also be performed if possible, because at least 5% of patients with rectal cancer have synchronous lesions that may alter treatment plans. If a full colonoscopy is not

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_23

possible, then a double-contrast barium enema or CT colonography may be used as an alternative. In addition to conducting basic laboratory blood tests, obtaining a baseline carcinoembryonic antigen (CEA) level is also recommended, mainly for postoperative surveillance purposes. Histologic confirmation of the diagnosis of an invasive adenocarcinoma should be obtained whenever possible, especially if neoadjuvant therapy is being considered.

Preoperative Imaging Studies

Accurate pretreatment imaging is needed to (1) delineate the depth of tumor penetration through the rectal wall, (2) assess whether locoregional lymph nodes (LN) are involved, and (3) determine the presence of distant metastatic disease. The most commonly used imaging studies for the assessment of rectal cancer are endorectal ultrasound (ERUS), magnetic resonance imaging (MRI), computed tomography (CT), and positron emission tomography (PET).

Both ERUS and pelvic MRI can provide important preoperative locoregional staging information. Pelvic MRI with high-resolution T2-weighted images including a narrow field of view (FOV) of the rectum provides the best evaluation of the rectal wall and perirectal fat, and is considered the best modality for distinguishing T2 from T3 tumors (Fig. 23.1). On T2-weighted images, three easily discernible layers of the rectal wall produce a characteristic alternating signal intensity pattern: an inner hyperintense layer represents the mucosa and submucosa, a hypointense middle layer represents the muscularis propria, and a hyperintense outer layer represents the perirectal fat. Distinguishing a T1 tumor (invasion through the muscularis mucosa into the submucosa) from a T2 (through the submucosa into the muscularis propria) can be difficult on MRI, because it is often difficult to discern the transition from the submucosa to the muscularis. However, distinguishing a T3 tumor (invasion into perirectal fat) from T4 (invasion into adjacent structures) can be done with a high degree of accuracy (Fig. 23.2).

MRI also provides accurate information on the relationship of the tumor to the mesorectal fascia, which is crucial in predicting the likelihood of achieving a negative circumferential resection margin (CRM) and carries significant prognostic value. A recent meta-analysis of 21 studies evaluating the accuracy of preoperative MRI in rectal cancer reported a 77% sensitivity and 94% specificity in identifying invasion of the mesorectal fascia, and a 77% sensitivity and 71% specificity in identifying lymph node involvement [1]. MRI also provides useful information

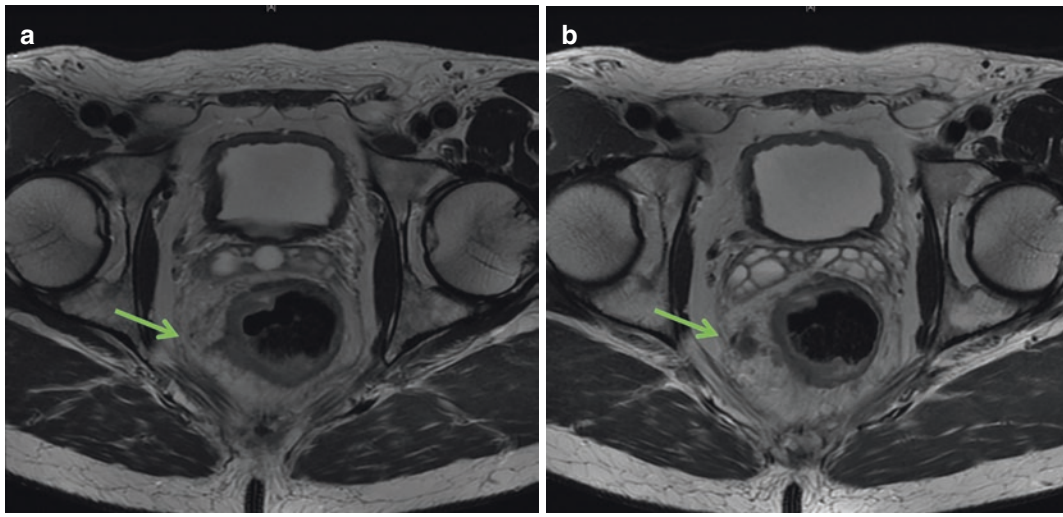


Fig. 23.1 Axial views of an MRI of the rectum with a rectal tumor penetrating into the perirectal fat (**a**) and involving the mesorectal nodes (**b**)

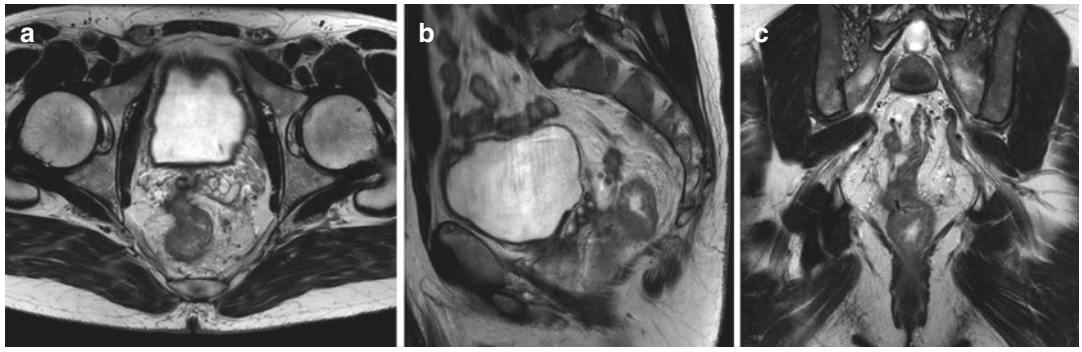


Fig. 23.2 Axial (**a**), sagittal (**b**), and coronal (**c**) views of an MRI of a locally advanced rectal cancer infiltrating the right seminal vesicle

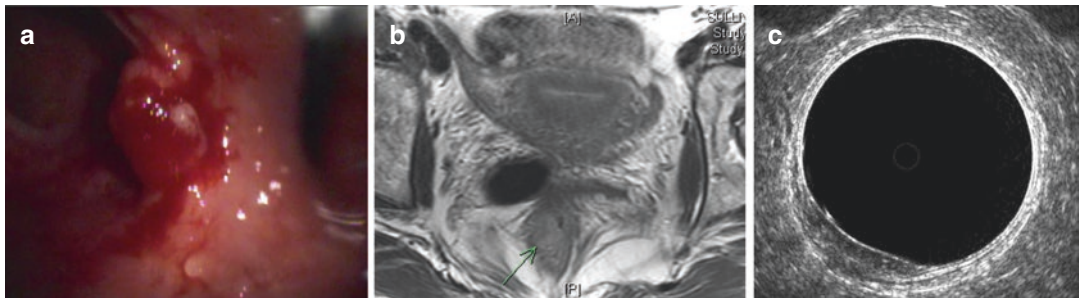


Fig. 23.3 Endoscopic (**a**), MRI (**b**) and ERUS (**c**) images of an early-stage rectal cancer

about overall pelvic anatomy and the relationship of the tumor to adjacent pelvic organs, which can assist with preoperative planning [2].

ERUS is an office-based procedure that can be used to assess the depth of bowel wall penetration (T stage) and LN involvement (N stage). Its overall accuracy in assessing T-stage and N-stage is comparable to that of MRI. The main advantage of ERUS over MRI is its ability to distinguish T0, T1, and T2 tumors, which may be particularly helpful when considering local versus radical resection (Fig. 23.3). However, MRI is superior to ERUS at evaluating the mesorectal fascia and pelvic lymph nodes that are remote from the rectum. CT of the abdomen and pelvis are used mainly in primary rectal cancer to assess for intra-abdominal metastasis and to evaluate other tumor-related features such as perforation and obstruction. CT may also provide information regarding adjacent organ involvement in advanced cases, but it is less accurate than either MRI or ERUS for T- and N-staging.

PET, or PET-CT, is often used as part of the initial staging of many cancers, but data are mixed regarding its utility in primary rectal cancer. PET has not been shown to offer an advantage over MRI or ERUS with regard to locoregional staging. However, PET and PET-CT may increase detection of distant metastases and may help to characterize lesions found on CT or MRI examination that are suspected to be distant metastases. A study of 93 patients with locally advanced rectal cancer reported an overall accuracy, sensitivity, and specificity of PET in detecting distant disease of 94%, 78%, and 99%, respectively [3]. However, some investigators have argued that although additional or discordant findings identified on PET or PET-CT may affect medical management, such findings are unlikely to alter surgical management, and they have not been shown to improve outcomes. Therefore, routine use of PET or PET-CT in the preoperative setting is not universally recommended.

The ultimate goal of the preoperative evaluation is to accurately stage the patient's dis-

ease in a timely and cost-effective manner. During the initial assessment of primary disease, our practice is to perform locoregional staging and assess resectability with a rectal MRI, as well as obtaining an intravenous contrast-enhanced CT of the chest, abdomen, and pelvis to assess for intra-abdominal and lung metastasis. These studies are consistent with the standards of the new American College of Surgeons Commission on Cancer National Accreditation Program for Rectal Cancer (ACS CoC NAPRC). https://www.facs.org/~/media/files/quality%20programs/cancer/naprc/naprc%20standards%20manual.ashx. We selectively obtain PET-CT scans when it is necessary to further characterize indeterminate distant lesions found on CT, although modern high-quality CT scans read by a team of radiologists who are adept at performing oncologic assessments has enabled us to confidently characterize most lesions without needing a PET-CT in the majority of cases.

Staging

Following the diagnosis of rectal cancer, the patient is clinically staged by integrating the history, physical examination, proctosigmoidoscopy findings, and the results of preoperative imaging studies. The clinical stage is then used to select the most appropriate treatment strategy for each patient. Although the imaging modalities described above form the current standard of care, there are clear limitations to these studies, and the implications of either clinically understaging or overstaging disease must be recognized.

Definite pathologic staging is carried out after surgical resection. Currently, the American Joint Committee on Cancer Tumor, Lymph Node, and Metastases classification (AJCC TNM) is the preferred system for the staging of rectal cancer. The most recent version of the AJCC TNM staging system further subdivides stages II, III, and IV disease to more accurately reflect prognosis within these groups (Table 23.1). One notable addition to the 2010 version of the AJCC staging system is the recognition of satellite tumor deposits within the subserosa, mesentery, or nonperitonealized pericolic or perirectal tissues that do not involve regional lymph nodes. These lesions are now given the designation N1c, but their impact on prognosis remains unclear.

The AJCC recommends the histologic examination of at least 12 lymph nodes to adequately assess nodal status and accurately stage patients. However, the increased use of neoadjuvant chemotherapy and/or chemoradiation has prompted a growing awareness that neoadjuvant treatment may reduce the number of identifiable lymph nodes in the surgical specimen following TME. Therefore, histologic examination of fewer than 12 lymph nodes may be considered adequate in this setting.

Management Based on Clinical Stage

The complexity of multimodal treatment algorithms for rectal cancer has increased in recent years, and it is now recommended that most rectal cancer cases be reviewed by a multidisciplinary team after the patient's initial presentation, so that to an individualized treatment plan can be developed. A proposed algorithm for the treatment of patients with rectal cancer is presented in Fig. 23.4.

But even with the advances made in combined modality therapy, surgery remains the cornerstone of curative treatment for rectal cancer. Early rectal cancers (stage I) can be definitively treated by surgery alone; however, patients with more advanced rectal cancers (stages II and III) are typically treated with neoadjuvant therapy (chemotherapy and/or chemoradiation) prior to surgery to decrease the risk of recurrence and optimize oncologic outcomes.

Surgical approaches depend largely on the location and extent of disease, although the patient's clinical factors, such as comorbid medical conditions and baseline anorectal function, are also considered. The most commonly used transabdominal surgical approaches for rectal cancers involve en bloc resection of the rectum, along with the blood vessels and lymphatics that lay within the mesorectum. Radical resections can be further subdivided into sphincter-preserving

Table 23.1 AJCC TNM definitions and staging of rectal cancer (7th Edition, 2010)

Primary tumor (T)			
Tx	Primary tumor cannot be assessed		
T0	No evidence of primary tumor		
Tis	Carcinoma in situ: intraepithelial or invasion of lamina propria		
T1	Tumor invades submucosa		
T2	Tumor invades muscularis propria		
T3	Tumor invades through the muscularis propria into pericolorectal tissue		
T4a	Tumor penetrates to the surface of the visceral peritoneum		
T4b	Tumor directly invades or is adherent to other organs or structures		
Regional lymph nodes (N)			
Nx	Regional lymph nodes cannot be assessed		
N0	No regional lymph node metastasis		
N1	Metastasis in 1–3 regional lymph nodes		
N1A	Metastasis in one regional lymph node		
N1b	Metastasis in 2–3 regional lymph nodes		
N1c	Tumor deposit(s) in the subserosa, mesentery, or nonperitonealized pericolic or perirectal tissues without regional nodal metastasis		
N2	Metastasis in four or more regional lymph nodes		
N2a	Metastasis in 4–6 regional lymph nodes		
N2b	Metastasis ≥7 regional lymph nodes		
Distant metastasis (M)			
M0	No distant metastasis		
M1	Distant metastasis		
M1a	Metastasis confined to one organ or site		
M1b	Metastases in >1 organ/site or the peritoneum		
Stage	T	N	M
0	Tis	N0	M0
I	T1–T2	N0	M0
IIA	T3	N0	M0
IIB	T4a	N0	M0
IIC	T4b	N0	M0
IIIA	T1–T2	N1/N1c	M0
	T1	N2a	M0
IIIB	T3–T4a	N1/N1c	M0
	T2–T3	N2a	M0
	T1–T2	N2b	M0
IIIC	T4a	N2a	M0
	T3–T4a	N2b	M0
	T4b	N1-N2	M0
IVA	Any T	Any N	M1a
IVB	Any T	Any N	M1b

procedures, and procedures in which the sphincters cannot be salvaged without compromising a negative resection margin, resulting in a permanent end colostomy. The goals of surgical resection with curative intent are complete resection of the primary tumor with adequate margins, an anatomically complete lymphadenectomy of draining lymph nodes, and en bloc resection of contiguously involved structures.

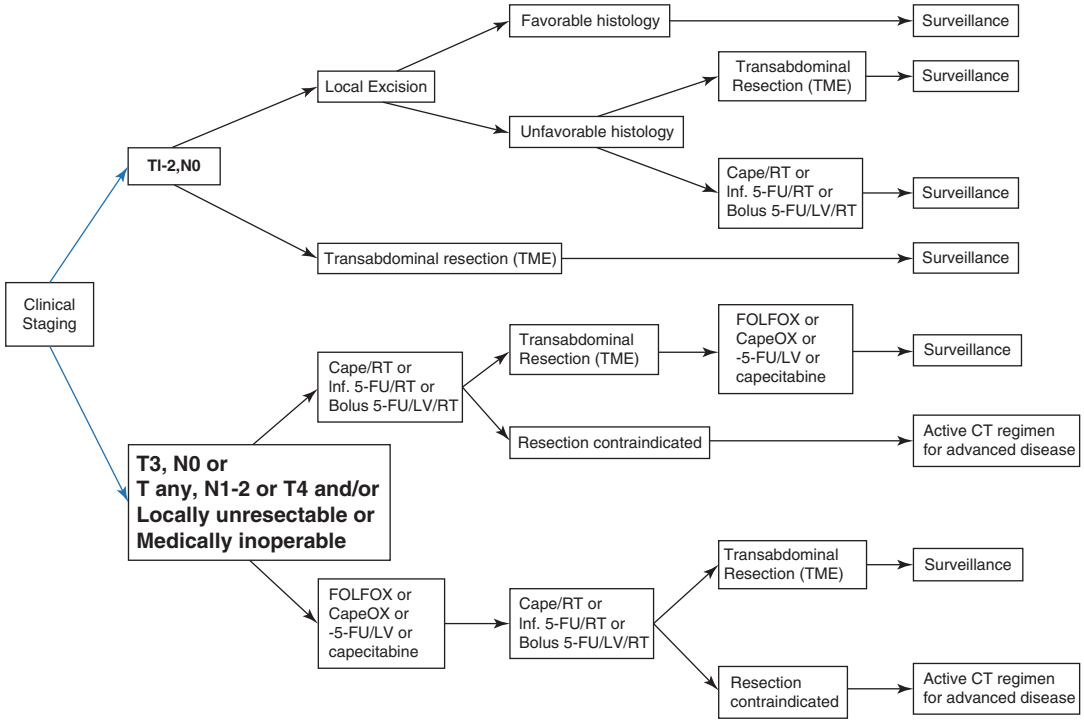


Fig. 23.4 Treatment algorithm for nonmetastatic rectal cancer

T2N0 Rectal Cancer

Although a local procedure that does not include resection of the mesorectum and draining lymph channels, such as a transanal excision (TAE), transanal endoscopic microsurgery (TEM), or transanal minimally invasive surgery (TAMIS), may be performed for a T2N0 rectal cancer, the failure rate for these procedures is likely to be greater than that for a properly performed total mesorectal excision (TME)-based resection. Therefore, most T2N0 rectal cancers are managed with an upfront transabdominal TME-based resection. Details of these approaches are provided below.

Locally Advanced Rectal Cancer

In patients with transmural and/or node-positive disease (T3-4/Nx or Tx/N1-2) without evidence of distant metastases, multimodality therapy involving a combination of TME, chemoradiation therapy (CRT), and chemotherapy is indicated. Until recently, the standard treatment regimen involved neoadjuvant CRT, then TME with either a low-anterior resection or abdominoperineal resection, followed by adjuvant chemotherapy. However, the optimal sequence and timing of these modalities continues to evolve and may vary by institution. Major studies leading to the evolution of neoadjuvant therapy options for rectal cancer are discussed below.

Neoadjuvant and Adjuvant Therapies

The Swedish Rectal Cancer Trial was the first randomized trial to assess whether administering preoperative RT (5 Gy/day × 5 days) within 1 week of surgery improved outcomes. The preoperative RT group had decreased local recurrence at five years (11% vs. 27%, $p < 0.01$), increased five-year overall survival (58% vs. 48%, $p = 0.004$), and increased nine-year cancer-specific survival (74% v. 65%, $p = 0.002$) [4]. This study was followed by the Dutch Colorectal Cancer Group trial, which also assessed whether adding preoperative RT (5 × 5 Gy) to TME surgery improved oncologic outcomes in patients with locally advanced rectal cancers [5].

On long-term follow-up, RT was found to improve five-year local recurrence rates (5.6% for the RT plus TME group vs. 10.9% for the TME-alone group), but no difference in overall survival was found. This study established a benefit for preoperative RT, even when optimal surgical resection with TME is performed.

The German Rectal Cancer Group compared preoperative with postoperative CRT (long-course RT with concurrent chemotherapy) for patients with stage II or III disease [6]. Preoperative CRT was found to be associated with fewer acute and chronic toxicities and an improved five-year local recurrence rate (6% vs. 13% for the preoperative and postoperative groups, respectively). Long-term follow-up data showed that, at 10 years, there was still a significant improvement in local control but no effect on overall survival. The benefits of preoperative long-course RT with concurrent chemotherapy for local control have been corroborated by others. In a report of 297 consecutive patients with T3-4 and/or N1 rectal cancer who were treated at Memorial Sloan Kettering Cancer Center (MSK) with standardized neoadjuvant CRT regimens followed by a TME-based resection, the recurrence rate was found to be 23% (2% local recurrence only, 19% distant recurrence, and 2% local and distant recurrence) after a median follow-up of 44 months, with an estimated 10-year recurrence-free survival of 62% and a 10-year overall survival of 58% [7].

There are two options for administering preoperative therapy for locally advanced rectal cancers: either short-course radiation therapy (5 Gy/day × 5 days) followed by surgery within 1 week, or long-course chemoradiation (1.8–2.0 Gy/day over 5–6 weeks to a total dose of 45–50 Gy, along with 5-fluorouracil-based intravenous or oral capecitabine chemotherapy) followed by surgery 8–12 weeks later. Multiple studies comparing short-course and long-course regimens have shown that both reduce local recurrence rates by more than half, but benefits for overall survival are less clear. Short-course radiotherapy remains popular in many European centers, but long-course chemoradiation has become the preferred treatment regimen within the United States, largely due to perceived increased local toxicity of the more concentrated doses of radiation administered with short-course therapy, as well as the increased pathologic response rates noted with long-course chemoradiation over short-course radiation therapy [8, 9].

Ongoing Debates in Neoadjuvant Therapy for Rectal Cancer

Following preoperative long-course RT and concurrent chemotherapy and a TME-based resection, current guidelines recommend further adjuvant chemotherapy for all patients with stage III disease, as well as considering it for patients with high-risk stage II disease. However, less than 50% of patients will go on to receive the complete course of chemotherapy without interruptions, and it is estimated that each 4-week delay in treatment may decrease overall survival by 14% [10, 11]. These findings have led some to advocate for delivering the chemotherapy prior to surgery as either induction chemotherapy (chemotherapy → CRT → TME) or consolidation chemotherapy (CRT → chemotherapy → TME). When compared with the traditional sequence of CRT followed by TME then adjuvant chemotherapy, the consolidation chemotherapy approach has been shown in a prospective clinical trial to be well-tolerated and to increase the pathologic response rate [12].

Another debate in the field of neoadjuvant therapy for rectal cancer is whether all patients with locally advanced rectal cancer require neoadjuvant CRT. Several retrospective analyses suggest that a subset of patients with low-risk disease (T3N0M0 lesions with negative margins and favorable histologic features) may not derive a significant benefit from RT [13]. Unfortunately, limitations with current imaging modalities make it impossible to preoperatively select with certainty those patients with low-risk T3N0 disease. A large multi-institutional study found that 22% of patients who received preoperative CRT for T3N0 rectal cancer clinically staged by ERUS or MRI actually had node-positive disease on pathologic review of resected specimens [14]. Because preoperative CRT may reduce the total number of LNs and may also sterilize mesorectal LNs, the true rate of patients clinically staged with T3N0 who actually have node-positive disease may be even higher [14]. Although the risks of overstaging T3 rectal cancer have been recognized (e.g., 18% of patients

with clinically staged T3N0 disease actually had T2N0 disease, according to data from the German Rectal Cancer Group [6], it is possible that twice as many of these cancers are understaged based on the findings cited above. These data support the use of preoperative CRT for patients with clinical T3N0 rectal cancers staged by ERUS or MRI, because understaged patients would otherwise require postoperative CRT, which is associated with inferior local control, higher toxicity, and poor functional outcomes.

Another ongoing question is whether neoadjuvant chemotherapy can be given alone, without routine chemoradiation prior to TME. In the phase II/III PROSPECT trial (Chemotherapy Alone or Chemotherapy Plus Radiation Therapy in Treating Patients With Locally Advanced Rectal Cancer Undergoing Surgery), patients with stage II or stage III rectal cancer are being randomized to receive either six cycles of neoadjuvant FOLFOX followed by immediate TME if the tumor has responded, or neoadjuvant CRT followed by TME if the tumor has not responded, or to a control arm of neoadjuvant CRT for 5.5 weeks immediately followed by TME and eight cycles of adjuvant FOLFOX. This trial is still ongoing and final results are not yet available, but results from a pilot trial are encouraging [15].

Distant Metastatic (M1) Disease

Patients with distant metastasis represent a heterogeneous population for whom it is difficult to define an all-encompassing strategy. The management of these complex and challenging cases should be discussed by a multidisciplinary team. Treatment strategies are based mainly on factors related to (1) the primary lesion (related symptoms, resectability); (2) the extent of metastases (sites, resectability); and (3) the patient (age, comorbidities, the ability to withstand major surgery, preferences regarding quality of life).

A strategy directed at curative intent can be adopted in patients with a resectable primary tumor and limited, resectable metastatic disease. In these patients, systemic chemotherapy is commonly used as the initial treatment modality. After restaging, resection of the primary and metastatic disease can be considered as either combined or staged operations. Alternatively, up-front surgical resection, as either combined or staged procedures, can be considered in patients with limited metastatic disease.

In selected patients with stage IV disease, systemic chemotherapy may provide effective palliation that obviates the need for surgery. However, some patients may present with symptoms such as pain, obstruction, or bleeding that do not respond to chemotherapy and require a palliative intervention such as a resection or diverting ostomy to alleviate symptoms. Although often utilized in obstructing descending and sigmoid colon cancers, endoscopic stents are generally avoided in rectal cancer because these devices tend to migrate and cause intolerable local symptoms such as pain and tenesmus.

Because as many as 60% of patients with colorectal cancer eventually develop liver metastases, the approach to the treatment of colorectal liver metastases (CRLM) deserves specific attention. With oligometastatic disease in an accessible location, complete resection remains the best option, with five-year survival rates of approximately 50%, and a 20% chance of cure. More commonly, however, patients present with borderline resectable or unresectable disease (80–90%). Traditional combination chemotherapy regimens may convert patients who were initially inoperable to potentially resectable, which results in 5-year survival similar to that in patients who were resectable initially. More recently, hepatic artery infusion (HAI) chemotherapy has emerged as an attractive adjunct to systemic chemotherapy and may increase the conversion rate to resectable disease [16, 17].

Surgical Considerations

Radical Resection

Radical resection for rectal cancer involves resection of the tumor and rectum en bloc with its blood and lymphatic supply, and the surrounding mesorectum. A sphincter-preserving low anterior resection (LAR) is the preferred approach to radical

resection, as long as the procedure is technically feasible and oncologically appropriate. With proper patient selection, and surgical training and experience, the procedure can usually be safely performed when cancers are located more than 1 cm from the upper portion of the anorectal ring. Generally, slender patients with wide pelvises provide more favorable conditions for sphincter-preserving surgery, and obese patients and those with long, narrow pelvises pose a technical challenge that can preclude a restorative procedure.

Contraindications to LAR include tumor invasion into the anal sphincter or levator muscles. Significantly impaired preoperative anorectal function is a relative contraindication, because it often leads to poor postoperative bowel function. An abdominoperineal resection (APR) is preferred in situations where a margin-negative resection would result in loss of anal sphincter function, leading to fecal incontinence. In radical surgery for rectal cancer, the following factors should be considered: (1) total mesorectal excision (TME), (2) autonomic nerve preservation, (3) negative circumferential and distal margins, and (4) sphincter preservation and restoration of bowel continuity and function, when possible. The following sections discuss each of these factors.

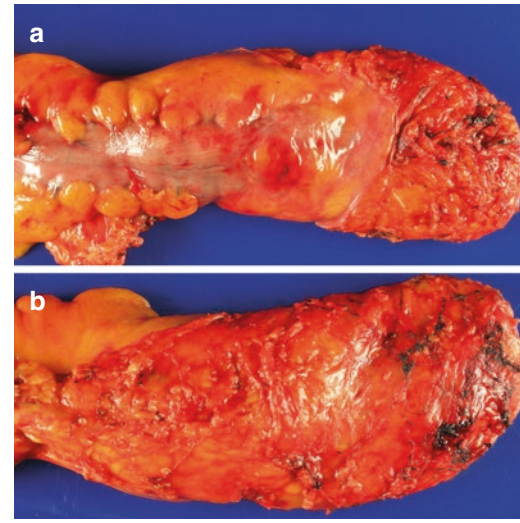


Fig. 23.5 Anterior (**a**) and posterior (**b**) views of a complete mesorectal excision specimen

Total Mesorectal Excision

TME has consistently been associated with significantly lower locoregional failure rates, ranging from 3 to 7%, compared with historic and contemporary controls. The markedly low local recurrence rates associated with TME have made it the standard of care in the surgical management of rectal cancer. TME is defined as complete excision of the visceral mesorectum, which refers to the fatty tissue that encompasses the rectum, contains the lymphatic drainage from the rectum, and is encased by visceral fascia (Fig. 23.5). When properly performed, TME results in en bloc removal of the primary rectal cancer and mesorectum as an intact "package," which is associated with high negative circumferential resection margin (CRM) rates. TME also facilitates the identification and preservation of the pelvic autonomic nerves. For most middle and low rectal cancers, the entire mesorectum is mobilized and resected. Cancers in the upper rectum, usually located above 10 cm from the anal verge, can be treated with a tumor-specific excision in which the mesorectum is divided at a right angle to the bowel 5 cm distal to the mucosal edge of the tumor. TME is one of the fundamental cornerstones of the American College of Surgeons (ACS) Commission on Cancer (Coc) National Accreditation Program for Rectal Cancer (NAPRC) [18]. Numerous studies have found that performance of a complete or near-complete TME is associated with lower local recurrence rates than is an incomplete TME [19]. However, it has been found that this association is only valid when the pathologist and the surgeon assesses the quality/completeness of TME [20].

Circumferential Resection Margin

Circumferential resection margin (CRM) status refers to the adequacy of the surgical resection margin relative to the 360° radial extension of the primary tumor, which may include extension into the mesorectum and adjacent extrarectal soft tissue. The prognostic significance of a negative CRM in the presence of an intact mesorectum has been well established [21]. In general, strive for a 2 mm or greater circumferential margin. When

MRI indicates a threatened margin, preoperative neoadjuvant chemoradiotherapy may help achieve a tumor-free CRM.

Distal Resection Margin

Distal resection margins (DRMs) of 2–5 cm have been the traditional standard in surgery for rectal cancer. However, recent whole-mount pathologic analyses of specimens from selected patients who underwent CRT followed by resection found intramural extension beyond the gross mucosal edge of residual tumor in only 2 (1.8%) of 109 patients. Moreover, when extension was present, it was limited to a distance of 0.95 mm or less [22]. Retrospective data suggest that margins as small as 1 cm may not compromise oncologic outcomes. A review from our institution found that local control and recurrence-free survival (RFS) with three years of follow-up after neoadjuvant CRT and TME-based resection were not significantly different when patients with DRMs less than or equal to 1 cm were compared with those of patients with DRMs greater than 1 cm [23]. We advocate striving for a DRM of at least 2 cm for most rectal cancers, even after preoperative CRT. However, a histologically negative DRM less than 1 cm is acceptable in carefully selected patients in the absence of adverse histologic features, particularly in situations in which an APR may be required to achieve a wider margin. In cases in which the DRM status is uncertain, we suggest obtaining an intraoperative frozen section of the distal margin. The editor (SDW) does not find intraoperative frozen sections valuable [24].

Reconstruction Options Following Low Anterior Resection

Reconstruction techniques following a low anterior resection (LAR) may include straight coloanal anastomoses (SCA) in either an end-to-end or side-to-end fashion, or the creation of a colonic reservoir with either a colonic J-pouch (CJP) or a transverse coloplasty pouch (TCP). Multiple prospective randomized studies have compared these options, and the majority shows better short-term (within the first postoperative year) functional outcomes in terms of urgency and number of bowel movements per day with CJPs; however, there do not seem to be any long-term (>1 year postoperatively) differences in terms of continence, leak rate, and overall quality of life [25]. In general, we consider a CJP after a very low anterior resection if the patient's pelvic anatomy is appropriate for this procedure (narrowed colon lumen, limited colonic mesenteric fat, and a wide pelvis). However, when a CJP is not technically feasible, we favor performing a SCA.

Temporary Diversion Following Low Anterior Resection

Although exceptions may occur, we tend to perform a diverting loop ileostomy on most LARs with a low anastomosis (within 5 cm from the anal verge or within 2 cm above the anorectal ring), and on most patients with a LAR following preoperative RT. The ileostomy reversal is usually scheduled by the authors at 3 months after surgery. However, when postoperative chemotherapy is required, reversal is postponed for several weeks beyond completion of chemotherapy. In all patients, an interim office visit with DRE and an enema study with water-soluble contrast are recommended to ensure that the anastomosis has remained patent, has not narrowed, and that there is no evidence of leakage prior to closure of the ileostomy.

A different approach is utilized by one of the editors (DEB). The option of early ileostomy closure is discussed with patients. In those choosing this option, the diverting ileostomy is closed 5–6 weeks after the rectal resection and before the chemotherapy, which can be started 3 weeks after the ileostomy closure. This editor performs the rectal resection approximately 6 weeks after the chemoradiotherapy in patients where maximal tumor shrinkage is not needed. These patients then start their chemotherapy 16–18 weeks after starting their chemoradiotherapy. A retrospective review of patients with rectal cancer who underwent a low anterior resection with diverting loop ileostomy followed by adjuvant chemotherapy from 2005 to 2013 identified 22 patients whose stomas were closed before chemotherapy (BC) and 50 whose stomas were closed after adjuvant

chemotherapy (AC) [26]. Comparing the two groups, there was no difference in mean age (or preoperative clinical stage). Follow-up revealed a similar mean duration from surgery to last contact (BC 50.6—23.6 months vs AC 43.5—22.1 months, P = 0.23), and similar overall survival (BC 86% vs AC 70%, P = 0.23) between groups. While this study was underpowered, it supports individualizing the timing of ileostomy closure.

Abdominoperineal Resection

The abdominoperineal resection (APR) refers to a combined abdominal and perineal approach to resecting the rectum, mesorectum, anus, surrounding perineal soft tissue, and pelvic floor musculature en bloc. An APR is indicated if the tumor directly involves the sphincter muscles, if adequate margins cannot be obtained during a restorative resection, or if the patient already suffers from fecal incontinence preoperatively.

Beginning in 2007, several European centers began reporting on a more radical resection of the perineal component of the APR [27]. With this approach, the patient is placed in the prone position for the perineal dissection, which is carried widely along the levator muscles to the point at which they originate on the pelvic sidewall before traversing the levators and joining the mesorectal dissection (Fig. 23.6). This approach leaves the levators in their anatomic location attached to the rectal wall and creates a more cylindrical surgical specimen (Fig. 23.7).

Surgeons who utilize this cylindrical or extralevatory abdominoperinal excision (ELAPE) technique believe that the more cylindrical specimen decreases the rate of tumor perforation and positive CRM, thereby improving outcomes. However, this procedure creates a larger perineal defect that typically requires tissue-flap reconstruction of the pelvic floor and is associated with increased morbidity, especially in the setting of neoadjuvant therapy. Although randomized data comparing traditional APR with ELAPE are limited, a retrospective review of the Swedish Colorectal Cancer Registry reported fewer intraoperative perforations during ELAPE compared with conventional APR (7% vs. 16%, p = 0.043), but only among the subset of tumors located within 4 cm of the anal verge [28]. However, ELAPE was associated with a significantly higher risk of postoperative wound infections (20% vs. 12%, p = 0.01). A similar retrospective review from the Danish Colorectal Cancer Group database found that CRM positivity was more common following ELAPE, compared with traditional APR (16% vs. 7%, p = 0.01) [29]. Although there is still no consensus on the optimal approach, this debate further

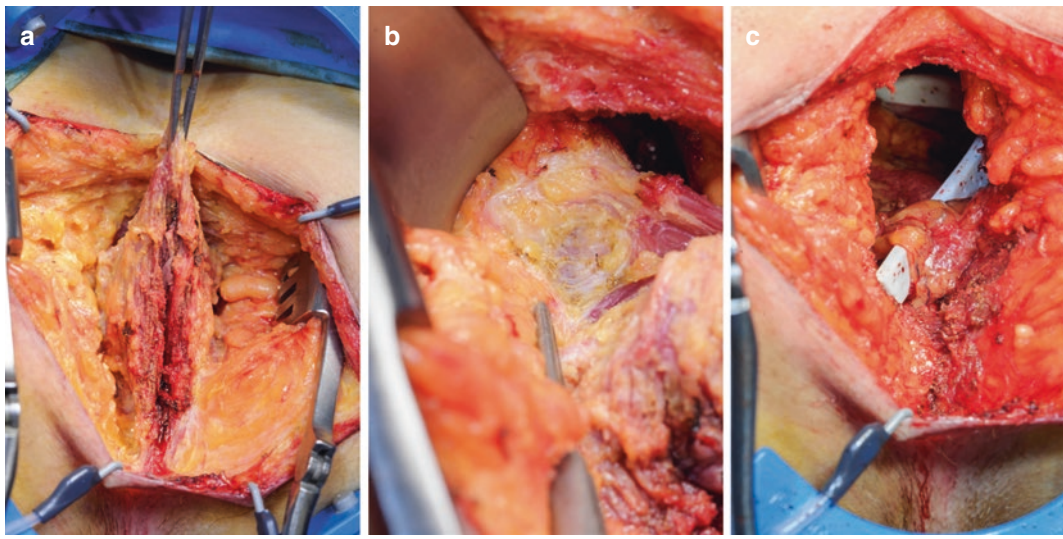


Fig. 23.6 Extralevator abdominoperineal excision of the rectum, showing dissection along the sphincter complex (**a**), division of the levator muscle at the apex of the ischiorectal fossa (**b**), and the perineal defect (**c**)

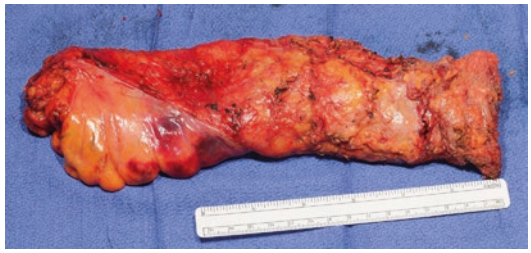


Fig. 23.7 Cylindrical abdominoperineal excision of the rectum specimen

underscores the importance of achieving a negative CRM and maintaining precise surgical technique when performing any type of APR.

Extent of Resection

When performing a resection for rectal cancer, the most commonly involved adjacent structures are located anteriorly: the prostate in men or the posterior wall of the vagina in women. If prostatic involvement is suspected and an en bloc prostatectomy/APR is required, the postoperative function of the bladder is likely to be very poor, and urinary diversion with an ileal conduit is often needed. If the posterior vaginal wall is involved, an en bloc anterior vaginectomy can be performed and the defect closed with a perineal flap. Another potential concern is pelvic sidewall lymphadenopathy. In these cases, an extended pelvic sidewall dissection and lymphadenectomy can be of benefit in carefully selected patients.

Abdominal Dissection: Minimally Invasive Versus Open Technique

The abdominal portion of a rectal cancer resection can be performed through a laparotomy, or by using minimally invasive techniques. Four large multicenter, prospective randomized trials have compared open and laparoscopic TME for rectal cancer.

In the COREAN (Randomized Prospective Trial for Laparoscopic vs Open Resection for Rectal Cancer) trial, 340 patients who had received neoadjuvant CRT were randomly assigned to either open or laparoscopic surgery. Three-year DFS and OS were also similar between the groups, although the study was powered to detect only a non-inferiority margin of 15% for DFS [30].

In the COLOR II (Laparoscopic Versus Open Rectal Cancer Removal) trial, a study in which 30 international centers participated, 1044 patients with solitary rectal cancers within 15 cm of the anal verge were randomized to either open or laparoscopic surgery. At 3 years, local recurrence (5% vs. 5%), DFS (75% vs. 71%), and OS (87% vs. 83%) were nearly identical in the laparoscopic and open groups, respectively [31]. However, the rates of tumor-free CRMs and local recurrence for patients with mid-rectal tumors was superior in the laparoscopic group.

A third prospective multicenter trial sponsored by the American College of Surgeons Oncology Group (ACOSOG Z6051) randomized 486 patients with stage II or III rectal cancer within 12 cm of the anal verge to either laparoscopic or open resection after completion of neoadjuvant therapy. The primary outcome assessing efficacy was a nonvalidated composite of circumferential radial margin (CRM) >1 mm, negative distal margin, and completeness of TME. Successful resection occurred in 82% of laparoscopic resections and 87% of open resections, which did not support non-inferiority. Operative time was significantly longer for laparoscopic resections (266 min vs. 220 min, $p < 0.001$), but there were no significant differences in length of stay, readmission, major complications, negative CRM, negative distal margin, or completeness of TME. The authors concluded that laparoscopic resection failed to meet the criterion for non-inferiority for pathologic outcomes and therefore should not be used in these patients [32]. A fourth study, the ALaCaRT randomized trial, examined patients with T1-T3 rectal cancers and also failed to demonstrate noninferiority of laparoscopic surgery compared with open surgery [33]. However, the subsequent two-year follow up study [34] found no differences in oncologic outcomes between the open and laparoscopic group. The problem with the Z-6051 study was not the technique of laparoscopy between the use of a never before used non-validated composite score. Sadly, but not surprising, using this score flawed composite score, the AlaCart study reached the same non-inferiority

conclusions relative to short term surrogate pathologic parameters.

Recently there has been increasing interest in adopting the robotic surgical platform for the surgical treatment of rectal cancer. However, critics cite the high cost of purchasing and maintaining the robotic platforms, as well as the lack of haptic feedback inherent in robotic surgery, as reasons why they hesitate to convert from conventional laparoscopy to robotic surgery. The literature to date comparing conventional laparoscopy to robotic surgery is limited to retrospective reviews and institutional case series, with most studies reporting that robotic surgery is associated with increased operative time, decreased blood loss, decreased conversion to open surgery, and similar oncologic outcomes [35]. The ROLARR trial (Robotic Versus Laparoscopic Resection for Rectal Cancer) also failed to demonstrate any statistically significant advantage of robotic as compared to laparoscopic TME [36].

Our preference is to utilize, whenever possible, the robotic platform for all pelvic work, as the visualization and dexterity are much improved in comparison with traditional laparoscopy. Robotic techniques above the level of the pelvis can be challenging in obese patients, as achieving exposure and retraction of the intra-abdominal contents is sometimes difficult, and an experienced assistant is extremely helpful. Male patients with a narrow pelvis and large mesorectum can be challenging using any technique, but the laparoscopic approach in these patients may be particularly difficult because of the straight instruments and limited range of motion. One of the editors prefers the laparoscopic approach and has shown its superiority to laparotomy [37].

Perineal Dissection: Prone Versus Lithotomy Positioning

For perineal dissection, putting the patient in the prone jackknife position facilitates maximum exposure, keeps the dissection away from the table edge, and increases access for a lateral-most dissection of the levator muscles. Although the "upside down" view may be challenging, there are distinct advantages to this approach, especially in anteriorly located low rectal cancers in men.

Very obese patients may not tolerate the prone jackknife position because their large abdomen may lead to restricted ventilation. In these patients, a left lateral (Sims) position, with the knees tucked and the right buttock taped up and away, allows exposure without restricting ventilation. The high lithotomy, also known as the Lloyd-Davies position, is another alternative that is ideal when a two-team approach is planned, so that perineal dissection and abdominal dissection can take place synchronously. Similarly, the plastic surgery team can harvest the rectus abdominus flap while the perineal portion of the APR is completed.

When the perineal portion of the operation is performed with the patient in the prone position, it is important to discuss the specific sequence of steps of the operation with the surgery, anesthesia, and nursing teams before the procedure to maximize timing and fluency and minimize overall operative time. For example, if a ventral rectus abdominis flap is planned, the tissue will need to be dissected, mobilized, and sutured to the proximal rectum prior to closing of the abdomen and maturing of the ostomy—all of which is done before the patient is turned to the prone position. However, one of the editors (SDW) prefers to perform the APR or ELAPR in the supine position. Data from the Cleveland Clinic Foundation found no differences in outcomes between the prone and supine positions [38].

Perineal Reconstruction Options

Primary closure of the perineal wound is associated with a significant risk of wound infection, dehiscence, and possible perineal hernia. Reconstruction of the perineum using a number of flaps may reduce these risks, particularly in patients undergoing an extended perineal resection. Unfortunately, these reconstructive procedures are themselves associated with specific morbidity. The use of a rectus muscle flap can lead to abdominal wall hernias at the midline incision or parastomal hernias. The use of gluteal rotational flaps is an alternative option, although this procedure can lead to permanent changes in mobility in the lower legs. A gracilis muscle flap is yet another option, but often this approach is

less advantageous, as the flap contains no skin and is rather small in size. In general, we reconstruct the perineum when the patient has any of the following: a large skin defect from a wide perineal resection, a residual large pelvic space from an exenteration; prior radiation therapy (more than 6 months before the procedure), poor nutritional status, or other comorbidities that significantly increase the risk of perineal wound infections.

In addition to a ventral rectus abdominus muscle flap and gracilis reconstruction, bilateral V–Y advancement gluteal flaps are a good alternative, especially if there is concern about retaining the integrity of the abdominal wall. These flaps provide for excellent tissue coverage and facilitate a posterior vaginal reconstruction. The strategy should be individualized based on each patient's needs, comorbidities, muscle mass, and functional limitations. The involvement of plastic surgeons early in the preoperative assessment and planning is essential.

Surgical Technique

Anatomic Relationships and Considerations

The key to a successful rectal cancer operation is an in-depth understanding of the anatomy of the left colon, the rectum and anus, as well as the vessels and nerves of the pelvis, the pelvic floor musculature, and the ischiorectal fossa. The pelvic floor, also known as the pelvic diaphragm, comprises the levator ani and coccygeus muscles. The levator ani muscle is composed of several smaller muscles (puborectalis, pubococcygeus, and iliococcygeus) that insert in the inner wall of the pelvis and unite with the muscle of the opposite side to form part of the funnel-shaped pelvic diaphragm. These muscles are divided during an APR. The coccygeus muscle, located in the same plane as the levator ani muscles but more posterior, is usually not divided.

The mesorectum is the visceral mesentery containing the terminal branches of the superior rectal vessels and the lymphatic drainage of the rectum. The upper third of the rectum is usually covered with peritoneum in the front and on both sides and has a posterior mesorectum attached to the concavity of the sacrum, which is a continuation of the mesentery of the sigmoid colon. Below the peritoneal reflection, the rectum is completely extraperitoneal. The mesorectum here is thick posteriorly and, when removed with an intact capsule, has a characteristic bilobar appearance. As the rectum funnels down toward the anorectal ring, the mesorectum also tapers off distally. At this very distal aspect, just above the anorectal ring, there is no appreciable mesorectum. The longitudinal layer of the muscularis propria of the posterolateral rectum is in direct contact with the levator muscles. Anteriorly, the mesorectum is either absent or reduced to a thin layer of areolar tissue in the mid- and distal rectum.

Fascial Structures and Planes

The fascia propria of the rectum is a thin, glistening membrane surrounding the mesorectum below the peritoneal reflection. Like the mesorectum proper, it is thinner anteriorly than posteriorly. Anteriorly, a remnant of the embryologic peritoneal cul-de-sac, known as Denonvilliers fascia, separates the mesorectum from the urogenital structures. The anatomic appearance of Denonvilliers fascia varies, from a barely visible translucent membrane to a distinct, tough, fibrinous layer of connective tissue. Posteriorly, the fascia propria extends from the sacral promontory to Waldeyer's fascia, a condensation of connective tissue spanning the area from the fourth sacral vertebra to the anorectal ring. Here the mesorectum is separated from the presacral fascia by loose, avascular, areolar tissue. The correct plane for dissection during a total mesorectal excision is between the fascia propria of the rectum and the presacral fascia.

Below the peritoneal reflection, the mesorectum is in intimate contact laterally with the connective tissue overlying the autonomic nerves that pass from the pelvic plexus to the rectum. These bilateral fusions of the endopelvic fascia, known as lateral ligaments, connect the pelvic sidewall with the mesorectum. In some patients, the lateral ligaments contain accessory middle rectal vessels. The middle rectal artery usually runs immediately above the levator muscles.

Blood Supply

The blood supply of the rectum comes primarily from the superior rectal artery, which is the continuation of the inferior mesenteric artery after it gives off the left colic artery (Fig. 23.8). The superior rectal artery gives several sigmoidal branches before diving into the mesorectum, where it gives multiple branches to the rectum but usually prominent left and right branches that run alongside the mesorectum. The lower portion of the rectum also receives blood supply from the internal iliac vessels. The middle rectal artery, an inconsistent branch of the inferior vesicle artery, is usually located deep in the pelvis, running over the levator muscle. The inferior rectal artery is a branch of the pudendal artery and provides blood supply to the anal canal and anal sphincter. The superior rectal vein has a parallel course to its homonymous artery, on its way to join the left colic vein to form the inferior mesenteric vein draining into the splenic vein. As in other locations, the superior, middle, and inferior rectal veins follow the course of their arteries. While the superior rectal vein joins the left colic vein to form the inferior mesenteric vein and drains into the portal system, the middle and inferior rectal veins drain into systemic circulation through the internal iliac veins. These anastomoses represent the potential portosystemic communication that becomes relevant in patients with portal hypertension.

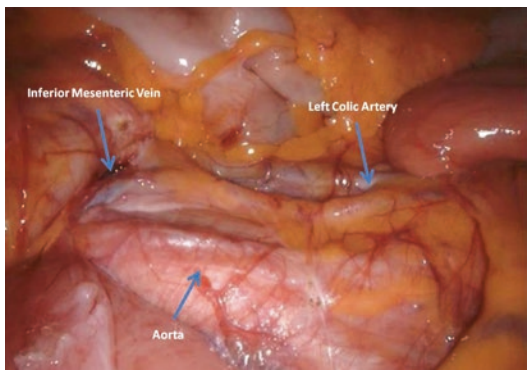


Fig. 23.8 Vascular anatomy of the left side of the colon

Autonomic Pelvic Nervous System

The superior hypogastric plexus, located in front of the aorta, contains preganglionic sympathetic fibers originating from the lumbar sympathetic trunk that converge at the level of the aortic bifurcation into two well-defined hypogastric nerves, which course laterally over the internal iliac vessels toward the lateral pelvic sidewall. There they join the splanchnic pelvic nerves, containing postganglionic parasympathetic fibers from S3 to S4, to form the inferior hypogastric plexus, which is located posterolateral to the seminal vesicles in men and in a corresponding location in women. Branches of the inferior hypogastric plexus provide innervation to the distal ureter, vas deferens, seminal vesicles, urinary bladder, prostate, and even the distal rectum in some patients. The inferior hypogastric plexus also forms the urogenital neurovascular bundles that pass anterior to Denonvilliers fascia. The pudendal nerve, originating from the sacral plexus, contains sensory, motor, and parasympathetic fibers that provide most of the innervation of the perineal region. Damage to any of these nerves during an operation can result in significant urinary, sexual, and sensory dysfunction.

Open Abdominal Dissection

As in any other colorectal cancer procedure, this operation begins with a thorough examination of the abdomen and pelvis. The sigmoid colon is mobilized by dividing the attachments and adhesions to the lateral abdominal and pelvic sidewall and rendered a midline structure. The incision is carried cephalad toward the splenic flexure and distally toward the pelvis. The mesentery of the sigmoid and descending colon is retracted away from the retroperitoneal attachments, exposing the left gonadal vessels and the left ureter. It is important to remain in the retromesocolic plane, as deeper dissection into the retroperitoneal fat can lead to increased bleeding and damage to the gonadal vessels and the left ureter. The sigmoid colon is retracted anteriorly and to the left to expose the root of the

sigmoid mesentery for the surgeon standing on the right side of the patient. Next, an incision is made in the peritoneum to the right side of the base of the sigmoid mesocolon, just anterior to the sacral promontory. A plane is developed underneath the superior rectal vessels in the loose areolar tissue, between the origin of the inferior mesenteric artery and the promontory. Care should be taken to avoid injuring the superior hypogastric plexus (SHP), situated between the superior rectal vessels and the bifurcation of the aorta. The division of the SHP into the left and right hypogastric nerves can be seen as two thick, bandlike structures just lateral to the midline that have the appearance of a "wishbone" when the rectum is tented up anteriorly.

Once the ureter is identified and left in situ in the retroperitoneum, the superior rectal vessels are isolated between the origin of the left colic vessels and the first sigmoidal vessels and ligated. We recommend a careful dissection of any enlarged lymph node around the bifurcation of the inferior mesenteric artery, taking great care not to damage the SHP. The mesentery of the sigmoid colon is then divided toward the point of the sigmoid colon that has been chosen to create the end sigmoid colostomy. The sigmoid colon itself is divided by using a linear stapler. The divided sigmoid colon and the descending colon should be sufficiently mobilized to ensure a tension-free, well-vascularized colostomy that is not retracting inferiorly.

The areolar space behind the fascia propria of the rectum is visualized by anterior reflection of the stump of the superior rectal vessels and the proximal rectum toward the ceiling and away from the sacral promontory. In the beginning of this dissection, it is important to identify and protect the bilateral hypogastric nerves. The areolar tissue is incised and the dissection continued inferiorly along the concavity of the sacrum as far as the sacrococcygeal junction and extending from the midline laterally. Distally, the pelvic splanchnic nerves are preserved, as they course from the lateral pelvic sidewall near the anterior sacral foramina to join the inferior hypogastric plexus.

We find that firm and precise traction with a St. Mark's pelvic retractor or a Wiley renal vein retractor—along with strong counter-traction from the surgeon's nondominant hand on the rectum—can help to place the areolar plane on tension and expose the proper plane for dissection. Division of the areolar connective tissue should be done using electrocautery or other sharp dissection. Blunt finger dissection is extremely imprecise and can lead to a poor-quality resection plane, which compromises the oncologic validity of the operation. Blunt dissection may also damage the pelvic nerves and lead to impotence or retrograde ejaculation, as well as severe pelvic bleeding that can be difficult to control.

The dissection is continued postero-laterally until the origin of the levator muscle is reached. Finally, the peritoneum is opened anteriorly in the cul-de-sac. Dissection is carried to the level of the prostate in men and halfway down the vagina in women. The anterior dissection can be performed in different planes, depending on the location of the tumor. For anteriorly located tumors, the dissection should proceed in front of Denonvilliers fascia to avoid dissecting into the tumor. For other tumors, dissection can be safely performed behind Denonvilliers fascia to preserve the nerves of the prostatic plexus.

Robotic Mobilization of Splenic Flexure and Left Colon

A medial-to-lateral mobilization of the left and sigmoid colon is preferred for the robotic approach. The inferior mesenteric vein (IMV) is used as the initial anatomic landmark. To expose the IMV, the ligament of Treitz and the attachments between the proximal jejunum and the descending mesocolon may have to be divided sharply, so that the small bowel can be retracted toward the right upper quadrant (Fig. 23.9).

Next, the peritoneum just under the vein is incised, and medial-to-lateral dissection begins by separating the mesocolon from Toldt's fascia. Dissection proceeds toward the abdominal wall, taking care to identify and preserve the ureter and gonadal vessels. More distally, the IMV runs parallel to the left colic artery (LCA). Therefore the IMV/LCA pedicle should be followed

inferiorly, and freed from its posterior attachments to the aorta, until the origin of the inferior mesenteric artery (oIMA) is identified. The peritoneum over the sacral promontory, just medial to the right common iliac vessels, is incised, entering the areolar plane posterior to the superior rectal artery. By extending this dissection plane to the left, the origin of the IMA is identified; the vascular anatomy creates a characteristic T-shaped structure (Fig. 23.10).

After identifying the ureter and gonadal vessels in the retroperitoneal plane, the IMA can be divided (Fig. 23.11). To obtain a full mesocolic mobilization and facilitate a tension-free low anastomosis, we routinely divide the artery with multiple applications of the robotic vessel sealer or vascular stapler in cases of a larger IMA. The medial-to-lateral dissection is taken laterally toward the abdominal wall. The colon is then retracted medially; the peritoneum along the white line of Toldt is opened, completely freeing the descending and sigmoid colon. Next, the splenic flexure is taken down by (1) opening the gastrocolic omentum just below the gastroepiploic vessels, or (2) dividing the avascular coloepiploic attachments next to the bowel wall. The splenocolic ligament is divided. We recommend using an energy-based vessel sealing device for these steps. Last, the attachments of the body and tail of the pancreas to the colonic mesentery are

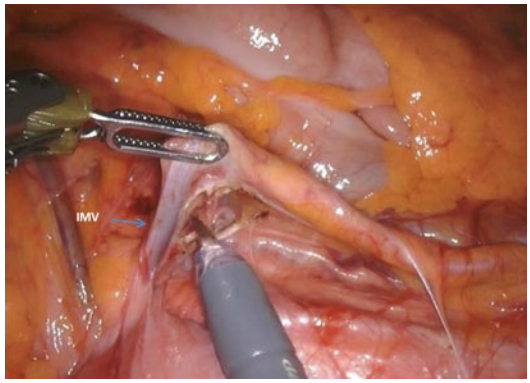


Fig. 23.9 Visualization of the azygos section of the inferior mesenteric vein, close to the inferior border of the pancreas

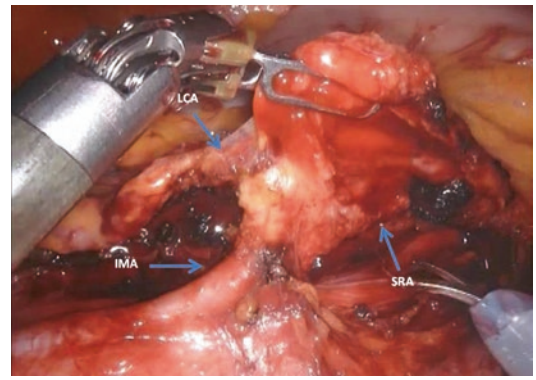


Fig. 23.11 View of the inferior mesenteric artery (IMA) and its branches, the left colic artery (LCA) and the superior rectal artery (SRA)

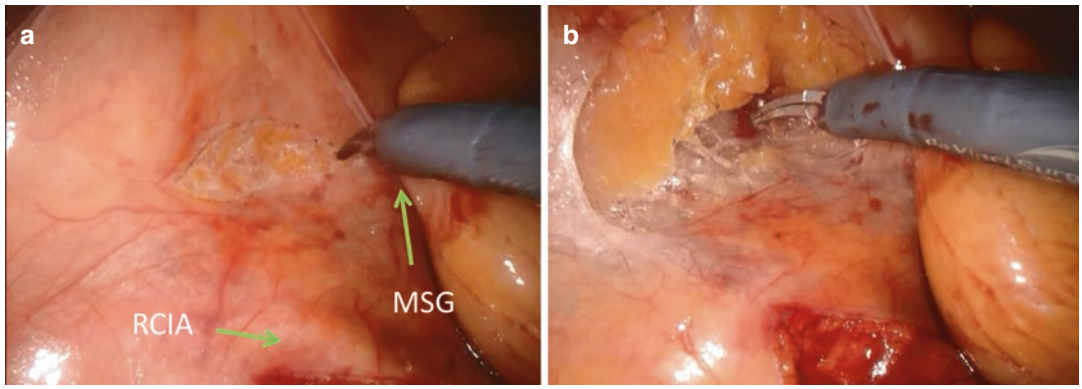


Fig. 23.10 Opening of the areolar space behind the superior rectal vessels. (**a**) The landmarks are the right common iliac artery (RCIA) and the fold of the mesentery of the sigmoid colon (MSC). (**b**) The areolar space is dissected carefully, keeping the hypogastric plexus, left ureter, and left gonadal vessels undisturbed in the retroperitoneum

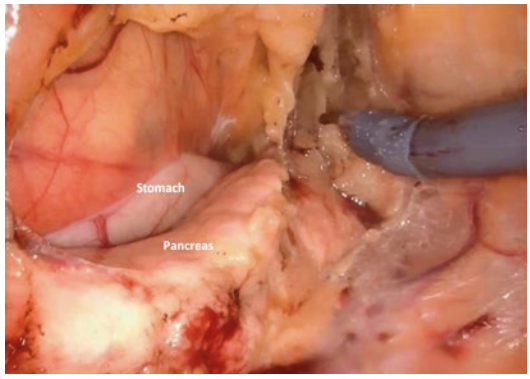


Fig. 23.12 Visualization of retroperitoneum and the lesser sac after division of the transverse colon mesentery attachment to the inferior border of the pancreas

carefully divided to obtain a full splenic flexure release (Fig. 23.12).

The mesentery of the descending colon is then divided from the stump of the IMA towards the colon at the point of future division of the bowel, usually at the junction of the descending and sigmoid colon. The mesentery can be divided with an energy source, or with several fires of a vascular stapler. Alternatively, the mesentery can be divided with electrocautery clipping the mesenteric vessels. We recommend dividing the marginal artery at this time to avoid tearing the vessels during the extraction manoeuvres, particularly if extraction of the specimen through the anus is anticipated.

Robotic Total Mesorectal Excision

After completing colonic mobilization, the robotic pelvic dissection can begin. A significant degree of Trendelenburg position is often necessary to maintain the small intestine out of the pelvis. The DaVinci® S HD, Si, or Xi can be docked over the patient's left hip, permitting access to the anus and perineum during the entire procedure.

The camera arm with a 0º telescope is first docked to trocar C. Next, we attach a robotic trocar to arm 1 and "piggyback" this into the 12 mm R1 port. Arms 2 and 3 are docked to trocars R2 and R3, respectively. For instruments we choose scissors for arm 1, a fenestrated bipolar grasper in 2, and a "pro-grasp" grasper in 3. The assistant remains on the right side, using ports L1 and L2 for suctioning and retraction of the rectum out of the pelvis. With the DaVinci Xi, the fourth robotic arm replaces the L2 laparoscopic arm (Fig. 23.13).

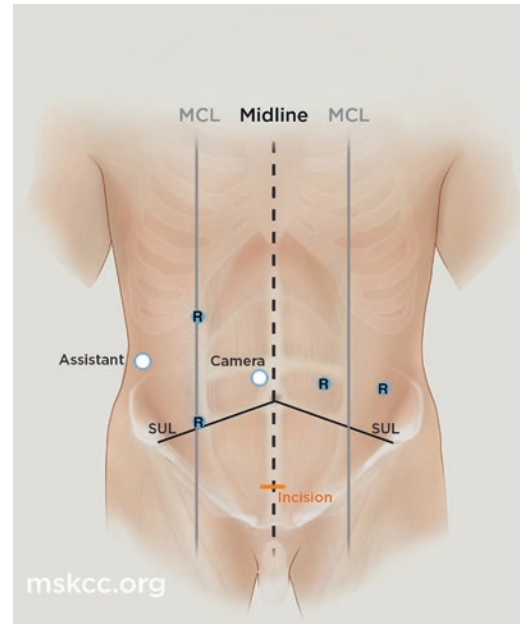


Fig. 23.13 Trocar positioning for a robotic total mesorectal excision. ©2018, Memorial Sloan Kettering Cancer Center

With the assistant elevating the rectosigmoid junction, dissection begins posteriorly at the sacral promontory, entering the plane between the fascia propria of the rectum and the presacral fascia. Care must be taken to identify and preserve the hypogastric nerves bilaterally. The dissection is carried out almost exclusively with monopolar cautery, applied with the scissors in shorts bursts, to prevent excessive smoke accumulation and nerve injury. The TME proceeds along the areolar plane down to the rectococcygeal ligament, which is opened (Fig. 23.14).

It is important to avoid grabbing the mesorectum with any of the robotic graspers. These instruments have considerable strength, and can cause bleeding as well as undesirable injuries to the fascia propria. We prefer to use the bipolar grasper in arm 2 chiefly as a retracting device.

Anteriorly, the peritoneal reflection is incised and dissection is continued along the rectovagi-

nal septum in women, or the rectovesical/rectoprostatic fascia (Denonvilliers fascia) in men. Arm 3 is very useful for retracting the bladder and other anterior structures as dissection proceeds distally (Fig. 23.15). The precise articulation of the robotic scissor tips allows the surgeon to carry out the dissection utilizing ideal angles of attack.

Laterally, dissection proceeds along the sidewalls medial to both ureters. Care must be taken to avoid injuring the autonomic pelvic plexus. Dissection continues down to the pelvic floor, separating the fatty mesorectum from the levators. In preparation for rectal division, DREs are performed regularly to ascertain the level of the tumour. The rectum is lifted off the levator muscle and prepared circumferentially.

Before dividing the rectum, one member of the team performs a DRE under direct visualization to fully assess the distal margin. In select cases we have tied a suture around the distal rectum to close off the rectal lumen and ensure application of the stapler below the level of the tumor. Thanks to the smooth articulation of the robotic arms, this manoeuvre is not technically challenging (Fig. 23.16).

The assistant can divide the rectum while the surgeon maintains proper exposure. Under ideal circumstances, the 12 mm R1 trocar can be used after undocking the robotic arm, leaving the robotic surgeon with only R2 and R3. If more exposure is necessary, another laparoscopic 12 mm trocar just lateral to R1 can be inserted as the stapling port. Stapler cartridge length should not exceed 45 mm; this length permits easy application of the jaws over the bowel. Usually two or three fires are necessary, and it is important to maintain proper alignment to avoid crossing staple lines. Given the thickness and pliability of the rectum, a green cartridge or the Tristaple® (Conmed, CT) purple cartridge is indicated, especially after neoadjuvant chemoradiation.

After division of the rectum the robotic cart can be undocked. We routinely extract the specimen through a 5–7 cm suprapubic Pfannensteil mini-laparotomy covered with a plastic wound protector. The proximal bowel is divided and an anvil secured to the proximal colon with a hand-sewn purse-string suture. After closing the fascia with interrupted absorbable sutures, the anastomosis is created with a circular stapler under direct laparoscopic visualization (Fig. 23.17). For cases requiring a very low

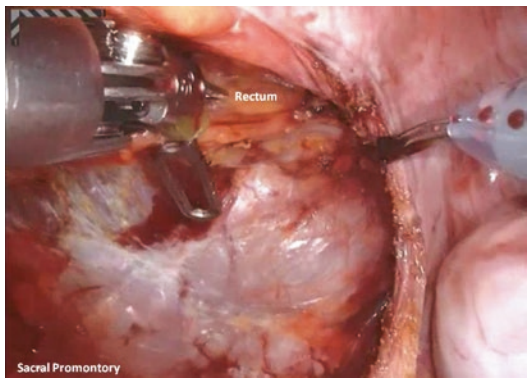


Fig. 23.14 Exposure of the areolar space behind the fascia propria of the rectum (top) and in front of the promontory (bottom)

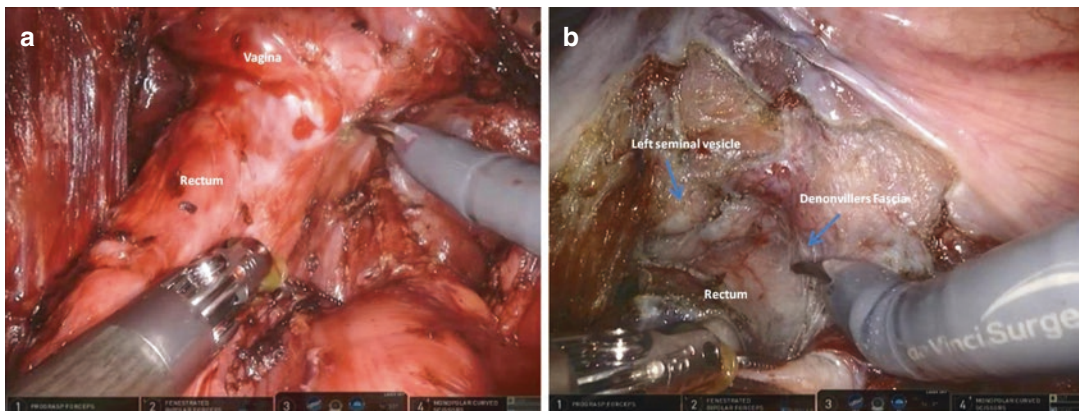


Fig. 23.15 Anterior dissection in a female patient (**a**) and a male patient (**b**)

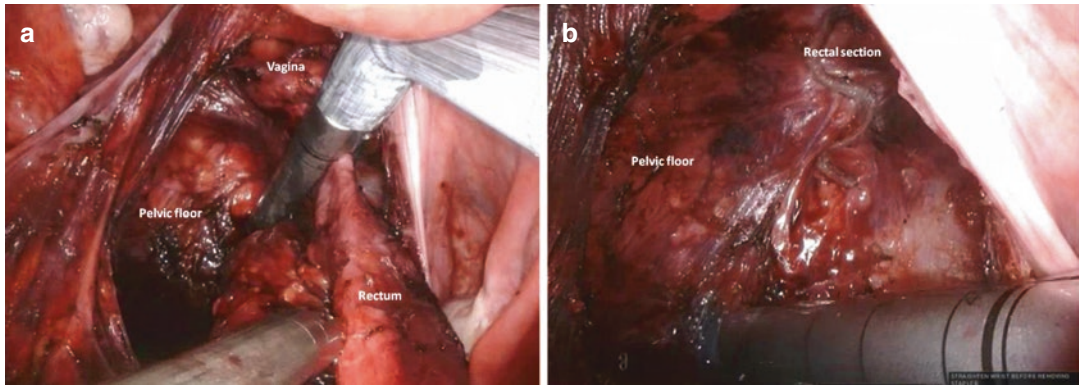


Fig. 23.16 (**a**) Division of the rectum with the robotic stapler. (**b**) Staple line on the rectal stump after division of the rectum

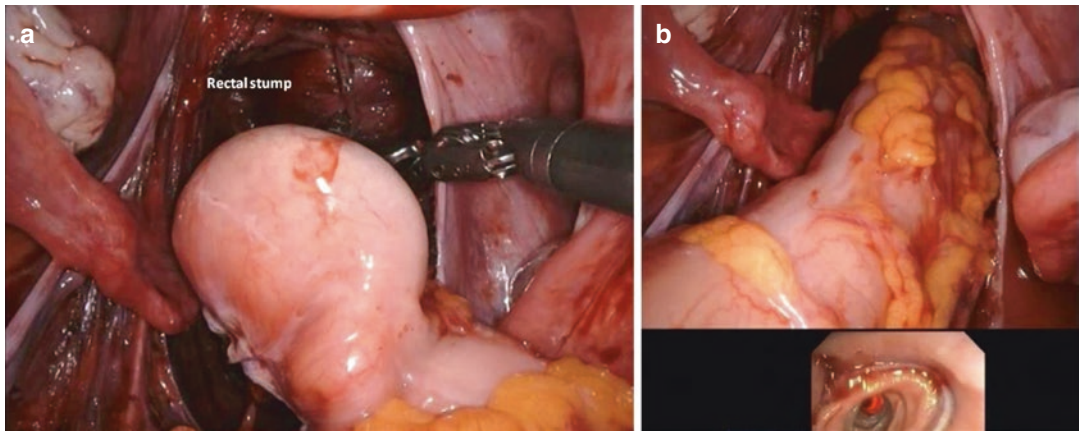


Fig. 23.17 (**a**) Creation of a colorectal anastomosis with a transrectal EEA stapler. (**b**) Endoscopic visualization and testing of the colorectal anastomosis

anastomosis, a diverting loop ileostomy is indicated, especially after neoadjuvant chemoradiation therapy.

Transanal Extraction Techniques

In lieu of a LAR with a traditional double-stapled anastomosis and transabdominal extraction, it is also possible to transanally extract the specimen and manually perform the anastomosis. This technique is indicated when the tumor is very close to the anorectal ring and safe application of the linear stapler can be difficult. The rectal wall is divided transanally at the beginning of the procedure, with a clear view of the distal margin. The transanal dissection is then carried as far as possible outside of the rectum and mesorectum. The open lumen of rectum distal to the tumor is therefore closed off with interrupted sutures to avoid spillage during the pelvic dissection. The robotic dissection proceeds until the perineal dissection is met, and the bowel is passed through the rectal stump, covered with a wound protector, and delivered to the outside. The proximal bowel is divided outside the anus at the point where the mesentery and the marginal vessels have been previously divided, and the anastomosis can then be accomplished manually with interrupted sutures. A transanal colonic J pouch may be created [39].

These techniques obviate the need for an abdominal incision and the associated potential for wound complications and incisional pain. However, they require a higher degree of techni-

cal expertise and are therefore not recommended at the beginning of the surgeon's learning curve.

Perineal Part of the APR: Prone Position

With the patient carefully and properly positioned in the prone position and the perineum prepped and draped, an elliptical incision is made outside the lateral edge of the external sphincter, medial to the ischial tuberosity. Palpating the tuberosity and placing the incision one to two fingerbreadths medially facilitates the medial incision. Posteriorly, the incision should be placed midway between the anus and the coccyx and can be extended if needed. Anteriorly, the incision should divide the perineal body.

For centrally located tumors and those that do not penetrate the anal sphincter or the levator musculature, a narrower incision can be utilized. If the resection is performed for more extensive anal disease, such as recurrent anal squamous cell cancer or adenocarcinoma arising in a fistula-in-ano, or Crohn's disease, a wider resection margin can be used. In this setting, it is important to stay in the same plane as the dissection is extended superiorly and avoid coning in. The dissection is done using electrocautery, watching for and controlling the perforating vessels, usually located at 2, 4, 8 and 10 o'clock, that may bleed profusely. A number of retractors can be helpful, such as the Lone Star Retractor (Cooper Surgical, Inc. Trumbull, CT) during the superficial portion of the procedure and the self-retaining Lace retractors and Wiley deep vein retractors during the deeper portions of the resection.

Dividing the anococcygeal ligament at the tip of the coccyx provides access to the posterior pelvis for joining the mesorectal dissection. Once the two dissection planes (the abdominal mesorectal plane and the perineal plane) have been connected posteriorly, just anterior to the coccyx, the surgeon should divide the levator muscles beginning at the apex of the ischiorectal fossa, close to their insertion on the tendinous arch covering the obturator internus. We find that placing the index finger of the nondominant hand into the pelvis and "hooking" the levator muscles facilitates this division. The puborectalis should be divided anteriorly before the transverse perineal muscle is reached. It is crucial not to violate the TME.

The rectum, which up to this point remains attached anteriorly to the prostate or vagina, is delivered through the wound to facilitate exposure for the anterior dissection. The distal portion of the anterior dissection—the separation of the distal rectum and anal canal from the perineal body—is best performed from proximal to distal, following the surgically dissected and visualized anterior surface of the prostate or vagina. The perineal approach affords better visualization of the neurovascular bundle (the distal portion of the pelvic plexus) and can help to avoid injury to the urethra. It is important to stay in the correct plane, and frequent bidigital and bimanual palpation can facilitate this. In men, palpating for the urethra and urinary catheter can help to avoid injury. In women, placing a finger in the vagina can help to define the plane of the rectovaginal septum. Once the specimen is removed, the drains previously placed in the pelvis during the abdominal phase of the procedure are repositioned and secured, and the perineal defect closed. For primary closure, we approximate the ischiorectal fat with a multilayer closure using large absorbable sutures, and approximate the skin with vertical mattress nylon sutures.

Perineal Part of the APR: Lithotomy Position

The operation proceeds as described above for the prone position. However, anterior dissection may be more difficult with the patient in the lithotomy position, especially in men. The surgeon must be in the correct plane, feeling for the urethral catheter in men and the vagina in women.

Postoperative Care

Following an uneventful operation in an otherwise healthy, ambulatory patient, we advocate an enhanced recovery strategy that permits early ingestion of clear liquids and advancement to a low-residue diet as tolerated, limited intravenous fluid resuscitation, early ambulation, and a pain control strategy to minimize the use of narcotics. Because of the extent of pelvic dissection and the risk of early overflow incontinence, the urinary

catheter remains in place until the second or third postoperative day.

When a laparotomy is planned, postoperative pain control is managed with an epidural, a transversus abdominis plane block, which is an injection of local anesthetic into the plane where the somatic nerves traverse, or injection of an extended duration local anesthetic (liposomal bupivacaine) [40].

To protect the perineal wound, physical activity is restricted. If the closure was primary, the patient should avoid prolonged sitting for 4–5 weeks following surgery, to allow the wound to fully heal. Often, the perineal sutures remain in place for 3–4 weeks, as this area has a high incidence of wound dehiscence and infection. If short-duration sitting is absolutely necessary, as is usually the case in the car ride home from the hospital, patients should sit on a soft pillow. They should avoid using a foam ring, which can lead to increased pressure in the perineum and disrupt blood flow. If a ventral rectus abdominus flap is used, the patient should also be instructed to avoid bending at the waist for 3–4 weeks to prevent placing undue tension on the reconstruction.

Management of Complications

The most significant source of morbidity following an APR is the perineal wound. The rate of wound infections in the perineum, often due to the large excision required and the necessity for preoperative radiation, is as high as 40%. Wound infections necessitate opening the wound. Because of the high risk of evisceration, especially with large defects—since there may be no fascia or muscle to support the pelvic floor—this procedure may need to be performed in the operating room. The wound is irrigated, necrotic tissue is removed, and additional drains are placed as needed. Once a granulating base is established, a negative-pressure dressing can be employed to expedite healing.

Genitourinary and sexual dysfunction following an APR may be noted in 50% of patients. Good surgical technique, including identification and protection of the pelvic nerves, helps to prevent such dysfunction. Fortunately, in some patients the dysfunction is relatively minor, and function often continues to improve for 12 months following surgery. However, a small percentage of patients sustain permanent dysfunction, and all patients undergoing an APR must be informed of this possibility preoperatively.

Stoma-related complications, particularly parastomal hernias, are a significant long-term consequence of APR. Because the risk of mesh-related complications is an important consideration, we avoid permanent mesh placement during the initial surgery. However, if a symptomatic parastomal hernia occurs, placement of permanent mesh during the repair operation should be strongly considered, as should a possible translocation of stoma.

Watch and Wait

While surgical resection remains the standard of care for patients regardless of clinical response to neoadjuvant therapy, ~10 to 44% of patients will experience a complete pathologic response (pCR) after long-course chemoradiation [41–43]. These patients have improved outcomes and there has been interest in avoiding the morbidity and mortality associated with radical surgery and consider a “watch and wait” approach [44].

Habr-Gama et al., was the first to report outcomes for the watch and wait approach [45]. Their experience and several other trials suggest that observation after complete clinical response is an option [46–48]. One of the significant barriers to the watch-and-wait approach is the ascertainment of complete clinical response of the primary tumor as well as nodal status. A combination of physical examination with endoscopic and radiologic evaluation should be used, as the diagnostic accuracy of each of these modalities is low. Endoscopic findings of complete response include whitening of the mucosa, telangiectasia without mucosal ulcerations, and subtle loss of pliability of the rectal wall. Residual disease should be highly suspected in the presence of a palpable nodule, ulceration or irregularity. Complete response is similarly problematic to

accurately predict on radiologic imaging [49, 50]. Finally, local excision of the tumor scar may confirm mural sterility, but is associated with significant pain and wound complications [51, 52].

Patients who demonstrate significant or complete mucosal response based on digital rectal exam/proctoscopy may be considered for further evaluation of complete response, whereas patients with moderate to poor response should undergo resection within 6–8 weeks after completion of neoadjuvant therapy as per current guidelines [53].

Patients who exhibit evidence of cCR should be willing and able to undergo a strict surveillance protocol, especially during the first year as this is when most recurrences occur. Based on the approach of Habr-Gama et al. [45], patients should undergo monthly follow-up with digital rectal exam or proctoscopy for the first 3 months, then every 2–3 months for the remainder of the first year. CEA is checked every 2 months. Radiologic evaluation using CT or MRI should be done at the time of initial tumor assessment then every 6 months. Follow-up visits should continue every 3 months after the first year. Suspicious findings on clinical assessment or imaging should prompt further evaluation or radical surgery.

Currently, the limited reported experience and lack of prospective randomized trials along with the difficulty of confirming a complete response, leads most surgeons to recommend a surgical resection for patients that are medically operable and willing to undergo surgery

References

1. Al-Sukhni E, Milot L, Fruitman M, Beyene J, Victor JC, Schmocker S, Brown G, McLeod R, Kennedy E. Diagnostic accuracy of MRI for assessment of T category, lymph node metastases, and circumferential resection margin involvement in patients with rectal cancer: a systematic review and meta-analysis. Ann Surg Oncol. 2012;19:2212–23.
2. Raman SP, Chen Y, Fishman EK. Evolution of imaging in rectal cancer: multimodality imaging with MDCT, MRI, and PET. J Gastrointest Oncol. 2015;6:172–84.
3. Nahas CS, Akhurst T, Yeung H, Leibold T, Riedel E, Markowitz AJ, Minsky BD, Paty PB, Weiser MR, Temple LK, Wong WD, Larson SM, Guillem JG. Positron emission tomography detection of distant metastatic or synchronous disease in patients with locally advanced rectal cancer receiving preoperative chemoradiation. Ann Surg Oncol. 2008;15:704–11.
4. Cedermark B, Dahlberg M, Pahlman L, Rutqvist LE, Wilking N, Swedish Rectal Cancer Trial. Improved survival with preoperative radiotherapy in resectable rectal cancer. New Engl J Med. 1997;336:980–7.
5. Kapiteijn E, Marijnen CA, Nagtegaal ID, Putter H, Steup WH, Wiggers T, Rutten HJ, Pahlman L, Gimelius B, van Krieken JH, Leer JW, van de Velde CJ, Dutch Colorectal Cancer Group. Preoperative radiotherapy combined with total mesorectal excision for resectable renal cancer. New Engl J Med. 2001;345:638–46.
6. Sauer R, Becker H, Hohenberger W, Rodel C, Wittekind C, Fletkau R, Martus P, Tschmelitsch J, Hager E, Hess CF, Karstens JH, Liersch T, Schmidberger H, Raab R, German Rectal Cancer Study Group. Preoperative versus postoperative chemoradiotherapy for rectal cancer. New Engl J Med. 2004;351:1731–40.
7. Guillem JG, Chessin DB, Cohen AM, Shia J, Mazumdar M, Enker W, Paty PB, Weiser MR, Klimstra D, Saltz L, Minsky BD, Wong WD. Long-term oncologic outcome following preoperative combined modality therapy and total mesorectal excision of locally advanced rectal cancer. Ann Surg. 2005;241:829–36. discussion 36-8
8. Bujko K, Nowacki MP, Nasierowska-Guttmejer A, Michalski W, Bebenek M, Kryi M. Long-term results of a randomized trial comparing preoperative short-course radiotherapy with preoperative conventionally fractionated chemoradiation for rectal cancer. Br J Surg. 2006;93:1215–23.
9. Ngan SY, Burmeister B, Fisher RJ, Solomon M, Goldstein D, Joseph D, Ackland SP, Schache D, McClure B, McLachlan SA, McKendrick J, Leong T, Hartopeanu C, Zalcberg J, Mackay J. Randomized trial of short-course radiotherapy versus long-course chemoradiation comparing rates of local recurrence in patients with T3 rectal cancer: Trans-Tasman Radiation Oncology Group trial 01.04. J Clin Oncol. 2012;30:3827–33.
10. Bosset JF, Calais G, Mineur L, Maignon P, Stojanovic-Rundic S, Bensadoun RJ, Bardet E, Beny a OJC, Bolla M, Marchal D, Van Laethem JL, Klein V, Giralt J, Clavere P, Glanzmann C, Cellier P, Collette L. EORTC Radiation Oncology Group. Fluorouracil-based adjuvant chemotherapy after preoperative chemoradiotherapy in rectal cancer: long-term results of the EORTC 22921 randomised study. Lancet Oncol. 2014;15:184–90.
11. Biagi JJ, Raphael MJ, Wj M, Kong W, King WD, Booth CM. Association between time to initiation of adjuvant chemotherapy and survival in colorectal cancer: a systematic review and meta-analysis. JAMA. 2011;305:2335–42.

12. Garcia-Aguilar J, Chow OS, Smith DD, Marcet JE, Cataldo PA, Varma MG, Kumar AS, Oommen S, Coutsoftides T, Hunt SR, Stamos MJ, Ternent CA, Herzig DO, Fichera A, Polite BN, Dietz DW, Patil S, Avila K. Effect of adding mFOLFOX6 after neoadjuvant chemoradiation in locally advanced rectal cancer: a multicentre, phase 2 trial. Lancet Oncol. 2015;16:957–66.
13. Gunderson LL, Sargent DJ, Tepper JE, Wolmark N, O'Connell MJ, Begovic M, Allmer C, Colangelo L, Smalley SR, Haller DG, Martenson JA, Mayer RJ, Rich TA, Ajani JA, Macdonald JS, Willett CG, Goldberg RM. Impact of T and N stage and treatment on survival and relapse in adjuvant rectal cancer: a pooled analysis. J Clin Oncol. 2004;22:1785–96.
14. Guillem JG, Diaz-Gonzalez JA, Minsky BD, Valentini V, Jeong SY, Rodriguez-Bigas MA, Coco C, Leon R, Hernandez-Lizoain JL, Aristu JJ, Riedel ER, Nitti D, Wong WD, Pucciarelli S. cT3N0 rectal cancer: potential overtreatment with preoperative chemoradiotherapy is warranted. J Clin Oncol. 2008;26:368–73.
15. Schrag D, Weiser MR, Goodman KA, Gonen M, Hollywood E, Cercek A, Reidy-Lagunes DL, Gollub MJ, Shia J, Guillem JG, Temple LK, Paty PB, Saltz LB. Neoadjuvant chemotherapy without routine use of radiation therapy for patients with locally advanced rectal cancer: a pilot trial. J Clin Oncol. 2014;32:513–8.
16. D'Angelica MI, Correa-Gallego C, Paty PB, Cercek A, Gewirtz AN, Chou JF, Capanu M, Kingham TP, Fong Y, DeMatteo RP, Allen PJ, Jarnagin WR, Kemeny N. Phase II trial of hepatic artery infusional and systemic chemotherapy for patients with unresectable hepatic metastases from colorectal cancer: conversion to resection and long-term outcomes. Ann Surg. 2015;261:353–60.
17. Chan DL, Alzahrani NA, Morris DL, Chua TC. Systematic review and meta-analysis of hepatic arterial infusion chemotherapy as bridging therapy for colorectal liver metastases. Surg Oncol. 2015;24(3):162–71.
18. Wexner SD, Berho ME. The Rationale for and Reality of the New National Accreditation Program for Rectal Cancer. Dis Colon Rectum. 2017;60(6):595–602. https://doi.org/10.1097/DCR.0000000000000840.
19. Quirke P, Steele R, Monson J, Grieve R, Khanna S, Couture J, O'Callaghan C, Myint AS, Bessell E, Thompson LC, Parmar M, Stephens RJ, Sebag-Montefiore D; MRC CR07/NCIC-CTG CO16 Trial Investigators, NCRI Colorectal Cancer Study Group. Effect of the plane of surgery achieved on local recurrence in patients with operable rectal cancer: a prospective study using data from the MRC CR07 and NCIC-CTG CO16 randomised clinical trial. Lancet. 2009;373(9666):821–8. https://doi.org/10.1016/S0140-6736(09)60485-2.
20. Kitz J, Fokas E, Beissbarth T, Ströbel P, Wittekind C, Hartmann A, Rüschoff J, Papadopoulos T, Rösler E, Ortloff-Kittredge P, Kania U, Schlitt H, Link KH, Bechstein W, Raab HR, Staib L, Germer CT, Liersch T, Sauer R, Rödel C, Ghadimi M, Hohenberger W, German Rectal Cancer Study Group. Association of plane of total mesorectal excision with prognosis of rectal cancer: secondary analysis of the CAO/ARO/AIO-04 phase 3 randomized clinical trial. JAMA Surg. 2018;153(8):e181607. https://doi.org/10.1001/jamasurg.2018.1607. Epub 2018 Aug 15.
21. Nagtegaal ID, Quirke P. What is the role for the circumferential margin in the modern treatment of rectal cancer? J Clin Oncol. 2008;26:303–12.
22. Guillem JG, Chessin DB, Shia J, Suriawinata A, Riedel E, Moore HG, Minsky BD, Wong WD. A prospective pathologic analysis using whole-mount sections of rectal cancer following preoperative combined modality therapy: implications for sphincter preservation. Ann Surg. 2007;245:88–93.
23. Nash GM, Weiss A, Dasgupta R, Gonen M, Guillem JG, Wong WD. Close distal margin and rectal cancer recurrence after sphincter-preserving rectal resection. Dis Colon Rectum. 2010;53:1365–73.
24. Hallböök O, Påhlman L, Krog M, Wexner SD, Sjödahl R. Randomized comparison of straight and colonic J pouch anastomosis after low anterior resection. Ann Surg. 1996;224(1):58–65.
25. Huttner FJ, Tenckhoff S, Jensen K, Uhlmann L, Kulu Y, Buchler MW, Diener MK, Ulrich A. Meta-analysis of reconstruction techniques after low anterior resection for rectal cancer. Br J Surg. 2015;102:735–45.
26. Brown SR, Kahn B, Green HJ, Beck DE. Overall survival associated with ileostomy closure in patients with rectal cancer before and after adjuvant therapy. Ochsner J. 2017;17(4):328–30.
27. Holm T, Ljung A, Haggmark T, Jurell G, Lagergren J. Extended abdominoperineal resection with gluteus maximus flap reconstruction of the pelvic floor for rectal cancer. Br J Surg. 2007;94:232–8.
28. Prytz M, Angenete E, Ekelund J, Haglind E. Extralevator abdominoperineal excision (ELAPE) for rectal cancer--short-term results from the Swedish Colorectal Cancer Registry. Selective use of ELAPE warranted. Int J Color Dis. 2014;29:981–7.
29. Klein M, Fischer A, Rosenberg J, Gogenur I. Extralevatory abdominoperineal excision (ELAPE) does not result in reduced rate of tumor perforation or rate of positive circumferential resection margin: a nationwide database study. Ann Surg. 2015;261:933–8.
30. Jeong SY, Park JW, Nam BH, Kim S, Kang SB, Lim SB, Choi HS, Kim DW, Chang HJ, Kim DY, Jung KH, Kim TY, Kang GH, Chie EK, Kim SY, Sohn DK, Kim DH, Kim JS, Lee HS, Kim JH, Oh JH. Open versus laparoscopic surgery for mid-rectal or low-rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): survival outcomes of an open-label, non-inferiority, randomised controlled trial. Lancet Oncol. 2014;15:767–74.
31. Bonjer HJ, Deijen CL, Abis GA, Cuesta MA, van der Pas MH, de Lange-de Klerk ES, Lacy AM, Bemelman WA, Andersson J, Angenete E, Rosenberg J, Fuerst

A, Haglind E. A randomized trial of laparoscopic versus open surgery for rectal cancer. N Engl J Med. 2015;372:1324–32.
32. Fleshman J, Branda M, Sargent DJ, Boller AM, George V, Abbas M, Peters WR Jr, Maun D, Chang G, Herline A, Fichera A, Mutch M, Wexner S, Whiteford M, Marks J, Birnbaum E, Margolin d LD, Marcello P, Posner M, Read T, Monson J, Wren SM, Pisters PW, Nelson H. Effect of laparoscopic-assisted resection vs open resection of stage II or III rectal cancer on pathologic outcomes: the ACOSOG Z6051 randomized clinical trial. JAMA. 2015;314:1346–55.
33. Stevenson AR, Solomon MJ, Lumley JW, Hewett P, Clouston AD, Gebski VJ, Davies L, Wilson K, Hague W, Simes J, investigators ALCRT. Effect of laparoscopic-assisted resection vs open resection on pathological outcomes in rectal cancer: the ALaCaRT randomized clinical trial. JAMA. 2015;314:1356–63.
34. Fleshman J, Branda ME, Sargent DJ, Boller AM, George VV, Abbas MA, Peters WR Jr, Maun DC, Chang GJ, Herline A, Fichera A, Mutch MG, Wexner SD, Whiteford MH, Marks J, Birnbaum E, Margolin DA, Larson DW, Marcello PW, Posner MC, Read TE, Monson JRT, Wren SM, Pisters PWT, Nelson H. Disease-free survival and local recurrence for laparoscopic resection compared with open resection of stage II to III rectal cancer: follow-up results of the ACOSOG Z6051 randomized controlled trial. Ann Surg 2018. https://doi.org/10.1097/SLA.0000000000003002. [Epub ahead of print].
35. Kim CW, Kim CH, Baik SH. Outcomes of robotic-assisted colorectal surgery compared with laparoscopic and open surgery: a systematic review. J Gastrointest Surg. 2014;18:816–30.
36. Jayne D, Pigazzi A, Marshall H, Croft J, Corrigan N, Copeland J, Quirke P, West N, Rautio T, Thomassen N, Tilney H, Gudgeon M, Bianchi PP, Edlin R, Hulme C, Brown J. Effect of robotic-assisted vs conventional laparoscopic surgery on risk of conversion to open laparotomy among patients undergoing resection for rectal cancer: the ROLARR randomized clinical trial. JAMA. 2017;318(16):1569–80. https://doi.org/10.1001/jama.2017.7219.
37. Boutros M, Hippalgaonkar N, Silva E, Allende D, Wexner SD, Berho M. Laparoscopic resection of rectal cancer results in higher lymph node yield and better short-term outcomes than open surgery: a large single-center comparative study. Dis Colon Rectum. 2013;56(6):679–88. https://doi.org/10.1097/DCR.0b013e318287c594.
38. de Campos-Lobato LF, Stocchi L, Dietz DW, Lavery IC, Fazio VW, Kalady MF. Prone or lithotomy positioning during an abdominoperineal resection for rectal cancer results in comparable oncologic outcomes. Dis Colon Rectum. 2011;54(8):939–46. https://doi.org/10.1097/DCR.0b013e318221eb64.
39. Person B, Vivas DA, Wexner SD. Totally laparoscopic low anterior resection with transperineal handsewn colonic J-pouch anal anastomosis for low rectal cancer. Surg Endosc. 2006;20(4):700–2.
40. Beck DE. Perioperstive care. In: Beck DE, Wexner SD, Rafferty JC, editors. Gordon and nitvatvongs principles and practice of surgery of the colon, rectum, and anus. New York: Thieme; 2016.
41. Stipa F, Chessin DB, Shia J, et al. A pathologic complete response of rectal cancer to preoperative combined-modality therapy results in improved oncological outcome compared with those who achieve no downstaging on the basis of preoperative endorectal ultrasonography. Ann Surg Oncol. 2006;13(8):1047–53.
42. Valentini V, Coco C, Picciocchi A, et al. Does downstaging predict improved outcome after preoperative chemoradiation for extraperitoneal locally advanced rectal cancer? A long-term analysis of 165 patients. Int J Radiat Oncol Biol Phys. 2002;53(3):664–74.
43. Maas M, Nelemans PJ, Valentini V, et al. Long-term outcome in patients with a pathological complete response after chemoradiation for rectal cancer: a pooled analysis of individual patient data. Lancet Oncol. 2010;11(9):835–44.
44. Monson JR, Arsalanizadeh R. Surgery for patients with rectal cancer-time to listen to the patients and recognize reality. JAMA Oncol. 2016;3(7):887–8.
45. Habr-Gama A, Perez RO, Nadalin W, et al. Operative versus nonoperative treatment for stage 0 distal rectal cancer following chemoradiation therapy: long-term results. Ann Surg. 2004;240(4):711–7. discussion 717-718
46. Habr-Gama A, Gama-Rodrigues J, Sao Juliao GP, et al. Local recurrence after complete clinical response and watch and wait in rectal cancer after neoadjuvant chemoradiation: impact of salvage therapy on local disease control. Int J Radiat Oncol Biol Phys. 2014;88(4):822–8.
47. Smith JD, Ruby JA, Goodman KA, et al. Nonoperative management of rectal cancer with complete clinical response after neoadjuvant therapy. Ann Surg. 2012;256(6):965–72.
48. Renehan AG, Malcomson L, Emsley R, et al. Watch-and-wait approach versus surgical resection after chemoradiotherapy for patients with rectal cancer (the OnCoRe project): a propensity-score matched cohort analysis. Lancet Oncol. 2016;17(2):174–83.
49. O'Neill BD, Brown G, Heald RJ, Cunningham D, Tait DM. Non-operative treatment after neoadjuvant chemoradiotherapy for rectal cancer. Lancet Oncol. 2007;8(7):625–33.
50. Perez RO, Habr-Gama A, Gama-Rodrigues J, et al. Accuracy of positron emission tomography/computed tomography and clinical assessment in the detection of complete rectal tumor regression after neoadjuvant chemoradiation: long-term results of a prospective trial (National Clinical Trial 00254683). Cancer. 2012;118(14):3501–11.
51. Marks JH, Valsdottir EB, DeNittis A, et al. Transanal endoscopic microsurgery for the treatment of rectal cancer: comparison of wound complication rates with and without neoadjuvant radiation therapy. Surg Endosc. 2009;23(5):1081–7.

52. Habr-Gama A, Sao Juliao GP, Perez RO. Pitfalls of transanal endoscopic microsurgery for rectal cancer following neoadjuvant chemoradiation therapy. Minim Invasive Ther Allied Technol. 2014;23(2):63–9.
53. Chadi SA, Malcomson L, Ensor J, Riley RD, Vaccaro CA, Rossi GL, Daniels IR, Smart NJ, Osborne ME, Beets GL, Maas M, Bitterman DS, Du K, Gollins S, Sun Myint A, Smith FM, Saunders MP, Scott N, O'Dwyer ST, de Castro Araujo RO, Valadao M, Lopes A, Hsiao CW, Lai CL, Smith RK, Paulson EC, Appelt A, Jakobsen A, Wexner SD, Habr-Gama A, Sao Julião G, Perez R, Renehan AG. Factors affecting local regrowth after watch and wait for patients with a clinical complete response following chemoradiotherapy in rectal cancer (InterCoRe consortium): an individual participant data meta-analysis. Lancet Gastroenterol Hepatol. 2018. pii: S2468-1253(18)30301-7. https://doi.org/10.1016/S2468-1253(18)30301-7. [Epub ahead of print]

24 Principles of Adjuvant and Neoadjuvant Therapy for Locally Advanced Rectal Cancer

Sepehr Khorasani, Arun Nagarajan, Timothy Nguyen, and Sami A. Chadi

Introduction

Over 39,000 individuals are diagnosed with rectal cancer in the United States annually with an overall mortality rate of 35% [1]. Approximately half of these patients present as locally advanced rectal cancer (LARC) defined as T3/4 with or without nodal involvement in the absence of distant metastasis [2, 3].

During the past few decades, there have been significant advancements in the care of rectal cancer patients, attempting to reduce the rates of local recurrences and improve survival outcomes, with the intended added attempt to increase sphincter preservation rates. This evolution has essentially occurred through improvements in surgical technique with the establishment of the widely adopted total mesorectal excision (TME) [4], as well as the development of adjuvant therapy regimens. The current standard of treatment employs multidisciplinary approaches through the improvements in diagnostic and staging assessments that are then used to guide medical, radiation and surgical management of this patient population. Overall, this approach has been shown to result in a 70% decrease in locoregional recurrences and an improvement in the quality of care [5, 6]. Various neoadjuvant treatment modalities have been combined with the standardized TME approach to proctectomy for patients with LARC [7–9]. Unfortunately, after more than 10 years of follow-up, this multimodal strategy has failed to show improvements in systemic recurrences, disease-free survival (DFS) or overall survival (OS) with advantages mainly seen in the area of local recurrences [10, 11].

This chapter will summarize the various components of the multimodal treatment of LARC based on the current available evidence. We will also discuss the current controversies in this field while highlighting the evolving role of individualized care to improve oncological outcomes while preserving the quality of life in patients with LARC.

S. Khorasani · S. A. Chadi (✉)
Department of Surgery, University Health Network, University of Toronto, Toronto, ON, Canada
e-mail: sepehr.khorasani@mail.utoronto.ca; Sami.chadi@uhn.ca

A. Nagarajan
Department of Radiation Oncology, Cleveland Clinic Florida, Weston, FL, USA
e-mail: nagaraa@ccf.org

T. Nguyen
Department of Hematology/Oncology, Cleveland Clinic Florida, Weston, FL, USA
e-mail: nguyent5@ccf.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_24

Locally Advanced Rectal Cancer

Total Mesorectal Excision

Prior to the advent of perioperative chemotherapy or radiation therapy, the local recurrence rates in LARC were as high as 40% [12]. Efforts to address this high local recurrence led to two seemingly different yet highly interlinked approaches. One movement focused on the enhancement of perioperative adjuvant therapy whereas the other, equally important approach focused on improving the surgical technique itself [13]. The latter was advocated by professor Richard "Bill" Heald from Basingstoke, UK, who gave total mesorectal excision in rectal cancer widespread attention in 1979 [14, 15]. In his article, Dr. Heald emphasized the importance of the direct visualization and resection of an intact mesorecum by sharp dissection along the visceral and parietal pelvic fascial planes while mobilizing the rectum [14]. This technique would theoretically allow for the removal of potential residual tumors in an otherwise retained and intact mesorectum which has been postulated to be one of the causes of local recurrence after rectal cancer surgery [16, 17]. Indeed, the adoption of this surgical technique by itself, irrespective of the administration of adjuvant treatment, has led to a reduction in local recurrence rates to as low as 5–10% [13].

Neoadjuvant Therapy

Neoadjuvant therapy is defined as the administration of medical or radiation adjuncts to treatment in the pre-operative setting [18]. In the past, local recurrence rates of LARC occurred as high as 40% of the time [12]. However, with the advent of neoadjuvant therapy as well as standardized TME surgery, this rate has been dropped to as low as 5–10% in some series of patients with LARC [19, 20].

Neoadjuvant therapy in the form of radiosensitizing chemotherapy and external beam radiation has become a standard component of the multimodal treatment in LARC. Although this strategy has resulted in significant improvements in local recurrence rates, studies have yet to demonstrate consistent disease-free or overall survival benefits [13]. One of the seminal studies to demonstrate a benefit to the addition of chemotherapy with neoadjuvant radiation was the multi-arm randomized controlled trial of European Organization for Treatment of Cancer Radiotherapy Study group (EORTC 22921). In this study, the authors randomized 1011 patients with T3/T4 rectal cancer into one of four arms: pre-operative radiotherapy, pre-operative chemoradiotherapy, pre-operative radiotherapy with post-operative chemotherapy, and pre-operative chemoradiotherapy with post-operative chemotherapy. They found that the addition of chemotherapy to preoperative radiotherapy resulted in significant improvement in local control despite no improvements in overall survival. The strongest local control at 5 years (7.6%) was observed in the group who received preoperative chemoradiotherapy and postoperative chemotherapy [21].

Chemoradiation

Types of Chemotherapy

Fluoropyridimidines have been used for their role as radiation sensitizing agents and are the standard chemotherapeutic agents used in neoadjuvant chemoradiotherapy (NACRT). Classically, infusional 5-fluorouracil (5-FU) +/− Leucovorin (folinic acid) has been the chemotherapy of choice in NACRT. 5-FU can be delivered as an interrupted bolus infusion or protracted venous infusion (PVI), concurrently with pelvic radiation. The US GI Intergroup 86-47-51 trial compared bolus 5-FU with PVI 5-FU showing the latter to be associated with improved 4-year DFS (53 vs. 63%; $p = 0.01$) and 4-year overall survival (60 vs. 70%; $p = 0.005$), at least partly due to reduced distant recurrences [22]. However, PVI chemotherapy requires central venous access and patient compliance and is known to be associated with an increased severity of diarrhea [23].

Capecitabine is an oral prodrug converted to 5-FU by intracellular thymidine phosphorylase and has been shown to be non-inferior to infusional 5-FU with a favorable adverse reaction profile in the setting of NACRT [24–26]. This non-inferiority of capecitabine was shown in a

German phase III randomized controlled trial where stage II and III rectal cancer patients were randomized to either capecitabine or 5-FU radiosensitizing chemotherapy with radiation, in the pre- or post-operative setting. This trial demonstrated Capecitabine to be non-inferior to 5-FU in 5-year overall survival (76% vs. 67%; p = 0.004) with a post-hoc test for superiority in favour of capecitabine (p = 0.05). 3-year Disease-free survival was 75% with capecitabine versus 67% with 5-FU (p = 0.07). There was no significant difference in local recurrences although there was a significantly lower rate of systemic recurrences with capecitabine [26]. In the NSAPB-R04 study, authors compared capecitabine, with or without oxaliplatin, to infusional 5-FU with or without oxaliplatin, as the neoadjuvant chemoradiation regimen for patients with stage II and III rectal cancer. When comparing oral capecitabine with infusional 5-FU groups, no differences were noted in sphincter preservation, complete pathological responsiveness, or rates of down-staging [24, 27].

Given the benefits of Oxaliplatin addition to 5-FU in the adjuvant treatment of locally advanced colon and rectal cancer (see Adjuvant Therapy section), various large prospective trials have investigated its utility in the setting of NACRT. The NSABP R-04, the STAR-01, the ACCORD 12/0405-Prodige 2, and the PETACC-6 trials all investigated the addition of this agent to 5-FU based NACRT. These studies failed to show any significant improvements in pathologic complete response, locoregional control, and survival outcomes associated with the addition of oxaliplatin. There was, however, an increase in grade 3–4 toxicity in the oxaliplatin groups in these studies [24, 28–30]. The German CAO/ARO/AIO-04 trial was the only study that showed higher pathological complete response (pCR) (17% vs 13%; p = 0.038) and 3-year DFS (75.9% vs 71.2%; p = 0.03) without increased overall toxicity in the Oxaliplatin group [31, 32]. It should be noted that this study has been criticized for the inclusion of Oxaliplatin in the adjuvant setting as well as using different 5-FU dosing regimens for the two arms [6]. The findings of these trials suggest that the addition of oxaliplatin to NACRT is currently not warranted given the increased associated toxicity with minimal survival benefit.

Lastly, initial results of the Chinese FOWARC multicenter, randomized phase III trial have shown that the use of modified FOLFOX6 (mFOLFOX6) chemotherapy concurrent with radiotherapy preoperatively may result in increased rates of down-staging with acceptable tolerability. In this study, patients with LARC were randomized to one of three groups: (1) fluorouracil-radiotherapy (5-FU with radiotherapy, followed by surgery and adjuvant 5-FU), (2) mFOLFOX6-radiotherapy [similar to the previous group with intravenous Oxaliplatin 85 mg/m^2 on day 1 of each cycle (modified FOLFOX6)], and (3) mFOLFOX6 (four to six cycles of mFOLFOX6 followed by surgery and six to eight cycles of mFOLFOX6). The mFOLFOX6-radiotherapy group had higher rates of pCR (14.0% vs 27.5%) compared with fluorouracil-radiotherapy group. Although there were increased grade 3–4 toxicity rates in the mFOLFOX6 group, the compliance was unchanged [33]. These findings suggest that NACRT with mFOLFOX6 may potentially result in improved outcomes given the observed increased pCR; however, this preliminary finding requires further confirmation. Additionally, the authors are expecting the final primary outcome, DFS, to be available in 2017, which may provide more robust evidence for this new neoadjuvant regimen. Until then, 5-FU/capecitabine based NACRT without oxaliplatin remains standard of care.

Types of Radiation Therapy

Currently, there are two common variations to delivering radiation therapy (RT) preoperatively. The efficacy of these forms of radiation stem from multiple sources of evidence, but one must be selective for those that were performed in the era of the TME approach to proctectomy. Short-course radiation therapy (SCRT), which is mostly endorsed in Europe, involves 5 Gy fractions of radiation over 5 days for a total of 25 Gy followed by surgery in 1 week. One of the seminal studies to investigate this was the Dutch TME trial. In this trial patients were randomized to short course radiation therapy before or after TME surgery. Local recurrence was found to be

significantly lower in the neoadjuvant radiation therapy group (4.6 vs. 11%; p < 0.0001) with similar 10-year distant recurrence (25 vs. 28%; p = 0.21) or overall survival (48 vs. 49%; p = 0.86) [10, 34].

The alternative approach, long-course chemoradiation therapy (CRT), is generally the standard regimen used in North America and involves 1.8–2.0 Gy radiation per day over 20–25 fractions for 5–6 weeks for a total of 45–50 Gy. This regimen is traditionally followed by surgery in 6–8 weeks, although this period has been gradually increasing as we will discuss further in an upcoming section. This regimen is often combined with radiosensitizing fluoropyrimidine-based chemotherapy. One of the original studies to demonstrate the effect of this form of neoadjuvant therapy was the German Rectal Cancer Trial. This landmark trial randomized patients with stage II and III rectal cancer to receive preoperative and postoperative chemoradiation in addition to 5FU-based adjuvant chemotherapy. They showed a significant reduction in local recurrence rates when CRT was given in the neoadjuvant setting (6% vs 13%; p = 0.006), which also persisted on the 10-year follow-up assessment. Chemotherapy associated toxicity was also lower in the neoadjuvant group (27 vs. 40 %; p = 0.01). However, overall survival and rates of distant metastasis (36%) did not change significantly between the two groups [35].

It is thought that, in addition to lower costs, SCRT would result in lower rates of early toxicity with a chance for delayed toxicity [13, 35–37]. Conversely, there is evidence that CRT could result in greater downstaging when delivered in the neoadjuvant setting. Two randomized controlled trials have investigated the potential benefits of one regimen over the other [38, 39]. The Polish Colorectal Study Group randomized 316 patients to receive either SCRT or CRT. The authors found no significant differences in rates of local recurrence (9 vs. 14.2%; p = 0.17), disease-free survival (58.4 vs. 55.6%; p = 0.82), or overall survival (67.2 vs. 66.2%; p = 0.96) when comparing the SCRT with CRT, respectively [38]. However, patients in the CRT group had higher pCR rates (16% vs. 1%) and lower incidences of involved circumferential resection margin (4% vs. 13%; p = 0.017) with no differences in sphincter preservation (58 vs. 61%; p = 0.57). Despite increased acute toxicity in the CRT group (18.2 vs 3.2%; p < 0.001) the rates of post-operative complications were similar [38].

In a similar trial by the Tran-Tasman Radiation Oncology Group (TROG-01.04), Ngan et al. [39] randomized 326 patients to SCRT or CRT followed by surgery and 6 months of adjuvant chemotherapy. The authors reported no significant differences in overall survival, distant recurrence or late toxicity between the two groups. Although there was a trend toward lower cumulative local recurrence at 3 years (4.4% vs. 7.5%) and 5 years (5.7% vs. 7.5%) in the CRT arm, these findings were not statistically significant [39].

Zhou et al. [40] recently published a meta-analysis of the existing studies comparing neoadjuvant SCRT with CRT and confirmed no significant difference in local recurrence, disease-free or overall survival between the two modalities. There was an increased rate of pCR (RR 0.15; p = 0.003) at the cost of having increased grade 3-4 toxicity in the CRT group (RR: 0.13; p < 0.00001). Of note, the long-term toxic effects were not substantially different between SCRT and CRT. Given the results of these studies, currently either SCRT or CRT is appropriate in the neoadjuvant setting as represented by the different European and North American Guidelines.

The Stockholm Colorectal Cancer Study Group initiated the multicenter randomized Stockholm III Trial, to further study the outcomes related to various RT fractionation regimens and timing to surgery for rectal cancer, with local recurrence as the primary endpoint [41]. The three preoperative RT regimens included short-course RT (5 × 5 Gy) and surgery within 1week (group 1), short-course RT and surgery after 4–8 weeks (group 2), and long-course RT (25 × 2Gy) and surgery after 4–8 weeks (group 3). The first interim analysis focused on feasibility, compliance and complications after RT and surgery, and found no significant difference in postoperative complications between the three groups (46.6%, 40.0%, and 32% in groups 1, 2, and 3, respectively; p = 0.164) [41]. The second interim analysis compared the pathological outcomes of delaying surgery in the

two short-course RT arms (groups 1 and 2), and demonstrated earlier ypT categories, higher pCR rates (11.8% vs. 1.7%; p = 0.001) and Dworak grade 4 tumor regression (10.1% vs 1.7%; p < 0.001) in group 2 compared with group 1 [42].

A novel approach for delivery of neoadjuvant RT is the consideration of selective use of RT. With recent evidence supporting potential benefits of neoadjuvant systemic chemotherapy (see *induction chemotherapy* section), the phase II/III PROSPECT trial (NCT01515787) is currently underway comparing neoadjuvant FOLFOX with selective use of chemoradiation to standard neoadjuvant CRT [23]. In this study, patients with LARC are randomized to two groups. The first group will undergo standard neoadjuvant chemoradiation therapy (5-FU or Capecitabine with RT), followed by surgery and adjuvant chemotherapy. In the second group, after 6 cycles of neoadjuvant FOLFOX, tumor response is measured by MRI or endorectal ultrasound (ERUS). If the tumor has not regressed by at least 20%, patients will undergo the standard CRT used in group 1. However, those with >20% tumor response will go on to surgical resection followed by adjuvant therapy [43].

Intraoperative Radiation Therapy

As previously discussed, radiotherapy, with or without chemotherapy, is currently used in the neoadjuvant setting to improve local recurrence and to potentially down-size tumors and facilitate an R0 surgical resection. However, normal tissue tolerance limits the dose of radiotherapy preoperatively [44]. Therefore, the concept of intraoperative radiotherapy (IORT) with either electrons (IOERT) or high dose brachytherapy (HDR-IORT), especially in cases of LARC, borderline resectable T4 rectal cancers, has been introduced as part of the multimodality treatment of LARC [45]. IORT allows for a targeted boost delivery comparable to an additional 30–40 Gy of fractionated irradiation with the possibility to shield or remove dose-sensitive surrounding structures [46].

Studies to date have shown mixed results in terms of the benefits of IORT on oncologic outcomes. As an example, two RCT's have failed to show a benefit to the addition of IORT to the treatment of LARC [47–49]. Conversely, a study by Kusters et al. [46] showed no local recurrences in 55% of patients treated with IORT for positive resection margins. In another study by Ferenschild et al. [50], the addition of HDR-IORT resulted in improved 5-year local control in patients where R0 resection was not feasible (58% vs 0%). Lastly, in a series by Valentini et al. [51], the authors demonstrated an improved 5-year local control rate in patients with T4 rectal cancer who received IORT following standard preoperative chemoradiation and an R0 resection (100% vs 81%; p = 0.014).

In summary, the results of these studies support the effect of IORT on residual tumor cells that may result in improved local control of locally advanced rectal cancers, in particular, margin positive or margin close T4 lesions.

Endoluminal Brachytherapy

High-dose rate endorectal brachytherapy (HDREBT) has been used in the preoperative setting to down-size tumors and facilitate sphincter preservation surgery, especially in low rectal cancers [52]. Kusunoki et al. [53] was the first to report improved local control with the use of endorectal brachytherapy prior to sphincter-preserving surgery. Patients who underwent brachytherapy and surgery had a lower cumulative 5-year local recurrence rate compared to those undergoing surgery alone (11% vs. 38%; p = 0.004) [53]. Aside from its role as monotherapy, HDREBT has also been successfully used as an adjunct to neoadjuvant external beam RT. Applet et al. [54] randomized 248 with non-metastatic LARC to chemoradiation with or without brachytherapy boost followed by surgical resection 8 weeks later. In the brachytherapy boost group, the authors found significant improvements in R0 resection rates and near 50% increase in tumor response for cT3 tumors, with no increase in surgical complications or early toxicity. There were no differences in progression free or overall survival between the two arms.

Lastly, given the lack of nodal drainage and mesorectal fascia coverage in HDREBT and potential added benefit of nodal sterilization by external beam radiation, a group from John Hopkins is comparing neoadjuvant external beam radiation to HDREBT in a phase III trial [52].

Currently, other studies are also analyzing the role of HDREBT in the radical treatment of early rectal cancer [52].

Timing of Surgery Post-Chemoradiation

The optimal timing of surgery after radiotherapy remains a topic of much debate. The rational for delaying surgery post radiation is to maximize the effects of RT on tumor cell death [55]. However, delay in surgery may also result in increased fibrosis and potentially a more challenging operation. In addition, theoretically the benefits of neoadjuvant therapy may wane with time.

One of the seminal randomized controlled trials to investigate this topic is the Lyon R90-01 trial. In this study, the authors randomized 201 patients to operation either 2 weeks or 6–8 weeks after radiation. They found significant improvements in clinical tumor response (53.1 vs. 71.1%; $p = 0.007$) and pathological tumor downstaging (10.3 vs. 26%; $p = 0.005$) when operation was performed 6 to 8 weeks after radiation. There were, however, no significant differences in sphincter preserving surgery, morbidity, local recurrence or short-term survival between the two groups [56]. Similarly, other studies by Tulchinsky et al. [57] and Kalady et al. [58] showed the only independent factor associated with good response or pCR was longer delay between radiation and surgery (7 weeks or longer). A recent meta-analysis of 13 retrospective studies also confirmed these findings [59].

To further study the relationship between a longer interval after neoadjuvant chemoradiation (nCRT-surgery interval) and pCR, Probst and colleagues [60] reviewed 17,255 patients from the National Cancer Database. The authors divided patients into various nCRT-surgery intervals of >8 weeks, 6–8 weeks, and <6 weeks and demonstrated pCR rates of 13.2%, 11.7%, and 8.7%, respectively for each group ($p < 0.001$). Higher odds of pCR (OR = 1.12, 95% CI = 1.01–1.25) and tumor downstaging (OR = 1.11, 95% CI = 1.02–1.25) were noted in the nCRT-surgery interval >8 weeks. Lastly, the cumulative pCR rate appeared to reach a maximum between weeks 10 and 11.

Most recently, the French GRECCAR-6 randomized trial compared the effect of delay of 7 weeks with 11 weeks from CRT to time of surgery on the pCR rate as the primary outcome of the study. They found that this 4-week increase in delay not only resulted in similar pCR but was also associated with increased post-operative morbidity and worse quality of mesorectal excision. The authors concluded that surgery after 11 weeks from time of CRT should be avoided, especially without the use of chemotherapy in the interim [61]. Additionally, a study from Royal Marsden Hospital in the United Kingdom is currently randomizing patients to surgery 6 weeks versus 12 weeks after neoadjuvant radiotherapy/chemoradiation. The primary end-point of this study is to measure the difference in the proportion of patients in each arm, down-staged according to the T stage. The results are pending at this time (clinicaltrials.gov ID: NCT01037049).

As can be seen from the available evidence, there appears to be a favorable impact on pCR by delaying the time interval from radiation to surgery; however, the most optimal waiting period is still to be determined, although 8-10 weeks is a reasonable period until further information is available.

Surgery Related Outcomes Post Chemoradiation

Although mostly as a secondary outcome, many studies have investigated the role of neoadjuvant therapy on various surgical outcomes including sphincter preservation (SP), anastomotic integrity and various functional outcomes after surgery.

For the most part, if feasible and oncologically safe, patients prefer sphincter-preserving procedures compared to radical abdominoperineal resection (APR). Due to improvements in surgical technique and concepts, changes in neoadjuvant treatment, as well as availability of specialty centers in rectal surgery, SP rates as high 77% have been achieved [62]. Lyon R90-01 study looked at SP as a secondary outcome when comparing 2 weeks versus a 6–8 week delay after completion of radiotherapy. The authors did not

find a significant difference in rates of SP between the two groups [56]. The Polish as well as several other trials have also failed to show any increase in SP rates in patients treated with neoadjuvant SCRT versus CRT, despite improved pCR rates with the latter [63–65].

Anastomotic leak (AL) is one of the most feared surgical complications in the treatment of rectal cancer. To date, there has been insufficient data on the relationship between neoadjuvant chemoradiation and AL. Most studies are either observational or insufficiently powered sine they include AL as a secondary outcome [66]. Although some small observational studies have suggested an increase AL associated with NACRT [67–69], a recent meta-analysis of 7 RCT's by Qin et al. [70] found that NACRT was not an independent risk factor for AL (OR 1.02; 95% CI: 0.80–1.30; p = 0.88). As it stands, there is insufficient data to show any strong association between NACRT and AL.

In addition to SP and AL, the effect of neoadjuvant treatment on various functional outcomes such as sexual dysfunction and urinary or fecal incontinence has also been investigated. A follow up of the Dutch trial investigating functional outcomes after neoadjuvant radiotherapy showed that radiated patients have significantly higher rates of daytime and night incontinence, anal mucus and blood loss, and daily pad use [71]. In a report of a multicenter randomized trial, Marijnen et al. [72] found preoperative radiotherapy to be associated with higher rates of sexual dysfunction. However, in a follow-up study from the MRC CR07/NCIC-CTG C016 trial, the authors found that surgery, and not radiotherapy, was the principally associated cause [73]. Lastly, a comprehensive meta-analysis of observational and prospective trials by Loos et al. [74] demonstrated an increased rate of stool incontinence in irradiated patients (RR 1.67; p < 0.00001). However, the authors did not find an increased incidence of sexual dysfunction in the irradiated group.

Toxicity and Compliance

In addition to tumor downstaging and the theorized increased effect on well-oxygenated tissue, one of the main benefits to neoadjuvant treatment (compared to adjuvant) is improved patient tolerance to the therapeutic regimen [75, 76]. Many studies have compared the toxicity of SCRT vs. CRT radiation regimens with inconsistent results. In 2014, Zhou et al. [40] performed a meta-analysis of 6 trials to investigate rates of grade 3–4 toxicity in patients undergoing neoadjuvant therapy. They reported a significantly lower rate of acute toxicity in the SCRT group (RR 0.13; 95% CI 0.06–0.28; p < 0.00001). This increase in grade 3–4 toxicity with CRT was also confirmed in a recent Cochrane review by De Caluwe et al. [77] (OR: 1.68–10; p < 0.002). The EORTC trial also investigated toxicity and adherence related to various pre- and post-operative treatments and demonstrated an adherence rate of 98% compared to 95.5% when comparing radiotherapy with combination chemoradiation therapy [21]. In the same study, authors also demonstrated a higher adherence rate to 5-FU infusion in the neoadjuvant setting compared to adjuvant (82% vs. 42.9%).

Nevertheless, it is now established that compliance to treatment is improved with neoadjuvant treatment compared to adjuvant. This may be the result of patients being more physically and mentally fit at the time of therapy delivery pre-operatively. For this reason, studies are now investigating the role of pre-habilitation programs peri-operatively to improve patient outcomes and adherence to treatment [78, 79].

Pathologic Complete Response and the "Watch and Wait" Approach

Approximately 15–27% of patients with LARC achieve pCR (ypT0N0) after neoadjuvant chemotherapy [80]. These responders are known to have better oncological outcomes such as local recurrence rates below 1% and 5-year survival rates greater than 95% [80, 81]. Given the excellent prognosis of this patient population and potential costs and morbidities associated with surgery, studies are now investigating the role of non-operative management (NOM) or "watch and wait" approaches in patients achieving a complete clinical response (cCR) post NACRT. The largest experience with this

approach comes from Brazil where Habr-Gama and colleagues [82] followed patients with evidence of a cCR post-neoadjuvant therapy clinically and radiologically using an intense form of surveillance. Patients underwent a TME if there was evidence of tumor persistence after neoadjuvant therapy or a local regrowth in the surveillance period. They achieved an overall rate of 78% organ preservation with 91% overall survival in the NOM group. There was a 10% local regrowth rate in the NOM group during follow-up; however, all patients underwent curative salvage surgery. Lastly, the oncological outcomes of the patients with cCR in the NOM group were similar to those with pCR after TME [82–85]. Similar promising results for NOM after cCR have been reported from Maastricht University in the Netherlands as well as Memorial Sloan Kettering Cancer Centre (MSKCC) in the United States [85, 86], among others.

In summary, these preliminary results demonstrate a potential role for NOM in a highly select group of patients who achieve cCR after neoadjuvant therapy. However, at this stage, such patients must be surveilled very closely in highly specialized cancer centers to be able to detect potential local recurrences early and treat them accordingly. Another limitation of this approach is the discordance between cCR and pCR and challenges with differentiating tumor from fibrosis on imaging after neoadjuvant treatment. Therefore, standardization of the clinical and endoscopic features to determine cCR is of utmost importance for this approach to be a reliable [13].

Adjuvant Therapy

Adjuvant Chemotherapy

The advent of modern surgical techniques combined with NACRT has resulted in improved locoregional control; however, distant relapse remains a significant issue [6].

In 1990, the landmark study by Moertel et al. [87] showed a 41% reduction in cancer recurrence and 33% reduction in death of patients with stage III colon cancer undergoing adjuvant chemotherapy (aCT) compared to observation alone after surgery. Additionally, a 2012 Cochrane review of 21 randomized control trials further showed a significant risk reduction in mortality of up to 17% in curatively treated rectal cancer patients undergoing adjuvant chemotherapy compared to post-operative observation. However, in 20 of these studies, patients did not receive neoadjuvant therapy preoperatively [88]. Lastly, a meta-analysis by Biagi et al. [89] showed a 14% increase in mortality for every 4 weeks of delay in aCT following the first 4 weeks after colorectal cancer surgery. The results of such studies combined with the extrapolation of data from colon cancer treatment have resulted in the routine use of aCT in LARC.

Given the lack of Level I evidence, there remains a great deal of controversy in the role of aCT post neoadjuvant therapy in reducing distant recurrences or improving survival in LARC. This is evident by varying treatment guidelines across the globe; for instance, per 2015 National Comprehensive Cancer Network (NCCN) guidelines, all patients who receive preoperative CRT should receive aCT regardless of pathological stage [90]. Although not standard practice in the Netherlands or Norway, the European Society for Medical Oncology (ESMO) recommends aCT in pathological stage III and “high-risk” stage II rectal cancers. Lastly, the 2012 European consensus conference on colorectal cancer did not reach a consensus for use of aCT in stage II or III disease [8, 91, 92].

In a recent review by Netter et al. [11], existing evidence addressing the role of aCT in LARC patients after neoadjuvant CRT was reviewed. Four randomized phase III trials recently compared the survival outcomes of aCT with observation and have failed to show any statistical efficacy for 5FU based aCT. The European Organization for Research and Treatment of Cancer Trial (EORTC 22921) randomized 1011 patients with LARC into 4 therapeutic groups: neoadjuvant radiotherapy or CRT followed by three months of aCT with FUFOL (5FU and Leucovorin) or observation only. There was no significant improvement in 10-year OS (51.8 vs. 48.4%, HR: 0.91, 95% CI: 0.77–1.09; p = 0.32) or DFS (47 vs. 43.7%, HR: 0.91, 95% CI: 0.77–

1.08; p = 0.29) [93]. The CHRONICLE Trial randomized 113 patients with LARC receiving preoperative 5FU CRT to post-operative 6 cycles of XELOX (capecitabine and oxaliplatin) or observation alone. This study too, failed to show a significant difference in 3-year DFS between the two groups (78 vs. 71%, HR: 0.80, 95% CI: 0.38–1.69; p = 0.56) [94, 95]. The PROCTOR-SCRIPT Trial compared observation with 5FU-based aCT in 437 patients receiving neoadjuvant radiation (86%) or CRT (14%). There was no significant difference in 5-year OS (80.4 vs. 79.2%, HR: 0.93, 95% CI: 0.62–1.39; p = 0.73) or DFS (62.7 vs. 55.4%, HR: 0.80, 95% CI: 0.60–1.07; p = 0.13) in this study either [96]. Lastly, the Italian trial, I-CNR-RT randomized 634 patients with LARC to 6 cycles of adjuvant 5FU/leucovorin or observation. The authors showed similar 5-year OS (69.1 vs. 70%, HR: 1.045, 95% CI: 0.775–1.410; p = 0.772) and DFS (65.3 vs. 62.8%, HR: 0.997, 95% CI: 0.724–1.319; p = 0.882) between the two arms [97]. Although none of these four RCT's showed any survival benefit for 5FU-based aCT, their results should be interpreted with caution because of limitations such as heterogeneity of the inclusion criteria between studies, lack of statistical power, poor adherence and variations in preoperative, operative and adjuvant regimens [11].

Three meta-analyses have also looked at the role of aCT post neoadjuvant treatment and surgery in patients with LARC. Breugom et al. [96] performed a meta-analysis of the aforementioned four RCT's (EORTC, CHRONICLE, PROCTOR-SCRIPT, I-CNR-RT,) including 1196 patients with ypTNM stage II and III and R0 resection. No improvement in 5-year OS, DFS or distant recurrences was observed. Conversely, the meta-analysis of 16 studies by Petrelli et al. [98] did show an improvement in 5-year OS (HR: 0.64, 95% CI: 0.46–0.88; p = 0.006) and DFS (HR: 0.71, 95% CI: 0.6–0.83; p < 0.0001) in patients treated with 5FU-based aCT; however, this survival benefit was more significant in retrospective studies analyzed. Lastly, Bujko et al. [99] in 2015 included 5 studies (EORTC, I-CNR-RT, PROCTOR-SCRIPT, QUASAR, CHRONICLE) as the first part of their meta-analysis and reached the same conclusion of no significant benefit with aCT on OS (HR: 0.95, 95% CI: 0.82–1.10; p = 0.49) or DFS (HR: 0.92, 95% CI: 0.80–1.04; p = 0.19). There was, however, an improvement in DFS only in patients with stage II and III disease after subgroup analyses (HR: 0.79, 95% CI: 0.62–1.00; p = 0.047).

Currently the combination of 5FU/leucovorin or capecitabine (an orally delivered prodrug formulation of 5-FU) with oxaliplatin (FOLFOX or XELOX, respectively) is the standard treatment for locally advanced colon cancer in the adjuvant setting (201). The evidence for this regimen came from the Multicenter International Study of oxaliplatin/(5-FU)/leucovorin in the Adjuvant Treatment of Colon Cancer (MOSAIC) trial which found addition of oxaliplatin to 5FU-based aCT improved 5-year DFS survival in stage II and III colon cancer (73.3 vs. 67.4%; p = 0.03) and 6-year OS in stage III colon cancer (72.9 vs. 68.7%; p = 0.023), when compared with 5FU alone [100]. The survival benefit of oxaliplatin addition to 5FU-based aCT in stage II and III colon cancer was further supported by the National Surgical Adjuvant Breast and Bowel Project (NSABP) C-07 in 2011 where a significant improvement in the 5year-DFS of the patients receiving combination therapy was observed (69.4 vs. 64.2%; p = 0.002) [101].

Extrapolating from colon cancer data, it seems logical that the addition of oxaliplatin to 5FU-based aCT in LARC would improve its efficacy. Two randomized trials have attempted to address this issue. The ADORE phase II Korean trial randomized 321 patients with LARC after neoadjuvant CRT and TME surgery to either receive mFOLFOX or 5FU/leucovorin. They showed an improved 3-year DFS in the FOLFOX group despite increased but acceptable, mostly grade 1–2, toxicity (72 vs. 63%, HR: 0.66, 95% CI: 0.43–0.99; p = 0.047). Subgroup analysis in this trial showed the 3-year DFS to be mainly attributable to stage III cancers [102]. Unlike previously, the adherence rates in both trials were fair (96% patients in ADORE trial and 82%) patients in CAO/ARO/AIO-04 completed aCT. In the phase III German trial of CAO/ARO/AIO-04, 1265 patients with LARC were randomized to receive 5FU with oxaliplatin (mFOLFOX) or 5FU bolus only

(without leucovorin) as neoadjuvant CRT and aCT (4 months). This trial, too, showed a significant improvement in 3-year DFS with the addition of oxaliplatin (75.9% vs. 71.2% HR: 0.79, 95% CI: 0.64–0.98; $p = 0.03$) [103]. Although both trials used a rather suboptimal 5FU regimen, they do provide support for the use of combination therapy with oxaliplatin as the chemotherapy regimen of choice with acceptable toxicities in at least stage III and high-risk stage II rectal cancers.

Induction vs. Adjuvant Chemotherapy

The current 'gold standard' treatment for LARC in the United States is neoadjuvant CRT, followed by TME resection and adjuvant chemotherapy (aCT). However, given the unchanged distant recurrence rate of 30% despite advances in operative and adjuvant therapies and difficulties with adherence to postoperative aCT, there is now interest in delivery of systemic chemotherapy preoperatively as induction chemotherapy (iCT) also known as total neoadjuvant therapy [33]. This strategy would theoretically improve distant metastasis control and potentially enhance survival by improving compliance as well as treating occult micro-metastases early in the treatment of LARC [104]. Additionally, iCT could potentially contribute to preoperative downstaging of the tumor which is known to be associated with a higher likelihood of R0 resection and a lower chance of local recurrence [33].

Chau et al. [105] from Royal Marsden Hospital, investigated the effect of neoadjuvant capecitabine/oxaliplatin before CRT and TME in patients with high-risk rectal cancer. Seventy-seven patients in the study received 12 weeks of neoadjuvant capecitabine/oxaliplatin followed by CRT, TME and additional 12 weeks of Capecitabine. Authors showed substantial tumor regression (97% after CRT) and symptomatic response rates (86%), and 99% R0 resection with a 24% pCR rate [105].

To follow-up on Royal Marsden Hospital findings, a phase II trial in Spain randomized 108 patients with LARC to either preoperative CRT, TME resection and 4 cycles of adjuvant capecitabine and oxaliplatin (CaPOX) or induction CaPOX followed by CRT and TME resection. They did not show any significant difference in pCR, downstaging, tumor regression or R0 resection rates. They did however find lower grade 3–4 toxicity (19% vs. 54%) and better compliance in the induction arm [106].

The role of iCT after CRT in the neoadjuvant setting for LARC has also been studied in the TIMING trial (NCT00335816; Timing of Rectal Cancer Response to Chemoradiotherapy Trial). They demonstrated that delivering two, four, or six cycles of FOLFOX after CRT increased the pCR rates up to 25%, 30%, and 38%, respectively, compared with CRT alone (18%). There was no significant increase in surgical complications or adverse events and 80% completed consolidation CT without interruption [107, 108].

As reflected in the updated NCCN guidelines, despite the lack of data from large scale prospective trials, the results of these studies show that iCT (FOLFOX or CAPOX) before CRT may be considered as an acceptable alternative in the treatment of LARC [7, 23].

Lastly, given the promising results of iCT, studies are currently investigating the feasibility of the selective use of CRT in the context of iCT. In particular, the PROSPECT study (NCT01515787) is a randomized trial comparing neoadjuvant FOLFOX with selective use of CRT (e.g. if intolerant to chemotherapy or progression of disease on chemotherapy) to standard neoadjuvant chemoradiation for patients eligible for TME surgery based on the location of tumor [23].

Adjuvant Chemotherapy Following PCR

The current recommendations from the NCCN guidelines encourage 6 months of total peri-operative 5-FU-based chemotherapy, with approximately 4.5 months of the therapy occurring in the adjuvant setting [7]. However, in attempts to further individualize care and reduce unnecessary

toxicity in the treatment of patients with LARC, multiple studies have looked at the possibility of withholding adjuvant chemotherapy in patients who achieve pCR after CRT.

Approximately 15–27% of patients with LARC undergoing CRT achieve pCR [109]. These patients with pCR are thought to have improved oncological outcomes when compared with non-responders. A literature review in 2010 by Maas et al. [80] found pCR to be associated with improved 5-year DFS (83.3 vs. 65.6%), lower local recurrence rates (2.8 vs. 9.7%), improved distant metastasis-free survival (88.8 vs. 74.9%), and improved overall survival (87.6 vs. 76.4%). Therefore, it is logical to consider foregoing aCT in this patient population with already good prognosis in hopes of reducing chemotherapy related costs and toxicities.

One of the main studies investigating this issue specifically has been an observational study published by García-Albéniz [110]. In this study, patients with cT3-T4 underwent CRT followed by TME surgery. Subsequently, patients with pCR (15%) did not receive aCT whereas others received 5FU-based aCT on an individual basis. After a median follow up of 58.3 months, the DFS (96%) and OS (100%) were analyzed. Only one patient out of 26 in the pCR group had distant recurrence at 15 months with no local recurrence. In comparison with an external cohort of patients with LARC receiving NACT and TME surgery followed by aCT, there was no significant benefit in the local recurrence, distant metastasis, overall survival, or disease-free survival rates.

Additionally, a recent propensity matched cohort of the National Cancer Database was completed comparing the oncologic outcomes of LARC patients treated with neoadjuvant chemoradiotherapy with a pCR. In this study, Dossa and colleagues matched 667 patients, in whom over a median follow up of 3.1 years, there was an improved overall survival in pCR patients who had receieved adjuvant therapy (hazard ratio, 0.44; 95% CI, 0.28–0.70). Furthermore, a stratified analysis suggested that the effect was only preent in patients with a positive pretreatment nodal status (hazard ratio, 0.24; 95% CI, 0.10–0.58) [111].

In an era in which the need for aCT is controversial, the role of this adjuvant modality in a subset of patients with an already improved prognosis needs to be reconsidered to reduce the associated costs and unnecessary toxicity [112, 113].

Toxicity and Compliance

Despite current recommendations by NCCN for adjuvant chemotherapy, the compliance rate appears to be low. A recent National Data Base analysis by Xu et al. [114] evaluated the compliance rate to the current NCCN guidelines for locally advanced rectal cancer recommending completion of adjuvant chemotherapy. They found an alarmingly low compliance rate of 32% among patients eligible to receive adjuvant chemotherapy. The previously mentioned clinical trials showing no survival benefit with the addition of aCT after neoadjuvant CRT and TME surgery in LARC also highlighted the issue of poor adherence to aCT. The compliance rates for EORTC, CHRONICLE and PROCTOR/SCRIPT trial were 43%, 48.1% and 73.6%, respectively [21, 96, 113].

Many system and patient factors have been identified to play a role in poor adherence to aCT. Age, gender, race, number of medical comorbidities, pathological complete response, stage and pathology, and type of hospital were all found to be associated with compliance by Xu et al. [114] in their analysis of the National Cancer Data Base.

Adjuvant Radiotherapy

Preoperative radiation has been shown to be superior to postoperative radiation in terms of local recurrence benefits and functional outcomes [6] and thus is the standard of care for LARC. This is based on two large studies, namely the Dutch TME trial and German CAO/

ARO/ AIO-94 phase III trial [10, 34]. As an example, in the Dutch trial patients were randomized to radiation therapy before or after TME surgery. Local recurrence was found to be significantly lower in the radiation therapy group (4.6 vs. 11%; $p < 0.0001$) with similar 10-year distant recurrence (25 vs. 28%; $p = 0.21$) or overall survival (48 vs. 49%; $p = 0.86$) [10, 34].

Chemoradiation

North Central Cancer Treatment Group (NCCTG 794751) trial was the first trial to provide support for improved local recurrence and survival in patients receiving adjuvant chemoradation [115]. The benefit of adjuvant chemoradiation was further supported by the Norwegian Adjuvant Rectal Cancer Project Group in 1997 where they randomized patients to adjuvant chemoradation (5FU-bolus with external beam radiation therapy) or surgery alone. No form of maintenance chemotherapy was used in this trial. The authors found a significant improvement in local recurrence (12% vs. 30%) and overall survival (64% vs. 50%) in the chemotherapy group compared with surgery alone group [116].

Subsequently, to further improve local recurrence and ease of operation by downstaging the tumor upfront as well preventing other downsides to adjuvant chemoradiation such as small bowel and anastomotic irradiation, attempts were made to deliver chemoradation preoperatively as a neoadjuvant treatment [75].

In 2004, results published from the German Trial solidified the superiority of chemoradiation therapy as a neoadjuvant modality as compared to the adjuvant setting. This landmark trial randomized patients with stage II and III rectal cancer to receive preoperative and postoperative chemoradiation in addition to 5FU-based adjuvant chemotherapy. They showed a significant reduction in local recurrence rates when CRT was given in the neoadjuvant setting (6% vs 13%; $p = 0.006$). Chemotherapy associated toxicity was also lower in the neoadjuvant group (27 vs. 40%; $p = 0.01$). However, overall survival and rates of distant metastasis (36%) did not significantly change between the two groups. Based on these results and others, as well as the improvement in local control, the use of CRT in the neoadjuvant setting is currently the recommended regimen [35].

Roles of Adjuvant Therapy in Metastatic and Recurrent Rectal Cancers

Metastatic (Stage IV) Rectal Cancer

Approximately 25% of colorectal cancer cases have metastases at the time of diagnosis, with liver presenting as the most common site for CRC metastasis. Patients with isolated liver metastases who are surgical candidates should be offered resection as this will offer them the greatest likelihood of cure. The median OS of untreated patients in this setting is less than 1 year [117] whereas those who have hepatic resection could have a 5-year survival of up to 31–45% [118–120].

The majority (80–90%) of colorectal liver metastases (CRLM) are unresectable at first presentation [121]; however, with chemotherapy these patients can be converted to having resectable disease and a comparable postoperative survival to initially unresectable CRLM ("conversion chemotherapy") [122, 123]. Additionally, systemic chemotherapy may not only alleviate symptoms but is also associated with improved disease control and survival [124]. The most commonly used components for systemic chemotherapy in metastatic CRC (mCRC) include fluoropyrimidines [intravenous 5-fluorouracil (5-FU) and oral Capecitabine], irinotecan, and Oxaliplatin [125]. FOLFOX (bolus and infusional 5-FU/LV plus Oxaliplatin), CapeOX (oral Capecitabine plus Oxaliplatin), and FOLFIRI [bolus and infusional 5-FU/leucovorin (LV) plus irinotecan] are the most common regimens used in mCRC [125].

The addition of biologic agents to target angiogenesis (e.g., bevacizumab, ramucirumab,

aflibercept and regorafenib) or the epidermal growth factor receptor (EGFR; e.g., panitumumab and cetuximab) have further resulted in improved survival in patients with mCRC [125]. Although the addition of bevacizumab has been shown to suit any cytotoxic regimen mentioned above, recent studies have shown that patients with *RAS* mutations have an inherent resistance to anti-EGFR antibody agents such as panitumumab and cetuximab [126–128]. Therefore, the use of these agents is now indicated in RAS wild type mCRC, further underlying the importance of individualized and targeted therapy.

Recurrent Rectal Cancer

Local recurrence in rectal cancer can range from 2 to 15% [35, 129, 130]. Pelvic morbidity such as pain, rectal bleeding or discharge, obstruction and sciatica may result from locally advanced primary and/or recurrent rectal cancer. To relieve symptoms, improve quality of life, and prolong survival, external beam radiotherapy (EBRT) may be used [131]. In addition to palliation in the case of inoperable tumors, radiation therapy has been used in the neoadjuvant setting to increase the chance of R0 resection rates for curative intent in recurrent rectal cancer [132]. Many of these patients, however, have received radiation therapy during their index treatment and therefore, there is concern regarding increased risk of toxicity.

Two recent systematic reviews have reported on the safety and benefit of re-irradiation in rectal cancer recurrence. Guren et al. [133] included 375 patients from retrospective and prospective studies (no RCT's were identified) who underwent (chemo)re-irradiation for either curative radical resection or palliation. Symptomatic relief in rectal bleeding and complete or partial pain relief in 83–94% of patients were observed in patients irradiated with palliative intent with median survival rate of 12–16 months. 39–89% underwent an R0 resection with a 50% recurrence and 39 to 60-month median survival. In this review, acute toxicities, mostly diarrhea and skin reactions, occurred in more than 30% of patients in earlier studies compared with 13% and 4% in later studies. The most common late toxicities were gastrointestinal and urinary complications but these were not prospectively followed consistently. Lastly authors found that hyperfractionation of chemoradiation in the case of curative treatment before surgery or once daily dosing for palliative patients to be the most appropriate regimens [133].

A more recent review by Meij et al. [134] included 474 patients who had received previous chemo(radiation) followed by surgical resection for their primary rectal cancer. All studies except one were retrospective. The authors mostly included studies utilizing re-irradiation in the form of chemoradiation for curative intent before (and some after) surgical resection of a local recurrence. Patients received either one dose of EBRT per day (n = 301) or hyperfractionated EBRT twice daily (n = 57). Grade 3–4 acute and late toxicities ranged from 0–7% and 5–16%, respectively. As expected, the most important prognostic factor was R0 resection. Overall, the authors found irradiation to be associated with improved R0 resection rates with subsequently improved local control and overall survival [134].

In summary, despite a lack of RCT's, current evidence supports the safety and benefit of re-irradiation (mostly in the form of hyperfractionated chemoradiation) in locally recurrent rectal cancer after the multimodal treatment of the primary cancer. Re-irradiation is also beneficial for palliation of recurrent rectal cancer symptoms.

Summary

The care of patients with locally advanced rectal cancer has significantly improved with the advent of various options for neoadjuvant and adjuvant therapy as well as sophisticated surgical techniques and peri-operative patient care. The rates of local recurrence in locally advanced rectal cancer are at all-time low. However, this has not translated to better survival outcomes.

Currently, studies are underway to balance the need for a survival benefit with reducing toxicity and costs associated with adjuvant therapy in rectal cancer treatment. Concepts such as induction chemotherapy, selective use of radiation therapy and the potential non-operative management of select patient groups are all indicative of efforts towards targeted, individualized care for patients with this disease. Hopefully, the introduction of the new American College of Surgeons Commission on Cancer National Accreditation Program for Rectal Cancer will result in improved use of neoadjuvant and adjuvant therapy [135].

References

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2016. CA Cancer J Clin. 2006;66:7–30.
2. Quah HM, Chou JF, Gonen M, et al. Pathologic stage is most prognostic of disease-free survival in locally advanced rectal cancer patients after preoperative chemoradiation. Cancer. 2008;113:57–64.
3. Bufalari A, Boselli C, Giustozzi G, et al. Locally advanced rectal cancer: a multivariate analysis of outcome risk factors. J Surg Oncol. 2000;74:2–10.
4. Heald RJ, Ryall RD. Recurrence and survival after total mesorectal excision for rectal cancer. Lancet. 1986;1:1479–82.
5. Sauer R, Liersch T, Merkel S, Fietkau R, Hohenberger W, Hess C, et al. Preoperative versus postoperative chemoradiotherapy for locally advanced rectal cancer: results of the German CAO/ARO/AIO-94 randomized phase III trial after a median follow-up of 11 years. J Clin Oncol. 2012;30(16):1926–33.
6. Millard T, Kunk PR, Ramsdale E, Rahma OE. Current debate in the oncological management of rectal cancer. World J Gastrointest Oncol. 2016;8(10):715–24.
7. Benson AB, Venook AP, Bekaii-Saab T, et al. Rectal cancer, version 2.2015. J Natl Compr Cancer Netw. 2015;13:719–28. quiz 728, 2015
8. Glimelius B, Tiret E, Cervantes A, et al. Rectal cancer: ESMO clinical practice guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2013;24(suppl6):vi81–8.
9. Khrizman P, Niland JC, ter Veer A, et al. Postoperative adjuvant chemotherapy use in patients with stage II/III rectal cancer treated with neo- adjuvant therapy: A National Comprehensive Cancer Network analysis. J Clin Oncol. 2013;31:30–8.
10. van Gijn W, Marijnen CA, Nagtegaal ID, et al. Preoperative radiotherapy combined with total mesorectal excision for resectable rectal cancer: 12-year ollow-up of the multicentre, randomised controlled TME trial. Lancet Oncol. 2011;12:575–82.
11. Netter J, Douard R, Durdux C, Landi B, Berger A, Taieb J. Advances in management of adjuvant chemotherapy in rectal cancer: consequences for clinical practice. Clin Res Hepatol Gastroenterol. 2016;40:546–52.
12. Wanebo HJ, Koness RJ, Vezeridis MP, Cohen SI, Wrobleski DE. Pelvic resection of recurrent rectal cancer. Ann Surg. 1994;220(4):586–95. discussion 595–7
13. Chadi SA, Berho M, Wexner SD. Surgeon perspectives on the use and effects of neoadjuvant chemoradiation in the treatment of rectal cancer: a comprehensive review of the literature. Langenbeck's Arch Surg. 2015;400:661–73.
14. Stewart DB, Dietz DW. Total mesorectal excision: what are we doing? Clin Colon Rectal Surg. 2007;20(3):190–202.
15. Heald RJ, Husband EM, Ryall RD. Themesorectum in rectal cancer surgery-the clue to pelvic recurrence? Br J Surg. 1982;69(10):613–6.
16. Quirke P, Durdey P, Dixon MF, Williams NS. Local recurrence of rectal adenocarcinoma due to inadequate surgical resection. Histopathological study of lateral tumour spread and surgical excision. Lancet. 1986;2(8514):996–9.
17. Quirke P. Training and quality assurance for rectal cancer: 20 years of data is enough. Lancet Oncol. 2003;4(11):695–702.
18. Trimble EL, Ungerleider RS, Abrams JA, Kaplan RS, Feigal EG, Smith MA, Carter CL, Friedman MA. Neoadjuvant therapy in cancer treatment. Cancer Suppl. 1993;72(11):3515.
19. Cecil TD, Sexton R, Moran BJ, et al. Total mesorectal excision results in low local recurrence rates in lymph node-positive rectal cancer. Dis Colon Rectum. 2004;47:1145–50.
20. Faerden AE, Naimy N, Wiik P, et al. Total mesorectal excision for rectal cancer: difference in outcome for low and high rectal cancer. Dis Colon Rectum. 2005;48:2224–31.
21. Bosset J-F, Collette L, Calais G, Mineur L, Maingon P, Radosevic- Jelic L, et al. Chemotherapy with preoperative radiotherapy in rectal cancer. N Engl J Med. 2006;355(11):1114–23.
22. O'Connell MJ, Martenson JA, Wieand HS, et al. Improving adjuvant therapy for rectal cancer by combining protracted-infusion fluorouracil with radiation therapy after curative surgery. N Engl J Med. 1994;331:502–7.
23. Patel SA, Ryan DP, Hong TS. Combined modality therapy for rectal cancer. Cancer J. 2016;22(3):211–7.
24. O'Connell MJ, Colangelo LH, Beart RW, Petrelli NJ, Allegra CJ, Sharif S, Pitot HC, Shields AF, Landry JC, Ryan DP, Parda DS, Mohiuddin M, Arora A, Evans LS, Bahary N, Soori GS, Eakle J, Robertson JM, Moore DF, Mullane MR, Marchello BT, Ward PJ, Wozniak TF, Roh MS, Yothers G, Wolmark N. Capecitabine and oxaliplatin in the preoperative multimodality treatment of rectal cancer:

surgical end points from National Surgical Adjuvant Breast and Bowel Project trial R-04. J Clin Oncol. 2014;32:1927–34.
25. Hofheinz RD, Wenz F, Post S, Matzdorff A, Laechelt S, Hartmann JT, Müller L, Link H, Moehler M, Kettner E, Fritz E, Hieber U, Lindemann HW, Grunewald M, Kremers S, Constantin C, Hipp M, Hartung G, Gencer D, Kienle P, Burkholder I, Hochhaus A. Chemoradiotherapy with capecitabine versus fluorouracil for locally advanced rectal cancer: a randomised, multicentre, non-inferiority, phase 3 trial. Lancet Oncol. 2012;13:579–88.
26. Twelves C, Wong A, Nowacki MP, Abt M, Burris H, Carrato A, et al. Capecitabine as adjuvant treatment for stage III colon cancer. N Engl J Med. 2005;352(26):2696–704.
27. Roh MS, Colangelo LH, O'Connell MJ, Yothers G, Deutsch M, Allegra CJ, et al. Preoperative multimodality therapy improves disease-free survival in patients with carcinoma of the rectum: NSABP R-03. J Clin Oncol. 2009;27(31):5124–30.
28. Aschele C, Cionini L, Lonardi S, Pinto C, Cordio S, Rosati G, Artale S, Tagliagambe A, Ambrosini G, Rosetti P, Bonetti A, Negru ME, Tronconi MC, Luppi G, Silvano G, Corsi DC, Bochicchio AM, Chiaulon G, Gallo M, Boni L. Primary tumor response to preoperative chemoradiation with or without oxaliplatin in locally advanced rectal cancer: pathologic results of the STAR-01 randomized phase III trial. J Clin Oncol. 2011;29:2773–80.
29. Gérard JP, Azria D, Gourgou-Bourgade S, Martel-Laffay I, Hennequin C, Etienne PL, Vendrely V, François E, de La Roche G, Bouché O, Mirabel X, Denis B, Mineur L, Berdah JF, Mahé MA, Bécouarn Y, Dupuis O, Lledo G, Montoto-Grillot C, Conroy T. Comparison of two neoadjuvant chemoradiotherapy regimens for locally advanced rectal cancer: results of the phase III trial ACCORD 12/0405-Prodige 2. J Clin Oncol. 2010;28:1638–44.
30. Schmoll HJ, Haustermans K, Price TJ, Nordlinger B, Hofheinz R, Daisne JF, Janssens J, Brenner B, Schmidt P, Reinel H, Hollerbach S, Caca K, Fauth F, Hannig C, Zalcberg JR, Tebbutt NC, Mauer ME, Messina C, Manfred P. Preoperative chemoradiotherapy and postoperative chemotherapy with capecitabine and oxaliplatin versus capecitabine alone in locally advanced rectal cancer: disease-free survival results at interim analysis. J Clin Oncol. 2014;32(suppl):abstr 3501.
31. Rödel C, Liersch T, Becker H, Fietkau R, Hohenberger W, Hothorn T, Graeven U, Arnold D, Lang-Welzenbach M, Raab HR, Sülberg H, Wittekind C, Potapov S, Staib L, Hess C, Weigang-Köhler K, Grabenbauer GG, Hoffmanns H, Lindemann F, Schlenska- Lange A, Folprecht G, Sauer R. Preoperative chemoradiotherapy and postoperative chemotherapy with fluorouracil and oxaliplatin versus fluorouracil alone in locally advanced rectal cancer: initial results of the German CAO/ARO/AIO-04 randomised phase 3 trial. Lancet Oncol. 2012;13:679–87.
32. Rodel C, Liersch T, Fietkau R, Hohenberger W, Graeven U, Hothorn T, Arnold D, Raab H-R, Wittekind C, Hess CF, Staib L, Becker H, Sauer R, German Rectal Cancer Study Group. Preoperative chemoradiotherapy and postoperative chemotherapy with 5-fluorouracil and oxaliplatin versus 5-fluorouracil alone in locally advanced rectal cancer: Results of the German CAO/ARO/AIO-04 randomized phase III trial. J Clin Oncol. 2014;32:3500.
33. Deng Y, Chi P, Lan P, Wang L, Chen W, Cui L, Chen D, Cao J, Wei H, Peng X, Huang Z, Cai G, Zhao R, Huang Z, Lin X, Zhou H, Wei Y, Zhang H, Zheng J, Huang Y, Zhou Z, Cai Y, Kang L, Huang M, Peng J, Ren D, Wang J. Modified FOLFOX6 with or without radiation versus fluorouracil and leucovorin with radiation in neoadjuvant treatment of locally advanced rectal cancer: initial results of the Chinese fowarc multicenter, open-label, randomized three-arm phase III trial. J Clin Oncol. 2016;34(27):3300–7.
34. Kusters M, Marijnen CA, van de Velde CJ, Rutten HJ, Lahaye MJ, Kim JH, Beets-Tan RG, Beets GL. Patterns of local recurrence in rectal cancer; a study of the Dutch TME trial. Eur J Surg Oncol. 2010;36:470–6.
35. Sauer R, Becker H, Hohenberger W, Rödel C, Wittekind C, Fietkau R, et al. Preoperative versus postoperative chemoradiotherapy for rectal cancer. N Engl J Med. 2004;351(17):1731–40.
36. Bujko K, Nowacki MP, Nasierowska-Guttmejer A, Michalski W, Bebenek M, Pudełko M, et al. Sphincter preservation following preoperative radiotherapy for rectal cancer: report of a randomised trial comparing short-term radiotherapy vs. conventionally fractionated radiochemotherapy. Radiother Oncol. 2004;2(1):15–24.
37. Birgisson H, Påhlman L, Gunnarsson U, Glimelius B. Swedish rectal cancer trial group. adverse effects of preoperative radiation therapy for rectal cancer: long-term follow-up of the swedish rectal cancer trial. J Clin Oncol Am Soc Clin Oncol. 2005;23(34):8697–705.
38. Bujko K, Nowacki MP, Nasierowska-Guttmejer A, et al. Long-term results of a randomized trial comparing preoperative short-course radiotherapy with preoperative conventionally fractionated chemoradiation for rectal cancer. Br J Surg. 2006;93:1215.
39. Ngan SY, Burmeister B, Fisher RJ, et al. Randomized trial of short-course radiotherapy versus long-course chemoradiation comparing rates of local recurrence in patients with T3 rectal cancer: Trans-Tasman Radiation Oncology Group trial 01.04. J Clin Oncol. 2012;30:3827–33.
40. Zhou Z-R, Liu S-X, Zhang T-S, Chen L-X, Xia J, Hu Z-D, et al. Short-course preoperative radiotherapy with immediate sur- gery versus long-course chemoradiation with delayed surgery in the treatment of rectal cancer: a systematic review and meta-analysis. Surg Oncol. 2014;23(4):211–21.

41. Pettersson D, Cedermark B, Holm T, Radu C, Pahlman L, Glimelius B, Martling A. Interim analysis of the Stockholm III trial of preoperative radiotherapy regimens for rectal cancer. Br J Surg. 2010;97:580–7.
42. Pettersson D, Lörinc E, Holm T, Iversen H, Cedermark B, Glimelius B, Martling A. Tumour regression in the randomized Stockholm III Trial of radiotherapy regimens for rectal cancer. BJS. 2015;102:972–8.
43. Joshua Smith J, Garcia-Aguilar J. Advances and challenges in treatment of locally advanced rectal cancer. J Clin Oncol. 2015;33(16):1797–808.
44. Gunderson LL. Past, present, and future of intraoperative irradiation for colorectal cancer. Int J Radiat Oncol Biol Phys. 1996;34(3):741–4.
45. Holman FA, Haddock MG, Gunderson LL, Kusters M, Nieuwenhuijzen GAP, van den Berg HA, Nelson H, Rutten HJT. Results of intraoperative electron beam radiotherapy containing multimodality treatment for locally unresectable T4 rectal cancer: a pooled analysis of the Mayo Clinic Rochester and Catharina Hospital Eindhoven. J Gastrointest Oncol. 2016;7(6):903–16.
46. Kusters M, Valentini V, Calvo FA, Krempien R, Nieuwenhuijzen GA, Martijn H, Doglietto GB, del Valle E, Roeder F, Buchler MW, van de Velde CJH, Rutten HJT. Results of European pooled analysis of IORT-containing multimodality treatment for locally advanced rectal cancer: adjuvant chemotherapy prevents local recurrence rather than distant metastases. Ann Oncol. 2010;21:1279–84.
47. Dubois JB, Bussieres E, Richaud P, et al. Intraoperative radiotherapy of rectal cancer: results of the French multi-institutional randomized study. Radiother Oncol. 2011;98:298–303.
48. Mirnezami R, Chang GJ, Das P, et al. Intraoperative radiotherapy in colorectal cancer: systematic review and meta-analysis of techniques, long-term outcomes, and complications. Surg Oncol. 2013;22:22–35.
49. Diaz-Gonzalez JA, Calvo FA, Cortes J, et al. Prognostic factors for disease-free survival in patients with T3-4 or N+ rectal cancer treated with preoperative chemoradiation therapy, surgery, and intraoperative irradiation. Int J Radiat Oncol Biol Phys. 2006;64:1122–8.
50. Ferenschild FT, Vermaas M, Verhoef C, Dwarkasing RS, Eggermont AM, de Wilt JH. Abdominosacral resection for locally advanced and recurrent rectal cancer. Br J Surg. 2009;96(11):1341–7. https://doi.org/10.1002/bjs.6695.
51. Valentini V, Coco C, Rizzo G, et al. Outcomes of clinical T4M0 extra-peritoneal rectal cancer treated with preoperative radiochemotherapy and surgery: a prospective evaluation of a single institutional experience. Surgery. 2009;145:486–94.
52. Patel SA, Wo JY, Hong TS. Advancing techniques of radiation therapy for rectal cancer. Semin Radiat Oncol. 2016;26:220–5.
53. Kusunoki M, Yanagi H, et al. Anoabdominal rectal resection and colonic J pouch-analanastomosis:10 years' experience. Br J Surg. 1997;84:1277–80.
54. Appelt AL, Vogelius IR, et al. Long-termresults of a randomized trialin locally advanced rectal cancer: no benefit from adding a brachytherapy boost. Int J Radiat Oncol Biol Phys. 2014;90:110–8.
55. Evans J, Tait D, Swift I, Pennert K, Tekkis P, Wotherspoon A, Chau I, Cunningham D, Brown G. Timing of surgery following preoperative therapy in rectal cancer: the need for a prospective randomized trial? Dis Colon Rectum. 2011;54(10):1251–9.
56. Francois Y, Nemoz CJ, Baulieux J, Vignal J, Grandjean JP, Partensky C, et al. Influence of the interval between preoperative radiation therapy and surgery on downstaging and on the rate of sphincter-sparing surgery for rectal cancer: the Lyon R90-01 randomized trial. J Clin Oncol. 1999;17(8):2396.
57. Tulchinsky H, Shmueli E, Figer A, et al. An interval 7 weeks between neoadjuvant therapy and surgery improves pathologic complete response and disease-free survival in patients with locally advanced rectal cancer. Ann Surg Oncol. 2008;15:2661–7.
58. Kalady MF, de Campos-Lobato LF, Stocchi L, et al. Predictive factors of pathologic complete re- sponse after neoadjuvant chemoradiation for rectal cancer. Ann Surg. 2009;250:582–9.
59. Petrelli F, Coinu A, Lonati V, et al. Asystematic review and meta-analysis of adjuvant chemotherapy after neoadjuvant treatment and surgery for rectal cancer. Int J Color Dis. 2015;30:447–57.
60. Probst CP, Becerra AZ, Aquina CT, Tejani MA, Wexner SD, Garcia-Aguilar J, Remzi FH, David W Dietz MD, Monson JRT, Fleming FJ. Extended intervals after neoadjuvant therapy in locally advanced rectal cancer: the key to improved tumor response and potential organ preservation. J Am Coll Surg. 2015;221(2):430–40.
61. Lefevre JH, Mineur L, Kotti S, et al. Effect of interval (7 or 11 weeks) between neoadjuvant radiochemotherapy and surgery on complete pathologic response in Rectal Cancer: A Multicenter, Randomized, Controlled Trial (GRECCAR-6). J Clin Oncol. 2016;34(31):3773–80.
62. Temple LK, Romanus D, Niland J, Veer AT, Weiser MR, Skibber J, et al. Factors associated with sphincter-preserving surgery for rectal cancer at national comprehensive cancer network centers. Ann Surg. 2009;250(2):260–7.
63. Gérard J-P, Azria D, Gourgou-Bourgade S, Martel-Lafay I, Hennequin C, Etienne P-L, et al. Clinical outcome of the ACCORD 12/0405 PRODIGE 2 randomized trial in rectal cancer. J Clin Oncol Am Soc Clin Oncol. 2012;30(36):4558–65.
64. Aschele C, Cionini L, Lonardi S, Pinto C, Cordio S, Rosati G, et al. Primary tumor response to preoperative chemoradiation with or without oxaliplatin in locally advanced rectal cancer: path- ologic results of the STAR-01 randomized phase III trial. J Clin Oncol. 2011;29(20):2773–80.
65. Gérard J-P, Rostom Y, Gal J, Benchimol D, Ortholan C, Aschele C, et al. Can we increase the chance of sphincter saving surgery in rectal cancer with neoadjuvant treatments: lessons from a systematic review

of recent randomized trials. Crit Rev Oncol Hematol. 2012;81(1):21–8.
66. McCarthy K, Pearson K, Fulton R, Hewitt J. Pre-operative chemoradiation for non-metastatic locally advanced rectal cancer. Cochrane Database Syst Rev. 2012;12:CD008368.
67. Jestin P, Påhlman L, Gunnarsson U. Risk factors for anastomotic leakage after rectal cancer surgery: a case-control study. Color Dis. 2008;10(7):715–21.
68. Warschkow R, Steffen T, Thierbach J, Bruckner T, Lange J, Tarantino I. Risk factors for anastomotic leakage after rectal cancer resection and reconstruction with colorectostomy. A retrospective study with bootstrap analysis. Ann Surg Oncol. 2011;18(10):2772–82.
69. Lee W-S, Yun SH, Roh Y-N, Yun H-R, Lee WY, Cho YB, et al. Risk factors and clinical outcome for anastomotic leakage after total mesorectal excision for rectal cancer. World J Surg. 2008;32(6): 1124–9.
70. Qin C, Ren X, Xu K, Chen Z, He Y, Song X. Does preoper- ative radio(chemo)therapy increase anastomotic leakage in rectal cancer surgery? A meta-analysis of randomized controlled trials. Gastroenterol Res Pract. 2014;2014(2):910956–7.
71. Peeters KCMJ. Late side effects of short-course preoperative radiotherapy combined with total mesorectal excision for rectal cancer: increased bowel dysfunction in irradiated patients—a Dutch colorectal cancer group study. J Clin Oncol. 2005;23(25):6199–206.
72. Marijnen CAM, van de Velde CJH, Putter H, van den Brink M, Maas CP, Martijn H, et al. Impact of short-term preoperative radiotherapy on health-related quality of life and sexual functioning in primary rectal cancer: report of a multicenter randomized trial. J Clin Oncol. 2005;23(9):1847–58.
73. Stephens RJ, Thompson LC, Quirke P, Steele R, Grieve R, Couture J, et al. Impact of short-course preoperative radiotherapy for rectal cancer on patients' quality of life: data from the Medical Research Council CR07/National Cancer Institute of Canada Clinical Trials Group C016 randomized clinical trial. J Clin Oncol Am Soc Clin Oncol. 2010;28(27):4233–9.
74. Loos M, Quentmeier P, Schuster T, Nitsche U, Gertler R, Keerl A, et al. Effect of preoperative radio(chemo)therapy on long- term functional outcome in rectal cancer patients: a systematic re- view and meta-analysis. Ann Surg Oncol. 2013;20(6):1816–28.
75. Glimelius BLG. The role of preoperative and postoperative radiotherapy in rectal cancer. Clin Colorectal Cancer. 2002;2(2):82–92.
76. Påhlman L, Glimelius B, Graffman S. Pre-versus postoper-ative radiotherapy in rectal carcinoma: an interim report from a randomized multicentre trial. Br J Surg. 1985;72(12):961–6.
77. De Caluwé L, Van Nieuwenhove Y, Ceelen WP. Preoperative chemoradiation versus radiation alone for stage II and III resectable rectal cancer. Cochrane Database Syst Rev. 2013;2:CD006041.
78. Dronkers JJ, Lamberts H, Reutelingsperger IMMD, Naber RH, Dronkers-Landman CM, Veldman A, et al. Preoperative ther- apeutic programme for elderly patients scheduled for elective abdominal oncological surgery: a randomized controlled pilot study. Clin Rehabil. 2010;24(7):614–22.
79. Li C, Carli F, Lee L, Charlebois P, Stein B, Liberman AS, et al. Impact of a trimodal prehabilitation program on functional recovery after colorectal cancer surgery: a pilot study. Surg Endosc. 2013;27(4):1072–82.
80. Maas M, Nelemans PJ, Valentini V, Das P, Rödel C, Kuo LJ, Calvo FA, García-Aguilar J, Glynne-Jones R, Haustermans K, Mohiuddin M, Pucciarelli S, Small W, Suárez J, Theodoropoulos G, Biondo S, Beets-Tan RG, Beets GL. Long-term outcome in patients with a pathological complete response after chemoradiation for rectal cancer: a pooled analysis of individual patient data. Lancet Oncol. 2010;11:835–44.
81. Park IJ, Eng C, You YN, et al. Exploratory analysis of adjuvant chemotherapy benefits after preoperative chemoradiotherapy and radical resection for rectal cancer. J Clin Oncol. 2012;30:21.
82. Habr-Gama A, Perez RO, Nadalin W, et al. Operative versus nonoperative treatment for stage 0 distal rectal cancer following chemoradiation therapy: long-term results. Ann Surg. 2004;240:711–7.
83. Habr-Gama A, Perez RO, Proscurshim I, et al. Patterns of failure and survival for nonoperative treatment of stage c0 distal rectal cancer following neoadjuvant chemoradiation therapy. J Gastrointest Surg. 2006;10:1319–28.
84. Habr-Gama A, Gama-Rodrigues J, São Julião GP, et al. Local recurrence after complete clinical response and watch and wait in rectal cancer after neoadjuvant chemoradiation: Impact of salvage therapy on local disease control. Int J Radiat Oncol Biol Phys. 2014;88:822–8.
85. Maas M, Beets-Tan RG, Lambregts DM, et al. Wait-and-see policy for clinical complete responders after chemoradiation for rectal cancer. J Clin Oncol. 2011;29:4633–40.
86. Smith JD, Ruby JA, Goodman KA, et al. Nonoperative management of rectal cancer with complete clinical response after neoadjuvant therapy. Ann Surg. 2012;256:965–72.
87. Moertel CG, Fleming TR, Macdonald JS, Haller DG, Laurie JA, Goodman PJ, et al. Levamisole and fluorouracil for adjuvant therapy of resected colon carcinoma. N Engl J Med. 1990;322:352–8.
88. Petersen SH, Harling H, Kirkeby LT, Wille-Jorgensen P, Mocellin S. Postoperative adjuvant chemotherapy in rectal cancer operated for cure. Cochrane Database Syst Rev. 2012;3:CD004078.
89. Biagi JJ, Raphael MJ, Mackillop WJ, Kong W, King WD, Booth CM. Association between time to initiation of adjuvant chemotherapy and survival in colorectal cancer. A systematic review and meta-analysis. JAMA. 2011;305:2335e2342.

90. NCCN: National Comprehensive Cancer Network. Clinical Practice Guidelines in Oncology (NCCN Guidelines). Rectal cancer; 2015.
91. Oncoline. Dutch Colorectal Cancer Guideline (version 3.0). Utrecht: Association of Comprehensive Cancer Centres. Available at: http://www.oncoline.nl/colorectaalcarcinoom; 2014.
92. Poulsen LO, Qvortrup C, Pfeiffer P, Yilmaz M, Falkmer U, Sorbye H. Review on adjuvant chemotherapy for rectal cancer e why do treatment guidelines differ so much. Acta Oncol. 2015;54: 437–46.
93. Bosset J-F, Calais G, Mineur L, Maingon P, Stojanovic-Rundic S, Bensadoun R-J, et al. Fluorouracil-based adjuvant chemotherapy after preoperative chemoradiotherapy in rectal cancer: long-term results of the EORTC 22921 randomised study. Lancet Oncol. 2014;15(2):184–90.
94. Glynne-Jones R, Counsell N, Quirke P, Mortensen N, Maraveyas A, Meadows HM, et al. Chronicle: results of a randomised phase III trial in locally advanced rectal cancer after neoad- juvant chemoradiation randomising postoperative adjuvant capecitabine plus oxaliplatin (XELOX) versus control. Ann Oncol. 2014;25(7):1356–62.
95. Breugom AJ, van Gijn W, Muller EW, Berglund A, van den Broek CBM, Fokstuen T, et al. Adjuvant chemotherapy for rectal cancer patients treated with preoperative (chemo)radiotherapy and total mesorectal excision: a Dutch Colorectal Cancer Group (DCCG) randomised phase III trial. Ann Oncol. 2015;26(4):696–701.
96. Breugom AJ, Swets M, Bosset J-F, Collette L, Sainato A, Cionini L, et al. Adjuvant chemotherapy after preoperative (chemo)radiotherapy and surgery for patients with rectal cancer: a systematic review and meta-analysis of individual patient data. Lancet Oncol. 2015;16(2):200–7.
97. Sainato A, Cernusco Luna Nunzia V, Valentini V, De Paoli A, Mau-rizi ER, Lupattelli M, et al. No benefit of adjuvant fluorouracilleucovorin chemotherapy after neoadjuvant chemoradiother-apy in locally advanced cancer of the rectum (LARC): longterm results of a randomized trial (I-CNR-RT). Radiother Oncol. 2014;113(2):223–9.
98. Petrelli F, Coinu A, Lonati V, Barni S. A systematic review and meta-analysis of adjuvant chemotherapy after neoad- juvant treatment and surgery for rectal cancer. Int J Color Dis. 2015;30(4):447–57.
99. Bujko K, Glimelius B, Valentini V, Michalski W, Spalek M. Postoperative chemotherapy in patients with rectal cancer receiving preoperative radio(chemo)therapy: a meta-analysis of randomized trials comparing surgery ± a fluoropyrimidine and surgery + a fluoropyrimidine ± oxaliplatin. Eur J Surg Oncol. 2015;41(6):713–23.
100. André T, Boni C, Navarro M, Tabernero J, Hickish T, Topham C, et al. Improved overall survival with oxaliplatin, fluorouracil, and leucovorin as adjuvant treatment in stage II or III colon cancer in the MOSAIC trial. J Clin Oncol. 2009;27:3109–16.
101. Yothers G, O'Connell MJ, Allegra CJ, et al. Oxaliplatin as adjuvant for colon cancer: updated results of NSABP C-07 trial, including survival and subset analyses. J Clin Oncol. 2011;29(28):3768–74.
102. Schmoll H-J, Cartwright T, Tabernero J, Nowacki MP, Figer A, Maroun J, et al. Phase III trial of capecitabine plus oxaliplatin as adjuvant therapy for stage III colon cancer: a planned safety analysis in 1864 patients. J Clin Oncol. 2007;25(1):102–9.
103. Rödel C, Graeven U, Fietkau R, Hohenberger W, Hothorn T, Arnold D, et al. Oxaliplatin added to fluorouracil-based preop- erative chemoradiotherapy and postoperative chemotherapy of locally advanced rectal cancer (the German CAO/ARO/AIO- 04 study): final results of the multicentre, open-label, randomised, phase 3 trial. Lancet Oncol. 2015;16(8):979–89.
104. Glynne-Jones R, Grainger J, Harrison M, et al. Neoadjuvant chemotherapy prior to preoperative chemoradiation or radiation in rectal cancer: should we be more cautious? Br J Cancer. 2006;94:363–71.
105. Chau I, Brown G, Cunningham D, et al. Neoadjuvant capecitabine and oxaliplatin followed by synchronous chemoradiation and total mesorectal excision in magnetic resonance imaging–defined poor-risk rectal cancer. J Clin Oncol. 2006;24:668–74.
106. Fernandez-Martos C, Pericay C, Aparicio J, et al. Phase II, randomized study of concomitant chemoradiotherapy followed by surgery and adjuvant capecitabine plus oxaliplatin (CAPOX) compared with induction CAPOX followed by concomitant chemoradiotherapy and surgery in magnetic resonance imaging–defined, locally advanced rectal cancer: Grupo Cancer de Recto 3 Study. J Clin Oncol. 2010;28:859–65.
107. Garcia-Aguilar J, Smith DD, Avila K, et al. Optimal timing of surgery after chemoradiation for advanced rectal cancer: preliminary results of a multicenter, nonrandomized phase II prospective trial. Ann Surg. 2011;254:97–102.
108. Garcia-Aguilar J, Marcet J, Coutsoftides T, et al. Impact of neoadjuvant chemotherapy following chemoradiation on tumor response, adverse events, and surgical complications in patients with advanced rectal cancer treated with TME. J Clin Oncol. 2011;224s:29.
109. Glynne-Jones R, Hughes R. Critical appraisal of the 'wait and see' approach in rectal cancer for clinical complete responders after chemoradiation. Br J Surg. 2012;99:897–909.
110. García-Albéniz X, Gallego R, Hofheinz RD, Fernández-Esparrach G, Ayuso- Colella JR, Bombí JA, et al. Adjuvant therapy sparing in rectal cancer achieving complete response after chemoradiation. World J Gastroenterol. 2014;20:15820–9.
111. Dossa F, Acuna SA, Rickles AS, Berho M, Wexner SD, Quereshy FA, Baxter NN, Chadi SA. Association between adjuvant chemotherapy and overall survival in patients with rectal cancer and pathological com-

plete response after neoadjuvant chemotherapy and resection. JAMA Oncol. 2018;4(7):930–7.
112. Kainthla R, Huerta S. Adjuvant chemotherapy for ypT0N0M0 rectal cancer following chemoradiotherapy and total mesorectal excision. Anti-Cancer Drugs. 2016;27:819–23.
113. Glynne-Jones R, Counsell N, Quirke P, et al. Chronicle: results of a randomised phase III trial in locally advanced rectal cancer after neoadjuvant chemoradiation randomising postoperative adjuvant capecitabine plus oxaliplatin (XELOX) versus control. Ann Oncol. 2014;25:1356–62.
114. Xu Z, Gupta Mohile S, Tejani MA, Becerra AZ, Probst CP, Aquina CT, Hensley BJ, Arsalanizadeh R, Noyes K, Monson JRT, Fleming FJ. Poor compliance with adjuvant chemotherapy use associated with poorer survival in patients with rectal cancer: an NCDB analysis. Cancer. 2016;123(1):52–61.
115. Krook JE, Moertel CG, Gunderson LL, Wieand HS, Collins RT, Beart RW, et al. Effective surgical adjuvant therapy for high- risk rectal carcinoma. N Engl J Med. 1991;324(11):709–15.
116. Tveit KM, Guldvog I, Hagen S, Trondsen E, Harbitz T, Nygaard K, Norwegian Adjuvant Rectal Cancer Project Group, et al. Randomized controlled trial of postoperative radiotherapy and short-term time-scheduled 5-fluorouracil against surgery alone in the treatment of Dukes B and C rectal cancer. Br J Surg. 1997;84(8):1130–5.
117. Wood CB, Gillis CR, Blumgart LH. A retrospective study of the natural history of patients with liver metastases from colorectal cancer. Clin Oncol. 1976;2:285–8.
118. Kornprat P, Jarnagin WR, Gonen M, et al. Outcome after hepatectomy for multiple (four or more) colorectal metastases in the era of effective chemotherapy. Ann Surg Oncol. 2007;14:1151–60.
119. Cummings L, Payes JD, Cooper GS. Survival after hepatic resection in metastatic colorectal cancer: a population-based study. Cancer. 2007;109:718–26.
120. Nathan H, de Jong MC, Pulitano C, et al. Conditional survival after surgical resection of colorectal liver metastasis: an international multi-institutional analysis of 949 patients. J Am Coll Surg. 2010;210:755–66.
121. Scheele J, Stangl R, Altendorf-Hofmann A. Hepatic metastases from colorectal carcinoma: impact of surgical resection on the natural his- tory. Br J Surg. 1990;77:1241–6.
122. Adam R, Delvart V, Pascal G, et al. Rescue surgery for unresectable colorectal liver metastases downstaged by chemotherapy: a model to predict long-term survival. Ann Surg. 2004;240:644–57. discussion 657e8
123. Morris EJA, Forman D, Thomas JD, et al. Surgical management and outcomes of colorectal cancer liver metastases. Br J Surg. 2010;97:1110–8.
124. Schmoll HJ, Büchele T, Grothey A, Dempke W. Where do we stand with 5-fluorouracil? Semin Oncol. 1999;26:589–605.
125. Ohhara Y, Fukuda N, Takeuchi S, Honma R, Shimizu Y, Kinoshita I, Hirotoshi DA. Role of targeted therapy in metastatic colorectal cancer. World J Gastrointest Oncol. 2016;8(9):642–55.
126. Lièvre A, Bachet JB, Le Corre D, Boige V, Landi B, Emile JF, Côté JF, Tomasic G, Penna C, Ducreux M, Rougier P, Penault- Llorca F, Laurent-Puig P. KRAS mutation status is predictive of response to cetuximab therapy in colorectal cancer. Cancer Res. 2006;66:3992–5.
127. Karapetis CS, Khambata-Ford S, Jonker DJ, O'Callaghan CJ, Tu D, Tebbutt NC, Simes RJ, Chalchal H, Shapiro JD, Robitaille S, Price TJ, Shepherd L, Au HJ, Langer C, Moore MJ, Zalcberg JR. K-ras mutations and benefit from cetuximab in advanced colorectal cancer. N Engl J Med. 2008;359:1757–65.
128. Amado RG, Wolf M, Peeters M, Van Cutsem E, Siena S, Freeman DJ, Juan T, Sikorski R, Suggs S, Radinsky R, Patterson SD, Chang DD. Wild-type KRAS is required for panitumumab efficacy in patients with metastatic colorectal cancer. J Clin Oncol. 2008;26:1626–34.
129. Kapiteijn E, Marijnen CA, Nagtegaal ID, et al. Preoperative radiotherapy combined with total mesorectal excision for resectable rectal cancer. N Engl J Med. 2001;345:638–46.
130. Sebag-Montefiore D, Stephens RJ, Steele R, et al. Preoperative radiotherapy versus selective postoperative chemoradiotherapy in patients with rectal cancer (MRC CR07 and NCIC-CTG C016): a multicentre, randomised trial. Lancet. 2009;373:811–20.
131. Cameron MG, Kersten C, Vistad I, Sophie Foss Å, Guren MG. Palliative pelvic radiotherapy of symptomatic incurable rectal cancer – a systematic review. Acta Oncol. 2014;53:164–73.
132. Glimelius B. Recurrent rectal cancer. The pre-irradiated primary tumour: can more radiotherapy be given? Color Dis. 2003;5:501–3.
133. Guren MG, Undseth C, Rekstad BL, Brændengen M, Dueland S, Spindler K-LG, Glynne-Jones R, Tveit KM. Reirradiation of locally recurrent rectal cancer: a systematic review. Radiother Oncol. 2014;113:151–7.
134. van der Meij W, Rombouts AJM, Rütten H, Bremers AJA, de Wilt JHW. Treatment of locally recurrent rectal carcinoma in previously (chemo) irradiated patients: a review. Dis Colon Rectum. 2016;59(2):148–56.
135. Wexner SD, Berho ME. The rationale for and reality of the new national accreditation program for rectal cancer. Dis Colon Rectum. 2017;60(6):595–602.

Rectal Polyps and Other Neoplasms

25

Kelli M. Bullard Dunn

Introduction

Although adenomas, adenocarcinoma and epidermoid carcinoma compose the majority of anorectal tumors, there are a variety of other more rare lesions that occur in the anorectum. In many cases, diagnosis may be challenging, especially because many patients and their caregivers attribute anorectal symptoms to hemorrhoidal disease. In this chapter, we will review the diagnosis and treatment of both the common and the more unusual neoplasms.

Benign

A polyp is a growth protruding from a mucous membrane. Rectal polyps have the same morphologic and histologic characteristics as polyps found in other parts of the large intestine and are classified as neoplastic or nonneoplastic polyps. The benign neoplastic polyps (also referred to as adenomatous polyps) include tubular adenomas, villous adenomas, tubulovillous adenomas, and serrated adenomas. Morphologically they are described as sessile (flat) or pedunculated (on a stalk). The varieties of nonneoplastic polyps are hyperplastic polyps, juvenile polyps, hamartomatous polyps, and inflammatory polyps.

Adenomatous Polyps

Adenomas are the most common benign neoplasm of the gastrointestinal tract (l); 8% of all colorectal adenomas are located in the rectum [1]. By definition all adenomas contain dysplastic epithelium. The nuclei of adenomas are hyperchromatic, elongated, crowded and arranged in a pseudo-stratified manner, which produces a 'picket fence' appearance. The microscopic architecture of adenomas divides them into three types (Fig. 25.1). Tubular adenomas have elongated crypts with adenomatous epithelium and crowded, branching tubules are separated by normal lamina propria (Fig. 25.2). Villous adenomas have finger-like projections of normal lamina propria, which are covered with adenomatous epithelium (Fig. 25.3). Tubulovillous adenomas (also called villoglandular adenoma or polyp, mixed polyp or polypoid-villous adenoma) contain more than 25% tubular and villous components [2–4]. Serrated polyps were long thought to be benign hyperplastic polyps with adenomatous features. However, these lesions are now recognized to have malignant potential [5].

K. M. Bullard Dunn (✉)
Surgery, University of Louisville,
Louisville, KY, USA
e-mail: kbdunn01@louisville.edu

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_25

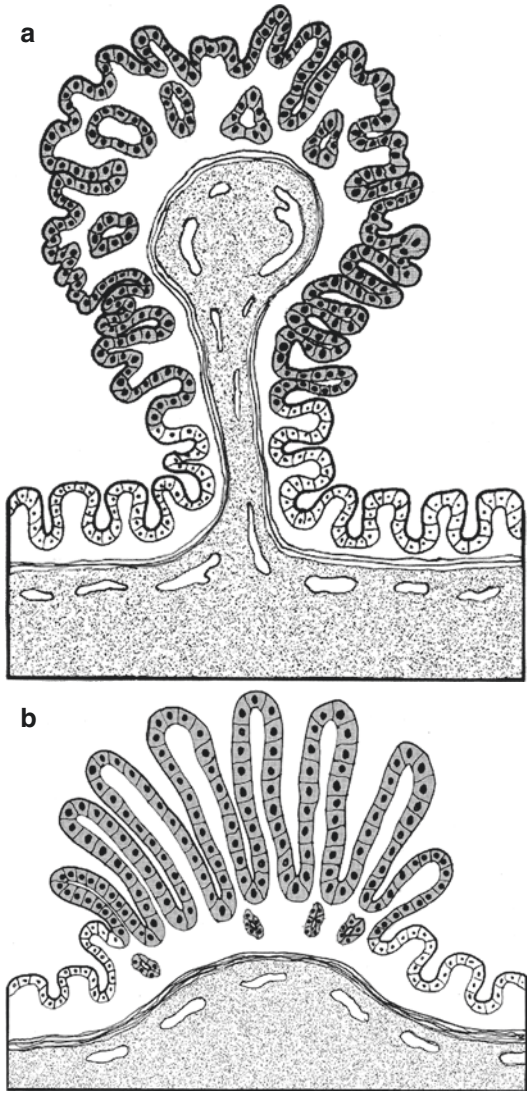


Fig. 25.1 Microscopic structure of adenomas. (**a**) Tubular adenoma (pedunculated) and (**b**) villous adenoma (Sessile)

Fig. 25.2 Histology of tubular adenoma

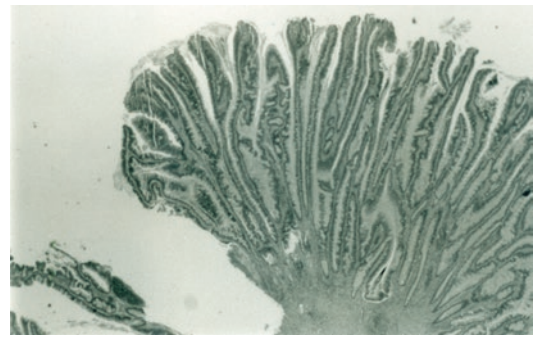


Fig. 25.3. Histology of villous adenoma

Treatment

Rectal polyps can be associated with diarrhea, hemorrhage, prolapse, and a risk of carcinoma. However, asymptomatic rectal polyps should be removed due to the risk of malignancy.

Risk of Malignancy

Factors which are associated with an increased chance of malignancy in a polyp are size, severity of dysplasia and histologic architecture. The majority of adenomas are less than 1 cm in diameter and have about a 1% malignancy rate [1, 6]. However, approximately 10% of polyps 1–2 cm in diameter contain a malignancy and greater than 35% of polyps over 2 cm will be malignant [1, 7]. The average size of a benign adenoma is 1 cm while those polyps with invasive cancer average 2 cm in diameter [8, 9].

Variance in polyp histologic architecture alters the risk of malignancy, and the likelihood of a polyp containing villous changes is directly related to its size [1]. The majority of villous tumors are greater than 1 cm in diameter. Table 25.1 shows the incidence of malignancy in polyps based on size and histologic type.

Natural History

Long-term patient surveillance, historical radiologic reviews and pathologic assessments established the natural history of neoplastic colorectal polyps. One study from the Mayo Clinic,

Table 25.1 Incidence of carcinoma in polyps by histologic type and size [1]

	Under 10 mm (%)	10–20 mm (%)	Over 20 mm (%)
Tubular adenoma	1	10	35
Tubovilous adenoma	4	7	46
Villous adenoma	10	10	53

Rochester, MN prior to the widespread use of colonoscopy, reported radiologic follow-up for 226 patients with polyps greater than 1 cm in diameter that were untreated [10]. Actuarial analysis showed a cumulative risk of cancer developing at the site of the polyp 2.5% at 5 years, 8% at 10 years, and 24% at 20 years.

Muto and colleagues [6] reviewed the time interval between identification of a neoplastic polyp and the development of malignancy. They reported on four patients with adenomatous polyps of the rectum who received no treatment. Three patients developed a cancer between 5 and 13 years from the time of diagnosis of their polyps. The fourth patient had a benign polyp resected after 11 years. Muto and colleagues concluded that the adenoma carcinoma sequence was at least 5 years and could take longer. Additionally, 10 patients with villous adenomas were observed for 5–30 years. Eight were treated by local excision or fulguration; two patients developed malignancies after 10 and 28 years of observation. These cases also demonstrate that a benign tumor can be present for many years without malignant change. Additional evidence for a time interval of at least 5 years in the adenoma carcinoma sequence is the difference in mean age at diagnosis for adenomas (58.1 years) versus that for carcinomas (62.1 years).

Malignant Polyps

Invasive carcinoma is defined as dysplastic cells, which penetrate through the muscularis mucosae. Two to nine percent of endoscopically removed colorectal polyps have malignant characteristics and treatment is based on the histopathology of the lesion [11]. Most current authors consider polypectomy adequate treatment for malignant polyps meeting certain criteria and suggest colectomy in patients whose polyps have histopathologic characteristics which put them at high risk for residual tumor in the bowel wall, lymph node metastasis, or distant metastasis [12, 13]. Widely accepted indications for surgical resection following polypectomy are listed in Table 25.2.

Table 25.2 Criteria for surgery for malignant polyps

- Inadequate endoscopic margin of resection is defined as >2 mm of non-malignant colonic tissue from the carcinoma to the cauterized margin as a clear margin
- Lymphovascular invasion
- Poorly differentiated

Another proposed indicator for surgical resection following polypectomy is level of invasion of the carcinoma. To facilitate optimal post-polypectomy intervention, Haggitt and Colleagues [14] described a classification system for levels of invasion (Figs. 25.4 and 25.5). For pedunculated polyps, Level 0 is carcinoma in situ (severe dysplasia), Level 1 is invasion through the muscularis mucosa in the head of the polyp, Level 2 is invasion into the neck, Level 3 is invasion into the stalk, and Level 4 is invasion into the submucosa of the bowel wall. Sessile polyps are classified as Level 4 if carcinoma extends through the muscularis mucosa. Haggit and colleagues [14] found that Level 4 invasion correlated with both a higher rate of residual cancer and nodal involvement. Subsequently, Nivatvongs and colleagues [15] reviewed 151 cases of patients who underwent resection of malignant colorectal polyps and found lymph node involvement only in patients with Level 4 invasion.

Polypectomy technique and specimen preparation are important in establishing proper criteria to prevent unnecessary surgery. Although complete excision is commonly accomplished with pedunculated polyps, the piecemeal techniques used frequently with sessile lesions prevent the pathologist from determining level of invasion and involvement of resection margins. Histopathologic sections should include a sagittal cut through the polyp head, neck, stalk, and resection margin (Fig. 25.6) [16]. Histologic preparation using this orientation allows the pathologist and surgeon to establish the above

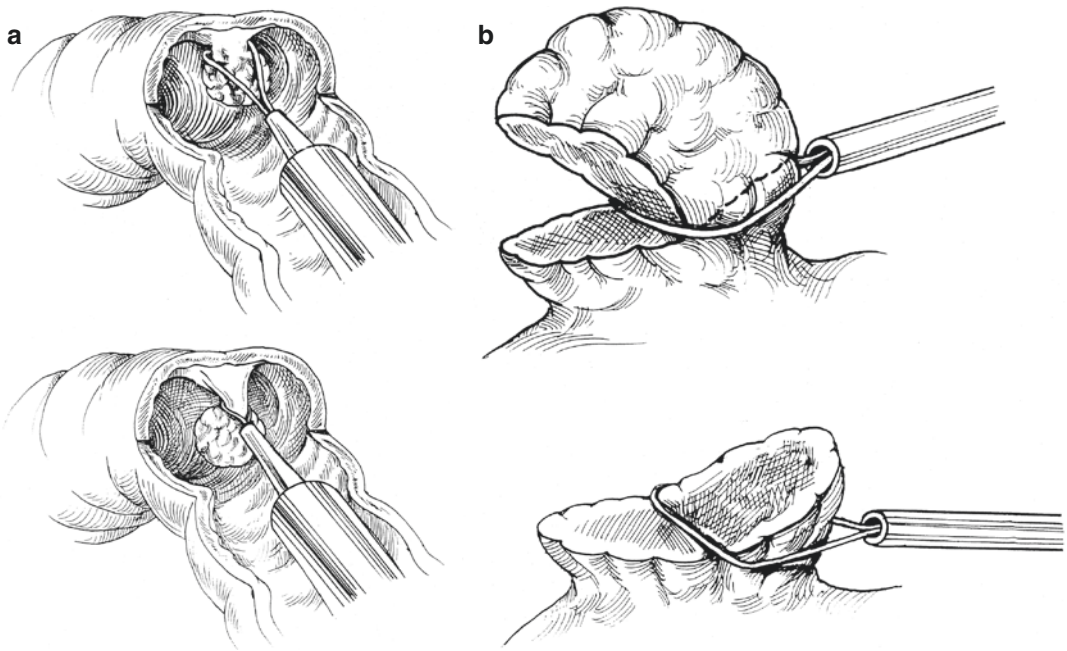


Fig. 25.4 Snare polypectomy of (**a**) pedunculated polyp and (**b**) sessile polyp

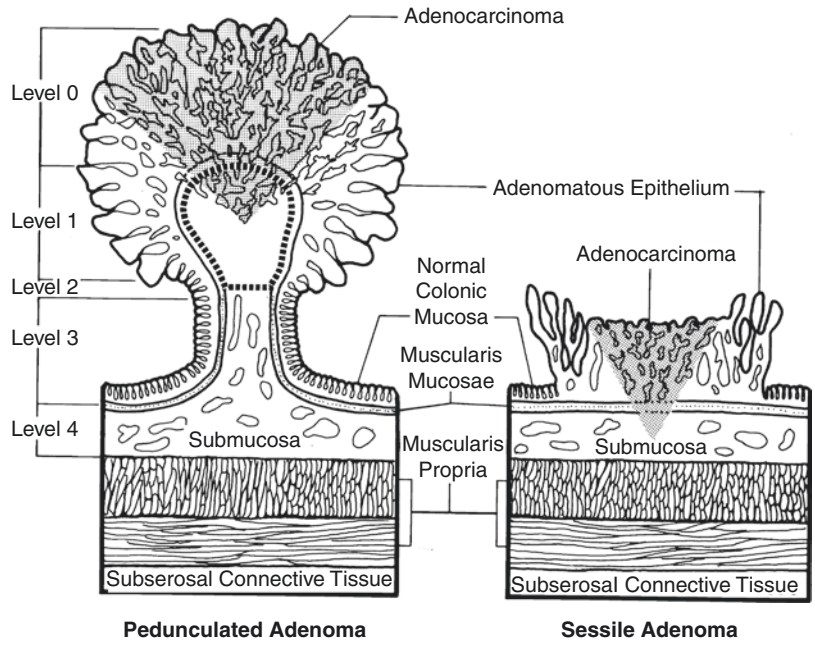


Fig. 25.5 Classification of polyps with invasive carcinoma

described resection criteria. Using current selection criteria, residual cancer (bowel wall, regional or distant metastasis) is found in 8–29% of patients who undergo polypectomy for malignant colorectal polyps [13]. Using the criteria in Table 23.2, Whitlow and colleagues [17] reported no difference in 5-year survival for patients treated by endoscopic polypectomy or surgical resection. The authors recommended colectomy for patients with 'high-risk' polyps. Other factors that should be considered are patient age, general medical condition, and tumor location. Lesions

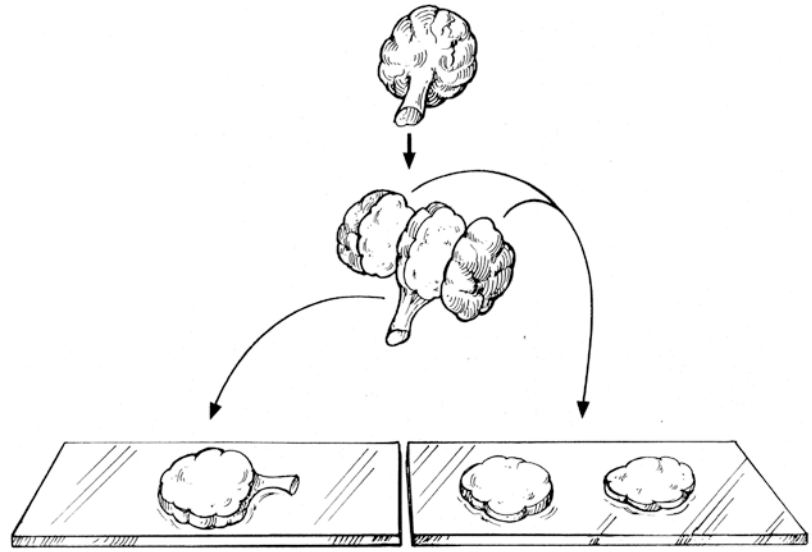


Fig. 25.6 Polyp preparation

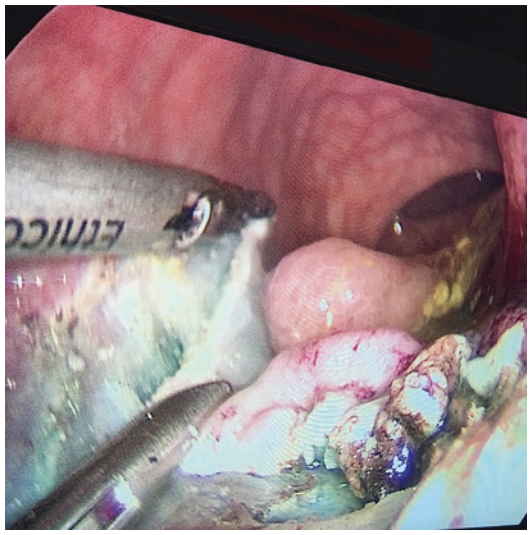


Fig. 25.7 Laparoscopic sleeve polypectomy. Courtesy of Scott R. Steele, MD

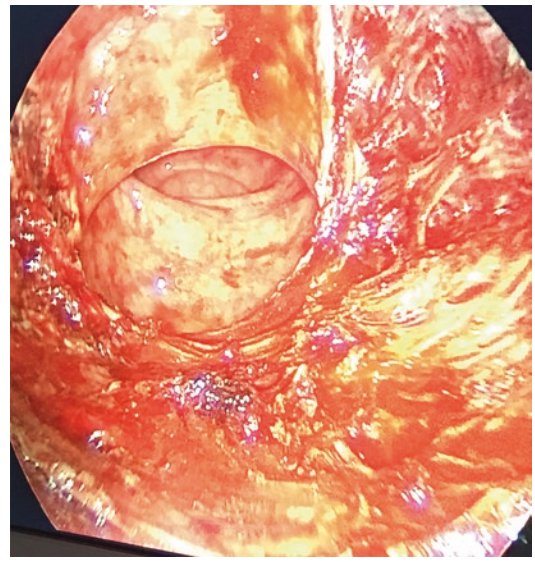


Fig. 25.8 Laparoscopic sleeve polypectomy. Courtesy of Scott R. Steele, MD

of the rectum present the potential complication of functional problems after proctectomy and low anterior resection or coloanal anastomosis or the need for abdominoperineal resection. Transanal excision may be appropriate management in some instances. Transanal excision is discussed further in Chap. 22. (Figs. 25.7 and 25.8)

Large Rectal Villous Tumors

Between 40 and 66% of villous tumors are found in the rectum (Fig. 25.9) [18]. They are typically less than 6 cm in diameter and located in the mid or distal rectum. Clinical evaluation is approximately 91 % accurate in detecting malignancy in rectal villous tumors [18, 19]. Features which indicate the presence of malignancy include induration on palpation and ulceration on endoscopy. Random biopsy has proven to be less accurate than palpation [18, 20]. As with other polyps, the finding of a villous tumor in the rectum mandates complete colonic evaluation due to the high incidence of synchronous neoplasms. In the absence of malignancy, large rectal villous

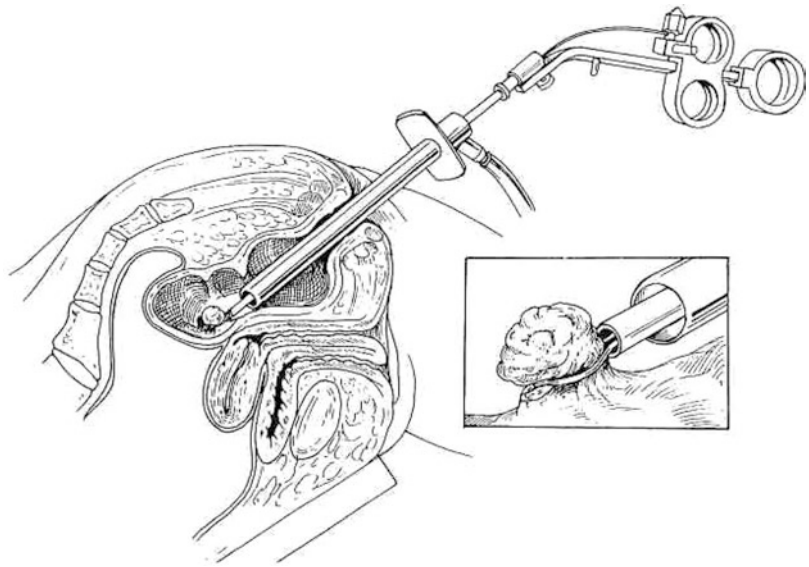


Fig. 25.9 Endoscopic snare of rectal villous tumor with a Frankfelt snare. Adapted from [17]

tumors should be removed by a sphincter-preserving technique. Transanal techniques include fulguration, snare excision, simple transanal excision, sleeve resection, transanal endoscopic microsurgery (TEMS) and transanal minimally invasive surgery (TAMIS).

Although fulguration treats the primary tumor it has the disadvantage of not providing a pathologic specimen to exclude any focus of invasive cancer. Laser ablation or photodynamic therapy are other means of ablating the lesion which suffer from the same drawback due to absence of a specimen. Distal tumors are frequently amenable to transanal excision (Fig. 25.10). The procedure involves infiltrating the submucosa with an epinephrine solution to minimize hemorrhage and improve visualization during excision. The tumor and a margin of normal mucosa are excised after which the mucosal defect can be primarily closed, marsupialized, or left open. Bleeding, stricture and rectal perforation are the most commonly reported complications. Recurrence rates range from 4 to 36% [21, 22].

Circumferential rectal villous tumors are a particularly challenging problem. Several authors employ a sleeve mucosectomy to excise the lesions [21, 22]. The mucosa is excised in a circumferential manner along the entire length of the tumor. After the exposed muscular wall is imbricated the proximal and distal mucosal margins are approximated (Fig. 25.11). Impaired

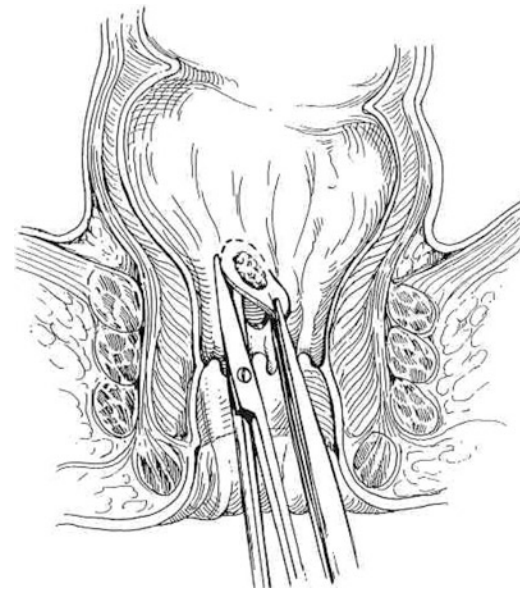


Fig. 25.10 Transanal excision of rectal villous tumor. Adapted from [17]

fecal continence occurred in 2 out of 12 patients reported by Keck and colleagues and 8% of lesions recurred [21].

The minimal access technique of transanal endoscopic microsurgery is an option to manage rectal villous tumors [23, 24]. A resectoscope with light source and magnifying optics allows CO_z insufflation and overcomes the problems of difficult exposure and poor light encountered

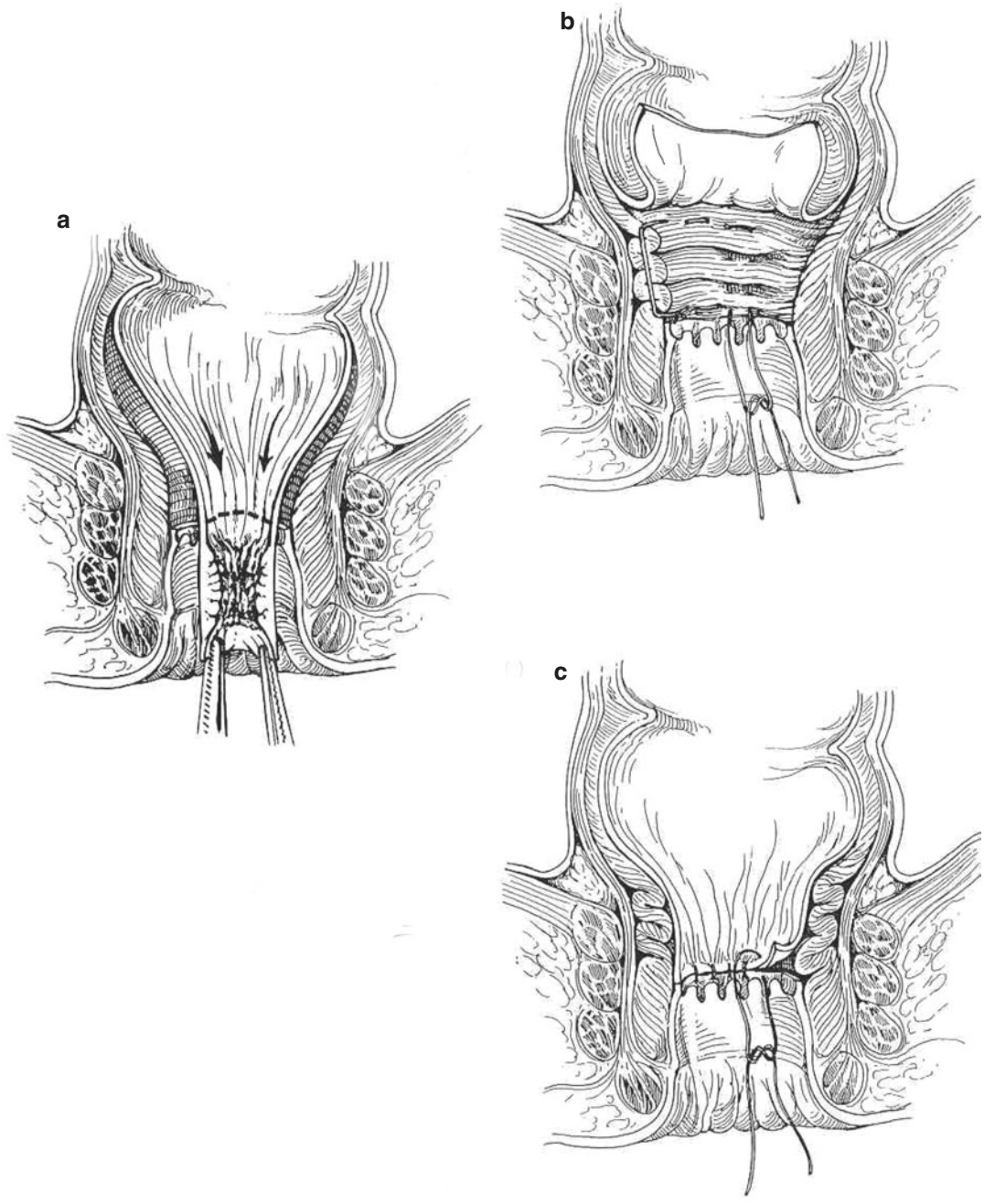


Fig. 25.11 Sleeve mucosectomy of a circumferential rectal villous tumor. (**a**) Lesion and normal bowel circumferentially excised. (**b**) Muscle layer is imbricated to reduce size of mucosal defect. (c) Mucosal defect is closed following rectal mucosectomy. Adapted from [17]

with proximal rectal lesions. The equipment expense, need for specialized training and length of time required to perform these procedures are some of the disadvantages of this technique. Conversely, the technique allows direct access to some proximal lesions, which would otherwise require a laparotomy and anterior resection. TAMIS uses laparoscopic instruments and a special access port. The technique is easier to learn and results have been good [25, 26].

Posterior approaches to proximal rectal villous tumors have been reported [27, 28].

However, most providers lack experience in these approaches. This along with a high incidence of incontinence and fecal fistula are the major complications associated with this approach [29]. Another approach to rectal villous tumors not amenable to transanal excision is low anterior resection [30]. Mortality is 1–2% and recurrence is very seldom reported. Numerous major potential morbidities include hemorrhage, anastomotic leak, pelvic abscess, anastomotic stricture, impaired continence, small bowel obstruction and sexual and urinary bladder dysfunction.

For extremely low lesions coloanal anastomosis is used to restore intestinal continuity [31]. Mortality rates are less than 4%, but again morbidities include hemorrhage, anastomotic leak, pelvic sepsis, small bowel obstruction and sexual and urinary bladder dysfunction [32, 33]. Abdominoperineal resection (APR) is reported in almost all large series of large rectal villous tumors [34]. Because transanal procedures are effective and have low morbidity rates, APR for the management of benign rectal villous tumors of the rectum should be extremely uncommon. In patients who are poor candidates for coloanal anastomosis due to poor sphincter function, a low Hartmann's procedure may be preferable to APR if an adequate distal margin (1–2 cm) can be obtained, thus avoiding the added potential morbidity of the perineal wound. In addition, the above-mentioned abdominal approaches have mortality and morbidity rates similar to APR.

Recurrence rates of 10–30% after transanal excision or fulguration mandate close endoscopic follow-up [21, 22]. If identified early, recurrent lesions are managed by fulguration or local excision or, on occasion, proctectomy.

In summary, the authors treat benign rectal villous tumors with transanal excision when possible. Patients who require rectal excision are managed by anterior or low anterior resection. Posterior approaches offer no advantage over transanal or intraabdominal approaches. For extremely large tumors that extend to the dentate line coloanal anastomosis (with or without colonic J pouch) is appropriate. Abdominoperineal resection with an intersphincteric proctectomy or a low Hartmann's procedure are reserved for those patients who would be rendered incontinent by a low pelvic anastomosis.

Hyperplastic Polyps

Hyperplastic polyps (Fig. 25.12), sometimes referred to as metaplastic polyps, are sessile growths that are usually slightly paler in color than the surrounding mucosa. Most hyperplastic polyps are less than 5.0 mm in diameter, they can be single or multiple and are invariably asymptomatic. Histologic examination reveals the crypts to be elongated (Fig. 25.11). The upper parts' of the crypts show papillary infoldings of normal-looking columnar, epithelial and goblet cells while the lower parts of the crypts contain fewer goblet cells. The cells are crowded together and project into the lumen in folds or tufts. On cross section, this distribution gives a characteristic stellate branching appearance of the glands. These polyps are generally regarded as the result of a disorder of maturation of unknown origin. It should be noted

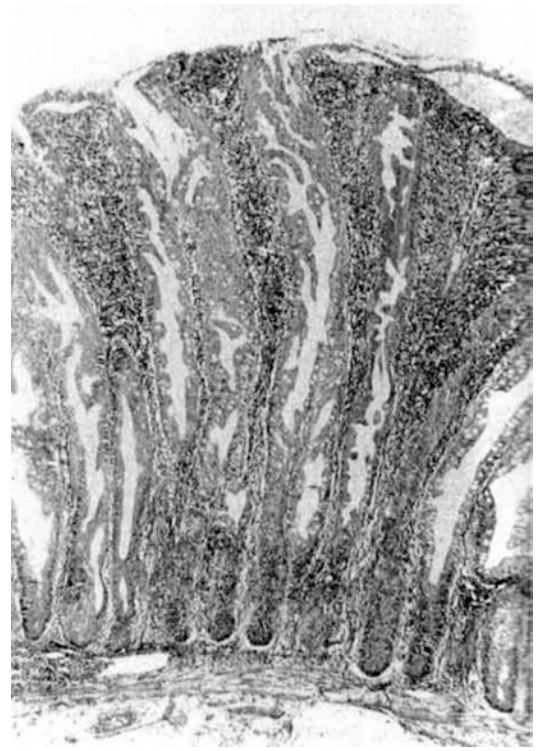


Fig. 25.12 Histology of juvenile polyp

that not all small sessile polyps seen in the rectum are hyperplastic and biopsy is essential to accurately identify the nature of the polyp.

Juvenile Polyps

Juvenile polyps (also called congenital polyps, retention polyps, or juvenile adenomas) are typically pedunculated, spherical polyps with a smooth surface. They are usually grey-white but may be dark red [35]. The majority are 1.0–1.5 cm in diameter but they may be as large as 4 cm. The cut surface of juvenile polyps shows mucous filled cystic spaces. Histologically, juvenile polyps are quite distinctive, consisting of normal columnar epithelial cells and goblet cells arranged in cystically dilated glands set in an abundant stroma (Fig. 25.13). The surface epithelium is often ulcerated. These lesions are thought to be hamartomatous or inflammatory in nature and have no malignant potential. Juvenile polyps are most frequently found in children under the age of 10 but can occur at any age [36]. Males are affected twice as often as females in the pediatric population while in adults, the ratio increases to 13:1.

The most common symptom of juvenile polyps is rectal bleeding, often due to autoamputation which occurs in 10% of cases [36]. Other presentations include prolapse of a rectal mass, intussusception, abdominal pain and diarrhea.

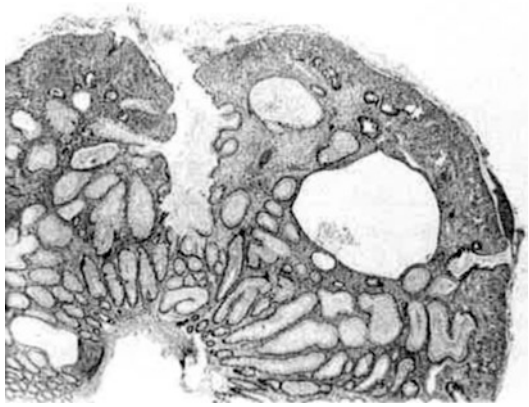


Fig. 25.13 Histology of hyperplastic polyp

Juvenile polyps are typically diagnosed by means of sigmoidoscopy or colonoscopy. Ninety percent of juvenile polyps are located within 20 cm of the anal verge and multiple polyps are found in 30% of patients. McColl and colleagues described a juvenile polyposis syndrome, which is inherited in an autosomal dominant manner [37]. Patients with this syndrome have multiple juvenile polyps, some of which may be in the stomach or small bowel, and a family history of adenomas or adenocarcinomas of the colon. In addition to juvenile polyps, patients with this syndrome may have colorectal adenomas.

Patients with juvenile polyposis coli have a higher recurrence rate (90%) than do those individuals who present with a single juvenile polyp (20%) [38]. They may present with iron deficiency anemia, hypoproteinemia, hypokalemia or finger clubbing [39]. Juvenile polyposis coli is considered a premalignant condition. Treatment is subtotal colectomy with ileorectal anastomosis. In cases in which the rectum cannot be cleared of polyps, restorative proctocolectomy should be considered.

Cronkhite-Canada Syndrome

Cronkhite-Canada syndrome is characterized by gastrointestinal polyposis, hyperpigmentation, alopecia and nail dystrophy [40]. It is felt to be a variant juvenile polyposis with ectodermal changes and without evidence of genetic transmission. Diarrhea and malabsorption produce severe vitamin deficiency, hypoproteinemia and fluid and electrolyte abnormalities. Other symptoms and signs include anemia, rectal bleeding, abdominal pain, weakness, nausea, vomiting, loss of taste, and a variety of neurologic complaints. Hair loss and nail and skin changes may be evident before the gastrointestinal symptoms become apparent.

Hamartomatous Polyps

The syndrome of characteristic hamartomatous polyps of the gastrointestinal tract and pigmented macules of the mucous membranes and skin was initially described by Peutz [41] Jeghers and colleagues [42] later reported a number of cases of

the syndrome. The disease is transmitted in an autosomal dominant fashion; however, there are sporadic cases [22]. In this syndrome, the small bowel is the most frequent location for polyps, particularly the jejunum.

Polyps may also be seen in the stomach, colon and rectum [43]. Grossly, Peutz-Jeghers polyps cannot be distinguished from adenomatous polyps. Peutz-Jeghers polyps may be sessile or pedunculated, and they range in size from a few millimeters to 6–7 cm. Histologically, these polyps are characterized by abnormal muscularis mucosae, which branches out in a tree like fashion (Fig. 25.14) while the epithelium appears normal.

The cutaneous pigmentation is typically on the buccal mucosa and on or around the lips although fingers and toes may also show these macules. The onset of pigmented areas is at birth or infancy, but may regress later in life while the polyps commonly occur in adolescence or early adulthood. Abdominal pain, the most common presenting symptom, can be difficult to control because of obstruction from the polyp or intussusception. Rectal bleeding, polyp prolapse, passage of a polyp, anemia or hematemesis are other reported signs and symptoms. Endoscopy and contrast studies such as enteroclysis are used to diagnose polypoid disease.

Patients not uncommonly undergo multiple operations for bleeding or small bowel obstruction. Under these circumstances, if the diagnosis is known, multiple polyps can be removed by enterotomy and polypectomy. Invagination of the bowel via an enterotomy or endoscopic polypectomy allows multiple polyps to be removed through one enterotomy site [43]. Massive small bowel resection should be avoided.

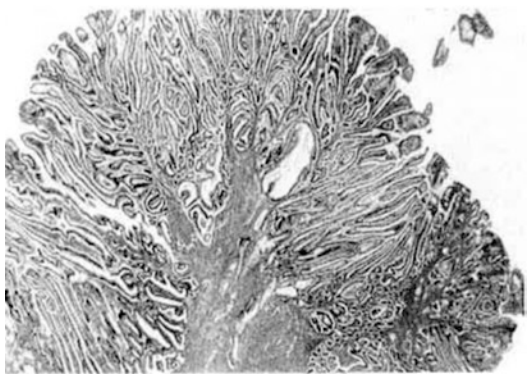


Fig. 25.14 Histology of Peutz-Jeghers polyp

The association of Peutz-Jegher syndrome with malignancy is unclear. Konishi and colleagues reviewed 103 cases reported in the literature [44]. These 103 patients had a total of 117 neoplasms including 50 cancers of the gastrointestinal tract. These were most commonly located in the colon and rectum. Spigelman and colleagues [45] found malignant tumors in 22% of 72 patients with Peutz-Jeghers syndrome in the St. Mark's Polyposis Registry. Giardiello and colleagues [46] reported a 48% rate of malignancy in 31 patients studied. In contrast to the above, Dozois and colleagues [47] failed to identify any cancers in a group of 48 patients from the Mayo Clinic followed for a median of 33 years.

Williams and colleagues [48] from St Mark's Hospital recommend upper and lower gastrointestinal endoscopy every other year, repeat evaluation if the patient becomes symptomatic, and laparotomy for any small bowel polyp larger than 1.5 cm in diameter. Periodic mammography and ultrasound of the abdomen are useful since these patients have a higher incidence of breast, ovarian and pancreatic cancers. The most important issue is to distinguish Peutz Jeghers polyps from familial polyposis coli, which are adenomatous polyps with high malignant potential.

Lipomas

Lipomas are benign submucosal fatty lesions that occur infrequently in the colon and rectum. [49] Although these neoplasms are more commonly found in the ascending colon, they can be found in the rectum. The majority of lipomas are asymptomatic and discovered incidentally. The typical endoscopic appearance of a lipoma is a smooth, yellow, submucosal lesion that exhibits the characteristic "pillow sign" or "cushion sign" when pressed with a forceps (Fig. 25.15). Larger lesions, usually greater than 2 cm, may rarely may cause bleeding or obstruction, or intussusception. Small asymptomatic lesions do not require resection, although ulceration can make differentiating these benign lesions from malignancy more difficult. Larger lipomas should be resected by transanal

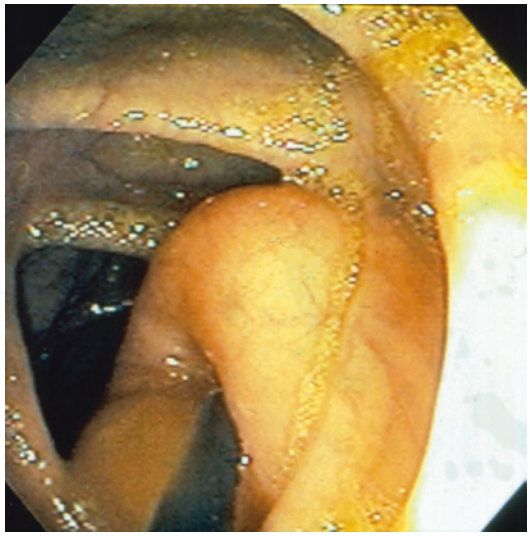


Fig. 25.15 Endoscopic appearance of a lipoma demonstrating the "pillow sign"

excision, enucleation or limited proctectomy. It is important to note that lipomas are difficult to resect using an endoscopic snare because of the energy required and the risk of bleeding and/or a transmural burn [49–51].

Hemangiomas

Hemangiomas are vascular malformations thought to be congenital in origin. Although gastrointestinal hemangiomas are considerably more rare than cutaneous hemangiomas, these lesions do occur throughout the gastrointestinal tract, including in the anorectum. Although rare, patients with GI hemangiomas often manifest cutaneous hemangiomas as well. Hemangiomas are classified as capillary hemangiomas that are comprised of fine, closely packed capillaries, or cavernous hemangiomas consisting of large, thin-walled blood vessels. Cavernous hemangiomas often present as a mucosal mass. In the colon and rectum, cavernous hemangiomas are far more common than capillary lesions.

Painless bleeding is the most common symptom of anorectal hemangiomas, often beginning early in life. Bleeding from capillary hemangiomas is typically slow and/or occult. Cavernous hemangiomas, on the other hand, may present with brisk and sometimes life threatening bleeding. Diagnosis is based upon endoscopic appearance, although confusion with other conditions, especially inflammatory, is not uncommon. Hemangiomas are typically dark red or blue, and cavernous lesions may appear as a polypoid mass [52]. CT scan may show calcification in the submucosal plexus, especially with cavernous hemangiomas.

Treatment for hemangiomas depends upon extent of bleeding, size, and location. Capillary lesions and small cavernous hemangiomas may be successfully treated endoscopically, either by excision, cautery, or sclerotherapy. Larger lesions are more difficult to treat. Sclerotherapy, angioembolization, and cryotherapy have all been reported. For larger, symptomatic lesions, resection is definitive therapy. Mucosal sleeve resection is sometimes successful in resecting anorectal lesions [53].

However, abdominoperineal resection is occasionally required for large cavernous hemangiomas with bleeding that cannot be controlled by other means [54–56].

Solitary Rectal Ulcer Syndrome/ Colitis Cystica Profunda

Solitary rectal ulcer syndrome and colitis cystica profunda (Fig. 25.16) can present as a rectal mass that can be difficult to differentiate from other rectal neoplasms. These lesions are thought to be associated with internal intussusception. Patients may complain of pain, bleeding, mucus discharge, or outlet obstruction. In solitary rectal ulcer syndrome, one or more ulcers are present in the distal rectum, usually on the anterior wall. In colitis cystica profunda, nodules or a mass may be found in a similar location. Biopsy of an ulcer or mass is mandatory to exclude malignancy. Nonoperative therapy including high-fiber diet, defecation training to avoid straining, and laxatives or enemas is effective in the majority of patients. Biofeedback has also been reported to be effective in some patients. Abdominal or perineal repair of prolapse as described above is reserved for highly symptomatic patients who have failed all medical interventions [49, 56].

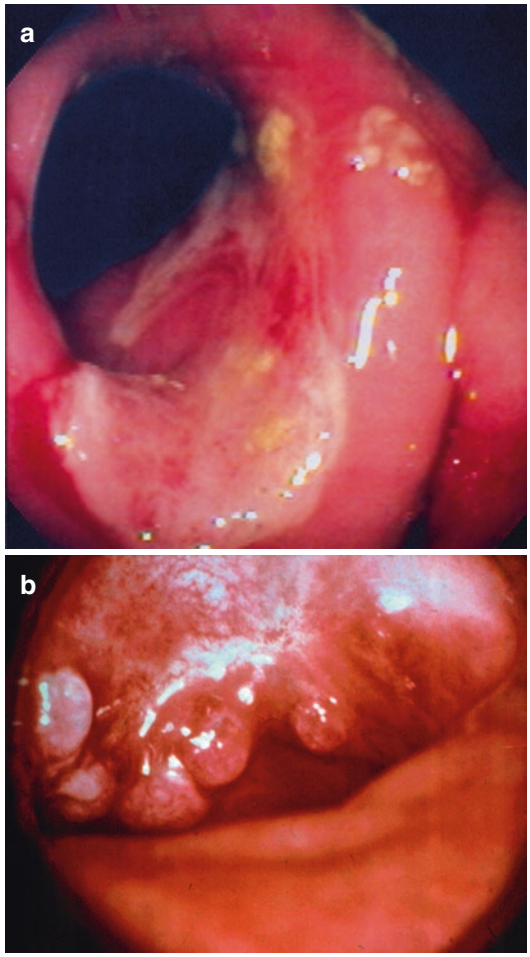


Fig. 25.16 (**a**) Solitary rectal ulcer syndrome. (**b**) Colitis cystica profunda can be difficult to distinguish from carcinoma

Leiomyomas

Leiomyomas are benign smooth muscle tumors that arise from the muscularis mucosa or muscularis propria of the bowel. Although they are most common in the upper GI tract, they can occur in the rectum or, less commonly, in the anal canal. Most patients are asymptomatic and lesions are often diagnosed incidentally when a mass is seen on endoscopy or felt on digital rectal examination. Large lesions may ulcerate and cause bleeding or result in tenesmus or frank obstruction. Management of leiomyoma is based largely upon the inability to differentiate a benign lesion from a malignant leiomyosarcoma. As such, wide local excision or radical resection is the treatment of choice. Recurrence is common after local resection, but most small leiomyomas can be adequately treated with limited resection. Lesions larger than 5 cm should be treated with radical resection because the risk of malignancy is high [49, 55].

Malignant

Leiomyosacrcoma

Leiomyosarcoma is rare in the gastrointestinal tract. When this malignancy occurs in the large intestine, the rectum is the most common site. Leiomyoma of the rectum is usually low grade, and, as such, can be difficult to differentiate from leiomyoma. Definitive diagnosis is usually made after resection. Symptoms, when they occur, are usually bleeding or obstruction. A radical resection is indicated for most of these tumors, although local excision can be considered for small lesions. Despite complete resection, recurrence is not uncommon and prognosis is generally poor [49, 57].

Gastrointestinal Stromal Tumors (GIST)

Are mesenchymal tumors that arise from the interstitial cells of Cajal. The vast majority (>95%) of GISTs express CD117 (KIT), and as such, are sensitive to tyrosine kinase inhibitors (TKIs), such as imatinib mesylate and sunitinib malate. GISTs are most common in the proximal GI tract but do occasionally occur in the colorectum (5–10%). While small GISTs may be asymptomatic and discovered incidentally, larger lesions can cause bleeding, obstruction, or abdominal pain. Treatment of choice is surgical resection (either local excision or radical resection) with microscopically negative margins if possible, however, local recurrence is common. For larger marginally resectable tumors, Tyrosine kinase inhibitors such as imatinib can be used to shrink the tumor. These agents can also be considered for adjuvant therapy after resction and are useful for treating metastatic disease [58].

Carcinoid Tumors

Carcinoid tumors are common in the gastrointestinal tract. Although nearly two thirds are found in the small bowel, up to 25% are found in the rectum. Most small rectal carcinoids are benign, and overall survival is greater than 80%. However, the risk of malignancy increases with size, and more than 60% of tumors greater than 2 cm in diameter are associated with distant metastases. In addition, smaller carcinoids that invade the muscularis propria or have other atypical features are more likely to metastasize. Unlike small bowel carcinoids, rectal carcinoid tumors are usually solitary and rarely present with synchronous lesions. Rectal carcinoids are less likely to secrete vasoactive substances than carcinoids in other locations, and carcinoid syndrome is uncommon in the absence of hepatic metastases. Serum and urine levels of serotonin, 5-HT, and 5-HIAA are typically normal. Very small carcinoids (<1 cm) can occasionally be endoscopically resected. Tumors up to 2 cm may be amenable to traditional transanal resection or to transanal endoscopic surgery. Larger tumors or tumors with obvious invasion into the muscularis require more radical surgery. In comparison to rectal carcinoids, carcinoid tumors in the proximal colon are less common but more likely to be malignant. Size also correlates with risk of malignancy in this location, and tumors less than 2 cm in diameter rarely metastasize. However, the majority of carcinoid tumors in the proximal colon present as bulky lesions and up to two-thirds will have metastatic spread at the time of diagnosis. These tumors should usually be treated with radical resection. Because carcinoid tumors are typically slow growing, patients with distant metastases may expect reasonably long survival. Symptoms of carcinoid syndrome can often be alleviated with somatostatin analogues including octreotide and/or interferon-a. Tumor debulking can offer effective palliation in selected patients [49, 59].

Carcinoid Carcinomas

Composite carcinoid carcinomas (adenocarcinoids) have histologic features of both carcinoid tumors and adenocarcinomas. In comparison to carcinoids, these tumors are usually high grade and poorly differentiated. They tend to be aggressive and are associated with a poor prognosis. The natural history of these tumors more closely parallels that of adenocarcinomas than carcinoid tumors, and regional and systemic metastases are common. Carcinoid carcinoma of the colon and rectum should be treated according to the same oncologic principles as followed for management of adenocarcinoma. Surgical resection for cure is sometimes possible for localized lesions without metastatic spread. Adjuvant chemotherapy and radiation have also been utilized in this setting [49, 60].

Lymphoma

Gastrointestinal lymphoma may be primary or generalized/secondary. Primary GI lymphomas occur most frequently in the terminal ileum and cecum. Lymphoma involving the colon and rectum is rare, but accounts for about 10% of all gastrointestinal lymphomas. Presentation, treatment and prognosis differ between patients with lymphoma occurring as a localized entity in the rectum versus those in whom there is generalized lymphoma with rectal involvement. Symptoms in isolated rectal lymphoma include bleeding, obstruction, and pain. These tumors may be clinically indistinguishable from adenocarcinomas. Bowel resection is the treatment of choice for isolated colorectal lymphoma. Radiation has been reported to be useful in unresectable cases. Adjuvant therapy may be given based upon the stage of disease and is useful for systemic disease [49, 56, 61].

Retrorectal/Presacral Tumors

Retrorectal/presacral tumors are rare and can be benign or malignant. The retrorectal space contains multiple embryologic remnants derived from a variety of tissues including the neuroectoderm, notochord, and hindgut. As such, tumors that develop in this space are often heterogeneous. Congenital lesions are most common,

comprising almost two-thirds of retrorectal lesions. The remainders are classified as neurogenic, osseous, inflammatory, or miscellaneous lesions. Malignancy is more common in the pediatric population than in adults, and solid lesions are more likely to be malignant than are cystic lesions. Inflammatory lesions may be solid or cystic and usually represent extensions of infection either in the perirectal space or in the abdomen.

The majority of congenital lesions are developmental cysts. These lesions may arise from all three germ cell layers. Dermoid and epidermoid cysts are benign lesions that arise from the ectoderm. Enterogenous cysts arise from the primitive gut. Anterior meningocele and myelomeningocele arise from herniation of the dural sac through a defect in the anterior sacrum. A "scimitar sign", a rounded, concave sacral border without any bony destruction) is the pathognomonic radiographic appearance of this condition (Fig. 25.17).

Solid lesions include teratomas, chordomas, neurologic tumors, or osseus lesions. Teratomas are true neoplasms and contain tissue from each germ cell layer and often contain both cystic and solid components. Teratomas are more common in children than in adults, but are more commonly malignant in adults. Chordomas are the most common malignant tumor in this region and arise from the notochord. These are slow growing, invasive cancers that show characteristic bony destruction. Neurogenic tumors include neurofibromas and sarcomas, neurilemomas, ependymomas, and ganglioneuromas. Osseous lesions include osteomas and bone cysts, as well as neoplasms such as osteogenic sarcoma, Ewing's tumor, chondromyxosarcoma, and giant cell tumors.

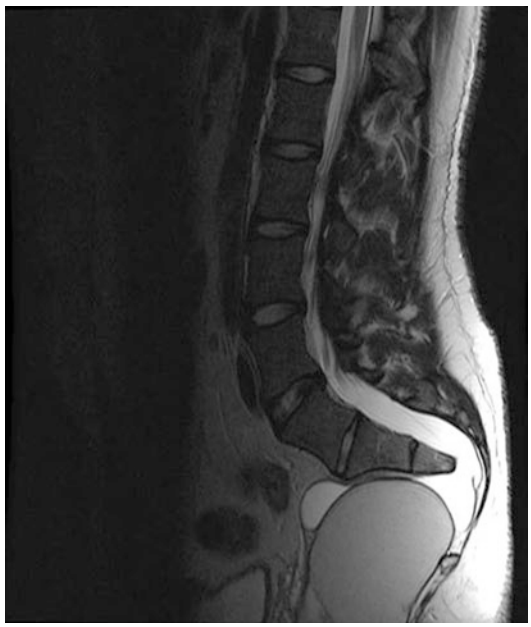


Fig. 25.17 Presacral meningocele demonstrating scimitar sign and delineation of anatomy on MRI. With permission from Eric J. Dozois, MD

Patients may present with lower back, pelvic, or lower extremity pain, gastrointestinal symptoms, or urinary tract symptoms. Most lesions are palpable on digital rectal examination. While plain X-rays and CT scans are often used to evaluate these lesions, pelvic MRI is the most sensitive and specific imaging study. Myelogram is occasionally necessary if there is central nervous system involvement. Treatment is almost always surgical resection. Although survival is excellent after resection of benign lesions, local recurrence is not uncommon. Prognosis after resection of malignant lesions is highly variable and reflect the biology of the underlying tumor.

The role of biopsy for solid tumors in this setting has been controversial. Historically, the recommendation was to *avoid* biopsy because of the risk of infection or needle tract seeding. This recommendation has recently been challenged, especially for large and/or unusual tumors that would be better treated with multimodality neoadjuvant therapy. A recent study confirmed the utility of needle biopsy of solid lesions and refuted concerns about needle tract seeding [2]. As such, most solid lesions should be biopsies regardless of resectability. In contrast, biopsy or aspiration of cystic lesions, should still be avoided because of the risk of infection [49, 62, 63].

Melanoma

Anorectal melanoma (Fig. 25.18) comprises less than 1% of all anorectal malignancies and 1–2% of melanomas. Diagnosis is often delayed and symptoms are attributed to hemorrhoidal disease. Compared to cutaneous melanoma, prognosis for patients with anorectal disease remains almost

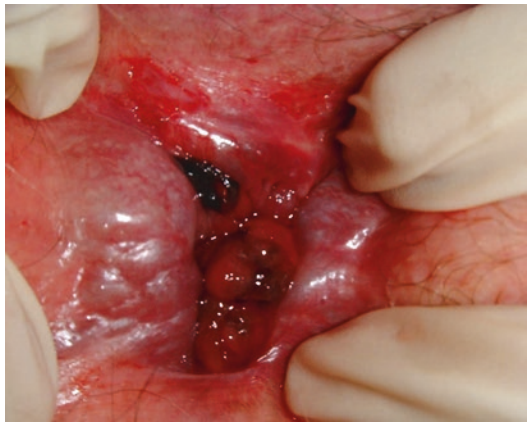


Fig. 25.18 Anal melanoma presenting in a hemorrhoid

universally poor. Overall 5-year survival is less than 10%, and many patients present with systemic metastasis and/or deeply invasive tumors at the time of diagnosis. A few patients with anorectal melanoma, however, present with isolated local or locoregional disease that is potentially resectable for cure, and abdominoperineal resection (APR) and wide local excision have been advocated. Recurrence is common and is usually systemic regardless of the initial surgical procedure. Local resection with free margins does not increase the risk of local or regional recurrence and APR offers no survival advantage over local excision. In some patients, wide local excision may not be technically feasible and APR may be required if the tumor involves a significant portion of the anal sphincter or is circumferential. The addition of adjuvant chemotherapy, biochemotherapy, vaccines, or radiotherapy may be of benefit in some patients, but efficacy remains unproven [49].

References

1. O'Brien MJ, Winawer SJ, Zauber AG, et al. The national polyp study. Patient and polyp characteristics associated with high-grade dysplasia in colorectal adenomas. Gastroenterology. 1990;98:371–9.
2. Whitlow CB, Opelka FG. Other rectal neoplasms. In: Beck DE, Wexner SD, editors. Fundamentals of anorectal surgery. 2nd ed. London: W B Saunders; 1998. p. 382–99.
3. Fenoglio-Prieser CM, Pascal RR, Perzin KH. Adenomas. In: Hartman WH, editor. Tumors of the intestines. Washington, DC: Armed Forces Institute of Pathology; 1990. p. 69–150.
4. Fenoglio-Prieser CM. Colonic polyp histology. Semin Colon Rectal Surg. 1990;2:234–45.
5. Wise PE. Polyps. In: Beck DE, Roberts PL, Saclarides TJ, Senagore AJ, Stamos MJ, Wexner SD, editors. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011. p. 636.
6. Muto T, Bussey HJR, Morson BE. The evolution of cancer of the colon and rectum. Cancer. 1975;36:2251–70.
7. Tierney RP, Ballantyne GH, Modlin M. The adenoma to carcinoma sequence. Surg Gynecol Obstet. 1990;171:81–94.
8. Silverberg SG. Focally malignant adenomatous polyps of the colon and rectum. Surg Gyneeol Obstet. 1970;131:103–14.
9. Grinnell RS, Lane N. Benign and malignant adenomatous polyps and papillary adenomas of the colon and rectum. An analysis of 1856 tumors in 1335 patients. Surg Gynecol Obstet. 1958;106:519–38.
10. Stryker JS, Wolff BG, Culp CE, et al. Natural history of untreated colonic polyps. Gastroenterology. 1987;93:1009–13.
11. Waye JO, O'Brien MJ. Cancer in polyps. In: Cohen AT, Winawer SJ, editors. Cancer of the colon, rectum and anus. New York: McGraw-Hill; 1995. p. 456–76.
12. Pollard CW, Nivatvongs S, Rojanasakul A, et al. The fate of patients following polypectomy alone for polyps containing invasive carcinoma. Dis Colon Rectum. 1992;35:933–7.
13. Whitlow CB, Gathright JB, Hebert SJ, et al. Long-term survival after treatment of malignant colonic polyps. Dis Colon Rectum. 1997;40:929–34.
14. Haggitt RC, Glotzbach RE, Soffer EE, Wruble LE. Prognostic factors in colorectal carcinomas arising in adenomas: implications for lesions removed by endoscopic polypectomy. Gastroenterology. 1985;89:328–36.
15. Nivatvongs S, Rojanasakul A, Reiman HM, et al. The risk of lymph node metastasis in colorectal polyps with invasive adenocarcinoma. Dis Colon Rectum. 1991;34:323–8.
16. Opelka FG, Hicks TE. Management of malignant polyps. Semin Colon Rectal Surg. 1991;2:296–304.
17. Whitlow CB, Beck DE, Gathright JB. Surgical excision of large rectal villous adenomas. Surg Oncol Clin N Am. 1996;5:723–34.
18. Galandiuk S, Fazio VW, Jagelman OG, et al. Villous and tubulovillous adenomas of the colon and rectum. Am Surg. 1987;153:41–7.
19. Nivatvongs S, Nicholson JO, Rothenberger OA. Villous adenomas of the rectum: the accuracy of clinical assessment. Surgery. 1980;87:549–5l.
20. Wheat MW, Ackerman LV. Villous adenomas of the large intestine. Ann Surg. 1958;147:476–87.
21. Keck JO, Schoetz OJ Jr, Roberts PL, et al. Rectal mucosectomy in the treatment of giant rectal villous tumors. Dis Colon Rectum. 1995;38:233–8.
22. Sakamoto GO, Mackeigan JM, Senagore AJ. Transanal excision of large, rectal villous adenomas. Dis Colon Rectum. 1991;34:880–5.
23. Buess G, Kipfmuller K, Ibald R, et al. Clinical results of transanal endoscopic microsurgery. Surg Endosc. 1988;2:245–50.

24. Saclarides TJ, Smith L, Ko S, et al. Transanal endoscopic microsurgery. Dis Colon Rectum. 1992;35:1183–91.
25. Jorgensen SJ, Ottsen M. Posterior rectotomy for villous tumors of the rectum. Acta Chir Scand. 1975;141:680–2.
26. Wilson SE, Gordon HE. Excision of rectal lesions by thoe Kraske approach. Am J Surg. 1969;118:213–7.
27. Thompson BW, Tucker WE. Transsphincteric approach to lesions of the rectum. South Med J. 1987;80:41–3.
28. Redmond HP, Austin OMB, Clery AP, Deasy JM. Safety of double-stapled anastomosis in low anterior resection. Br Surg. 1993;80:924–7.
29. Franklin R, McSwain B. Juvenile polyps of the colon and rectum. Ann Surg. 1992;216:432–7.
30. Cohen AM, Enker WE, Monsky BD. Protectomy and coloanal construction for rectal cancer. Dis Colon Rectum. 1990;33:40–3.
31. Enker WE, Steams MW Jr, Janov AJ. Peranal coloanal anastomosis following low anterior resection for rectal carcinoma. Dis Colon Rectum. 1985;28:576–81.
32. Chiu YS, Spencer RJ. Villous lesions of the colon. Dis Colon Rectum. 1978;21:493–5.
33. Fenoglio-Prieser CM, Pascal RR, Perzin KH. Nonneoplastic polyps. In: Hartman WH, editor. Tumors of the intestines. Washington, DC: Armed Forces Institute of Pathology; 1990. p. 31–67.
34. Mazier WI, Mackeigan JM, Billinghan RP, Dignan RD. Juvenile polyps of the colon and rectum. Surg Gynecol Obstet. 1982;154:829–32.
35. McColl I, Bussey HJ, Veale AMO, Be M. Juvenile polyposis coli. Proc R Soc Med. 1964;57:896–7.
36. Haggitt RC, Pitcock JA. Familial juvenile polyposis of the colon. Cancer. 1970;26:1232–8.
37. Grosfield JL, West KW. Generalized juvenile polyposis coli. Clinical management based on long-term observations. Arch Surg. 1986;121:530–4.
38. Cronkhite LW Jr, Canada WJ. Generalized gastrointestinal polyposis. An unusual syndrome of polyposis, pigmentation, alopecia and onychotrophia. N Engl J Med. 1955;252:1011–5.
39. Peutz JLA. Very remarkable case of familial polyposis of mucous membrane of intestinal tract and nasopharynx accompanied by peculiar pigmentations of skin and mucous membrane. Nederl Maandschr V Geneesk. 1921;10:134–46.
40. Jeghers H, McKusick VA, Katz KH. Generalized intestinal polyposis and melanin spots of the oral mucosa, lips and digits: a syndrome of diagnostic significance. N Engl J Med. 1949;241:993–1005.
41. Utsunomiya J, Gocho H, Miyanaga T, et al. PeutzJeghers syndrome: its natural course and management. Johns Hopkins Med J. 1975;136:71–82.
42. Konishi F, Wyse NE, Muto T, et al. Peutz-Jeghers polyposis associated with carcinoma of the digestive organs: report of three cases and review of the literature. Dis Colon Rectum. 1987;30:790–9.
43. Spigelman AD, Arese P, Phillips RKS. Polyposis: the Peutz-Jeghers syndrome. Br J Surg. 1995;82:1311–4.
44. Giardiello FM, Welsh SB, Hamilton SR, et al. Increased risk of cancer in the Peutz-Jeghers Syndrome. N J Med. 1987;316:1511–4.
45. Dozois HK Judd ES, Dahlin DC, et al. The Peutz-Jeghers syndrome. Is there a predisposition to the development of intestinal malignancy? Arch Surg. 1969;98:509–17.
46. Williams CB, Goldblatt M, Delaney PV. Top and tail endoscopy' and follow up in Peutz-Ieghers syndrome. Endoscopy. 1982;14:82–4.
47. Bullard Dunn KM, Rothenberger DA. Colon, rectum, and anus. In: Brunicardi C, editor. Schwartz's principles of surgery. 10th ed. New York: McGraw Hill; 2014. p. 1175–240.
48. Silverstein FE, Tytgat GNJ, Polyps CI. Tumors in gastrointestinal endoscopy. 3rd ed. London: Mosby; 1997. p. 268–9.
49. Ghanem OM, Slater J, Singh P, Heitmiller RF, DiRocco JD. Pedunculated colonic lipoma prolapsing through the anus. World J Clin Cases. 2015;3(5):457–61.
50. Silverstein FE, Tytgat GNJ, Polyps CI. Tumors in gastrointestinal endoscopy. 3rd ed. London: Mosby; 1997. p. 340–1.
51. Londono-Schimmer EE, Ritchie JK, Hawley PR. Coloanal sleeve anastomosis in the treatment of diffuse cavernous hemangioma of the rectum: long term results. Br J Surg. 1994;81:1235–7.
52. Ugolini G, Rosati G, Montroni I, Manaresi A, Blume JF, Taffurelli M. Diffuse cavernous haemangioma of the rectum and anus: an unusual case of rectal bleeding with challenging management. BMJ Case Rep. 2009;2009:bcr02.2009.1545.
53. Nivatvongs S. Benign neoplasms of the colon and rectum. In: Gordon PH, Nivatvongs S, editors. Principles and practice of surgery for the colon, rectum, and anus. 2nd ed. St. Louis: Quality Medical Publishing; 1999. p. 567–8.
54. Whitlow CB, Opelka FG. Other rectal neoplasms. In: Fundamentals of anorectal surgery. 2nd ed. Philadelphia: WB Saunders; 1998.
55. Nivatvongs S. Benign neoplasms of the colon and rectum. In: Gordon PH, Nivatvongs S, editors. Principles and practice of surgery for the colon, rectum, and anus. 2nd ed. St. Louis: Quality Medical Publishing; 1999. p. 695–6.
56. NCCN Task Force Report. Update on the management of patients with gastrointestinal stromal tumors. J Natl Compr Cancer Netw. 2010;8(2):S1–S44.
57. Demetri GD, von Mehren M, Antonescu CR, DeMatteo RP, Ganjoo KN, Maki RG, Pisters PWT, Raut CP, Riedel RF, Schuetze S, Sundar HM, Trent JC, Wayne JD, Kwaan MR, Goldberg JE, Bleday R. Rectal carcinoid tumors: review of results after endoscopic and surgical therapy. Arch Surg. 2008;143:471–5.
58. Barakat MT, Meeran K, Bloom SR. Neuroendocrine tumors. Endocr Relat Cancer. 2004;11:1–18.

59. Nivatvongs S. Benign neoplasms of the colon and rectum. In: Gordon PH, Nivatvongs S, editors. Principles and practice of surgery for the colon, rectum, and anus. 2nd ed. St. Louis: Quality Medical Publishing; 1999. p. 693–5.
60. Merchea A, Dozois EJ. Lesions originating within the retrorectal space. J Gastrointest Surg. 2014;18(12):2232–3.
61. Dozois EJ, Jacofsky DJ, Billings BJ, Privitera A, Cima RR, Rose PS, Sim FH, Okuno SH, Haddock MG, Harmsen WS, Inwards CY, Larson DW. Surgical approach and oncologic outcomes following multidisciplinary management of retrorectal sarcomas. Ann Surg Oncol. 2011;18(4):983–8.
62. Merchea A, Larson DW, Hubner M, Wenger DE, Rose PS, Dozois EJ. The value of preoperative biopsy in the management of solid presacral tumors. Dis Colon Rectum. 2013;56(6):756–60.
63. Chen H, Cai Y, Liu Y, He J, Hu Y, Xiao Q, Hu W, Ding K. Incidence, surgical treatment, and prognosis of anorectal melanoma from 1973 to 2011: a population-based SEER analysis. Medicine. 2016;95(7):e2770.

Retrorectal (Presacral) Tumors

26

Ramon A. Brown and David A. Margolin

Introduction

Retrorectal tumors encompass a heterogeneous group of lesions and neoplasms that demonstrate variable growth patterns. As a result of their anatomic location these rare lesions, manifest with non-specific symptoms that makes their initial diagnosis difficult. Often they are found incidentally on physical exam or imaging in the work up of other disease processes. While these lesions are fairly well documented in the literature they are discussed largely in case studies. The largest series is maintained by the Mayo clinic representing 1 in 40,000 hospital admissions [1, 2]. This chapter will illustrate and characterize the etiology, diagnosis and management of these lesions, specifically focusing on minimally invasive approaches to this disease process.

Anatomy

The retrorectal space lies between the upper two-thirds of the rectum and the sacrum, above the rectosacral fascia. The boundaries of this potential space include the posterior wall of the rectum (fascia propria) anteriorly and the sacrum posteriorly. This space extends superiorly to the peritoneal reflection and laterally is bound by the lateral stalks of the rectum, the ureters, the sacral nerve roots and the iliac vessels. This retroperitoneal space contains loose connective tissue. The presacral fascia protects the extensive vertebral plexus of presacral vessels that lie deep to it.

The retrorectal space is thought to contain totipotential cells from all three germ cell layers. The wide range of histological variance may be due to the presence of multiple embryologic remnants and heterogeneous tissue types. These lesions range from benign cysts to malignant masses which can invade the surrounding pelvic structures [3].

Classification

While a variety of classifications systems have been proposed for presacral tumors, the current system is a modification of Uhlig and Johnson's system which places retrorectal tumors into broad categories: congenital, neurogenic, osseous, inflammatory, and miscellaneous. In the current

R. A. Brown
The Ochsner Clinic Foundation, Ochsner Clinical School, Ochsner Clinic, New Orleans, LA, USA

D. A. Margolin (✉)
The Ochsner Clinic Foundation, Ochsner Clinical School, Ochsner Clinic, New Orleans, LA, USA

The University of Queensland School of Medicine, St. Lucia, QLD, Australia
e-mail: damargolin@ochsner.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_26

scheme, Dozois et al. subcategorized these lesions into malignant and benign entities [4, 5]. While the majority of the lesions in the presacral space are benign up to one third will be malignant. Malignant tumors occur more frequently in men and are associated with worse outcomes than benign with regard to recurrence, function and post-operative complications [6]. The current classification system aids in the characterization of these lesions but in guiding the appropriate therapeutic approach.

Congenital Lesions

Congenital lesions arise from the remnants of embryonic tissue and may be cystic or solid in nature. Benign cystic congenital lesions include developmental cysts and anterior meningoceles while benign solid lesions consist of teratomas, and adrenal rest tumors. Malignant congenital lesions consist of sacrocoxygyl chordomas, teratocarcinoma and can result from the malignant degeneration of cystic lesions. Congenital lesions are the most common retrorectal tumors, accounting for 60.5% of all tumors in the presacral space. They are usually benign and are more common in females. Malignant lesions typically present at an older age (53.9 ± 11.5 vs. 40.1 ± 12.2 years; $p = 0.05$) and occur more frequently in males [7].

Cystic Lesions

Developmental Cysts

Developmental cysts are the most common congenital lesions and can be further classified based on cell layer of origin and are divided into epidermoid, dermoid, duplication and tail gut cysts.

Epidermoid Cysts and Dermoid Cysts

Epidermoid and dermoid cysts result of closure failure of the ectodermal tube. They are lined with squamous epithelial cells. Epidermoid cysts are composed of stratified squamous cells; they are typically unilocular lesions and do not contain skin appendages while dermoid cysts have stratified squamous epithelium with skin appendages (sweat glands, hair follicles, sebaceous cysts). They tend to be well circumscribed, round and have a thin outer layer. Both of these cysts may communicate with the skin and be associated with a postanal dimple or sinus. The postanal dimple or sinus that can are frequently misdiagnosed and managed as a perirectal abscesses, fistula in ano, or pilonidal disease. If errantly drained there is a secondary infection rate of 30% [2, 8].

Duplication Cysts (Enterogenous)

Enterogenous cysts arise from the endoderm of the primitive hindgut. As these lesions originate from endodermal tissue, they are typically lined with squamous, cuboidal, or columnar epithelium. They care called rectal duplication cysts if they are related to the rectum. These tumors usually have a multilobular appearance with one dominant lesion and smaller satellite cysts. Similar to epidermoid and dermoid cysts, they are more common in women and may become infected. Although the vast majority of these lesions are benign, malignant degeneration is possible [9].

Tail Gut Cysts (Cystic Harmatomas)

Tail gut cysts, or cystic hamartomas, arise from remnants of the postanal primitive gut that fail to regress. These multinodular encapsulated, well-circumscribed cysts may contain of squamous, columnar, or transitional epithelium. Morphologically, these cysts are similar to the adult or fetal intestinal tract. Tail gut cysts can be differentiated from epidermoid and dermoid cysts by the presence of glandular or transitional epithelium as well as the presence of a defined muscular wall with a myenteric plexuses. In general, these are benign lesions, however, malignant transformation has been reported in up to 13% in some series [10, 11].

Anterior Sacral Meningocele

Anterior sacral meningoceles are a result of a defect in the thecal sac and may be seen in combination with presacral cysts or lipomas. Only rarely do these cysts contain neural elements; if they are present the lesion is considered a

myelomeningocele. Anterior sacral meningocele may be associated with other congenital anomalies, such as spina bifida, tethered spinal cord, urinary tract or anal malformations as well as uterine or vaginal duplications [12]. They are secondary to protrusions of the dural sac through a unilateral defect in the anterior sacrum. Of note, this defect results in a sacrum that demonstrates a rounded concave border without bony destruction on plain radiograph resulting in the classic radiologic finding of the "scimitar sign" seen on plain films (Fig. 26.1). Patients often have vague symptoms including headaches related to postural changes, Valsalva manuver, coughing and defecation. This can be attributed to the compression-induced increase in cerebrospinal fluid pressure due to the continuity between the dural sac and subdural space. Biopsy or aspiration is contraindicated as secondary infection may result in life-threatening meningitis. Surgical management requires ligation of the dural defect [12, 13].

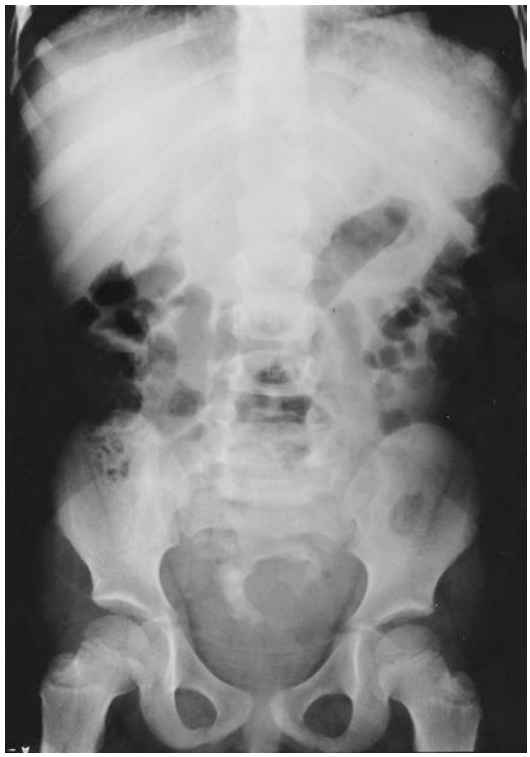


Fig. 26.1 Classic radiologic finding of the "scimitar sign" associated with sacral meningocele

Solid Lesions

Teratomas and Teratocarcimona

Teratomas are neoplasms derived from pluripotential cells and include all three germ cell layers. They include epithelium of the gastrointestinal tract, respiratory tract, and nervous system. These lesions may be solid or cystic and often contain both components (Fig. 26.2). Teratomas have the potential may undergo malignant squamous cell carcinoma arising from the ectodermal tissue or rhabdomyosarcoma arising from the mesenchymal cells. Furthermore, anaplastic tumors in which the germ cell origin is not be distinguishable are also seen. This is of primary concern because up to 10% of teratomas will undergo malignant degeneration if left untreated [3, 13]. Teratomas are more common in females and in the pediatric population and are often associated with anomalies of the vertebra, urinary tract, or anorectum. Histologically, these tumors are referred to as either "mature" or "immature" reflecting the degree of cellular differentiation [11]. Malignancy is rare beyond the second decade; however, the neonatal malignancy rate is 4%. In adults, malignant degeneration can occur in 40–50% [11, 14]. These lesions tend to adhere to the coccyx and surgical approach requires en bloc coccygectomy (Fig. 26.3). Incomplete or intralesional resection increases the likelihood of malignant degeneration. These lesions can also become infected and be misdiagnosed as a perirectal abscess or fistula.

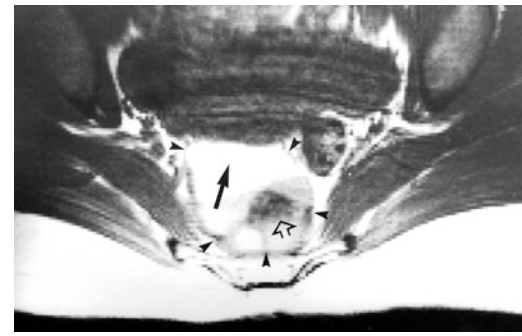


Fig. 26.2 Teratomas may be solid or cystic and often contain both components

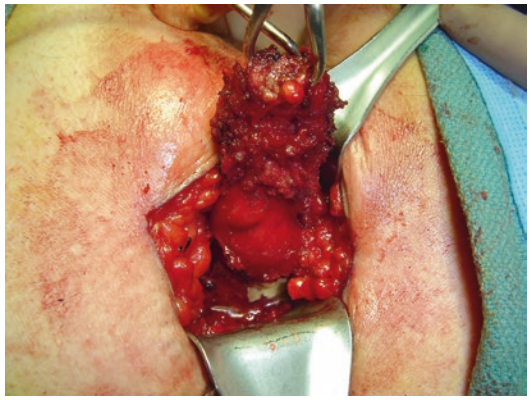


Fig. 26.3 Coccygectomy with retrorectal tumor removal

Due to their location diagnosis is often delayed and these tumors may reach considerable size [15, 16].

Sacrococcygeal Chordomas

Chordomas arise from the primitive notochord, which extends from the base of the occiput to the caudal limit of the embryo. They are the most common malignancy in the retrorectal space and may occur anywhere along the embryologic notochord with 30–50% occurring in the sacrococcygeal region (Fig. 26.4) [17]. These lesions occur more frequently in men and are rarely encountered in patients younger than 30 years of age. The most common symptoms include pelvic, buttock, and lower back pain aggravated by sitting and alleviated by standing or walking. These slow-growing tumors may be soft, gelatinous, or firm and may invade, distend, or destroy bone and soft tissue (Fig. 26.5). Hemorrhage and necrosis within tumors may lead to secondary calcification and pseudocapsule formation. Teratomas metastasize to lung, liver, and bone in 20% of cases [18]. These tumors often reach substantial size because of delays in diagnosis secondary to the indolent nature of the disease. Patients may be asymptomatic, present with vague complaints including positional buttock, pelvic, or lower back pain; or they may present with specific symptoms secondary to invasion, including impotence and incontinence. Local recurrence rates are high despite radical resection; the 10-year survival rate is only 9–35% [19].

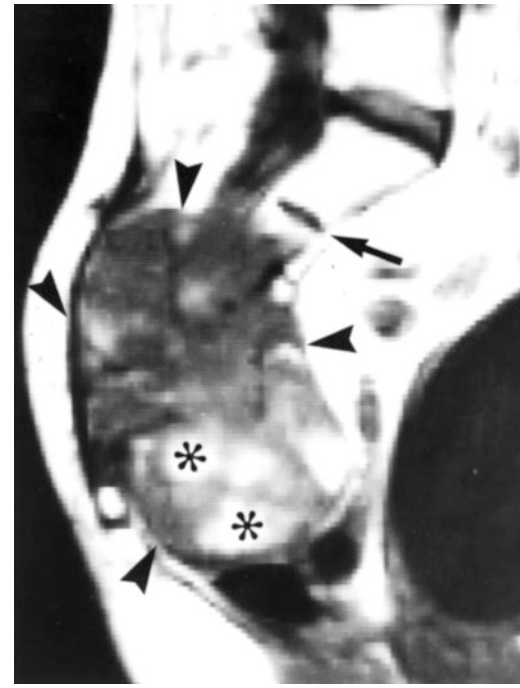


Fig. 26.4 Chordoma

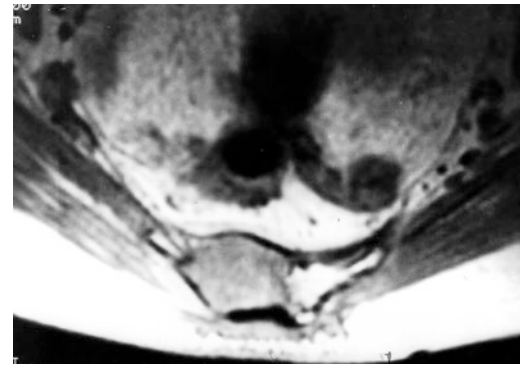


Fig. 26.5 Chordomas are slow-growing tumors may be soft, gelatinous, or firm and may invade, distend, or destroy bone and soft tissue

Neurogenic Tumors

Neurogenic tumors represent 10% of retrorectal tumors and are the second most common presacral lesion after congenital lesions. They typically arise from peripheral nerves and 85% are benign. Neurogenic tumors include neurilemmomas, ganglioneuromas, ganglio-neuroblastomas, neurofibromas, neuroblastomas, ependymomas,

and malignant peripheral nerve sheath tumors (neurofibrosarcoma, malignant schwannomas, and neurogenic sarcomas) [20]. Neurilemmomas were the most common benign neurogenic tumors. Neurofibrosarcoma were the most common malignant neurogenic tumors. Malignant tumors had a higher recurrence rate compared to benign neurogenic tumors (42 vs. 6.7%; $p < 0.05$) [7]. These slow-growing tumors cause non-specific symptoms and may be of considerable size when diagnosed. If symptoms are present, pain distribution and neurologic dysfunction are related to the route of the affected nerve. Preoperative tissue biopsy is of paramount importance as the operative approach is guided by pathology.

Osseous Tumors

Osseous tumors represent approximately 10% retrorectal tumors. They arise from bone, cartilage, fibrous tissue, or marrow. Osseous tumors include chondrosarcoma, osteosarcoma, myeloma, and Ewing's sarcoma. These tumors arise from the bone, cartilage, fibrous tissue, and marrow. All osseous tumors of the presacral space are associated with sacral destruction.

Giant cell tumors are the most common benign osseous tumors. Although benign, giant-cell tumors can metastasize to the lungs, Ewing tumors are the most common malignant osseous tumor [6, 20].

Miscellaneous Tumors

Miscellaneous tumors account for 10–25% of all retrorectal tumors and include lipoma, fibroma, leiomyoma, hemangioma, endothelioma, locally aggressive desmoid tumors, various sarcomas, metastatic adenocarcinoma, hematomas, carcinoid tumors, anomalous pelvic ectopic kidneys and inflammatory tumors. Inflammatory lesions include extension of infection from Crohn disease and perforated diverticulitis. Leiomyoma is the most frequent benign histologic type, followed by a fibroma. The most frequent malignant tumors are metastatic tumors [21].

History and Physical Examination

Due to their indolent growth, presacral tumors are typically found incidentally on imaging, physical exam or during childbirth. The symptoms caused by retrorectal lesions are related to their site, size and, in the case of retrorectal cysts (Fig. 26.6), the presence or absence of infection. Benign lesions tend to be asymptomatic whereas malignant lesions are more likely to produce symptoms. Symptomatic patients typically complain of vague, long-standing pain localized to the low back or perianal area associated with rectal ache, or deep rectal pain. Their pain may be postural, aggravated by sitting and improved by standing or walking. Often the onset of pain relates to local trauma such as a fall on the sacrum or coccyx. If the sacral plexus is involved, patients may experience referred pain in the legs or buttocks.

Patients with retrorectal tumors may present with signs and symptoms infection, pelvic outlet obstruction or central nervous system manifestations. Patients may present with isolated or recurrent fever, chills and rigors. Patients may also complain of perineal discharge and may have midline dimpling just posterior to the anus or the gluteal muscle. This may lead to misdiagnosis of a fistula or pilonidal disease. Large retrorectal tumors may cause symptoms of pelvic outlet obstruction including constipation, sexual dysfunction, rectal or urinary incontinence, or obstructive labor in pregnant patients secondary to obstruction or direct invasion. Large masses may interfere with the passage of stool giving the

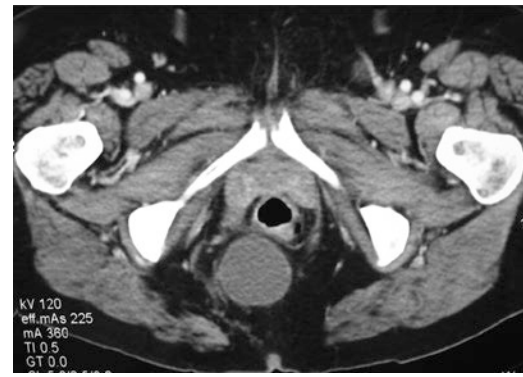


Fig. 26.6 Retrorectal cyst

feeling of incomplete evacuation or disturbances in bladder function secondary to interference with pelvic parasympathetic supply, direct pressure on the bladder or urethra, or obstruction of the pelvic ureters. Both urinary and fecal incontinence may occur due to impingment on the sacral nerve roots or overflow incontinence secondary to outlet obstruction.

Patients should be carefully examined, focusing on the perineum and rectal examination. Identification of a postanal dimple may assist in identifying the presence of a developmental cyst. Approximately, 97% of tumors are diagnosed incidentally on rectal exam [2]. Digital rectal exam frequently reveals the presence of an extrarectal mass displacing the rectum anteriorly with a smooth and intact overlying mucosa. Rectal examination is also critical in assessing the level of the uppermost portion of the lesion, degree and extent of fixation, as well as the relationship to other pelvic organs. Rigid or flexible sigmoidoscopy can be used to assess the overlying mucosa and rule out transmural penetration of the tumor. Location of the mass should be recorded, as well as whether it is lobulated or solitary, and whether it is possible to define its upper limits. In particular, the mass must be assessed for its relationship to the sacrum and the coccyx. This assessment is important as the tumor location will determine the operative approach. A careful neurologic exam focusing on the sacral nerves and musculoskeletal reflexes is mandatory and may also aid in the diagnosis of extensive local tumor invasion. Soiling and a pouting anus may indicate interference with the sacral nerves. Laxity of the anal sphincters and saddle anesthesia of the perineum further support involvement of sacrococcygeal nerves [5].

Imaging

Once a diagnosis of a retrorectal tumor is suspected radiographic imaging should be obtained to assist in the verification of the diagnosis. Plain radiographs, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonography (US) all play a role in the identification of these lesions.

Plain radiographs of the sacrum are often obscured by overlying viscera containing gas, fecal material, or osseous structures making these images non-specific for retrorectal tumors. However, anterior-posterior and lateral radiographs (AP/LAT) of the sacrum can identify osseous expansion seen in a meningocele or destruction, or calcification of soft tissue masses indicative of locally aggressive tumors including chordomas, sarcomas, giant cell tumor, aneurysmal bone cyst, and neurilemoma. Furthermore, barium enemas may demonstrate anterior displacement of the rectum prompting more specific imaging.

Computed tomography (CT) scans and magnetic resonance imaging (MRI), have emerged as the imaging modalities of choice in diagnosing retrorectal tumors. These modalities complement each other. Computerized tomography can characterize lesions as solid or cystic, determine the spatial relationships between structures in the pelvis and evaluate for cortical bone destruction. MRI with contrast is more sensitive in evaluating soft tissue specifically, spinal imaging where it can demonstrate cord anomalies, thecal sac compression, osseous or nerve root involvement (Fig. 26.7). MRI is extremely important in deter-

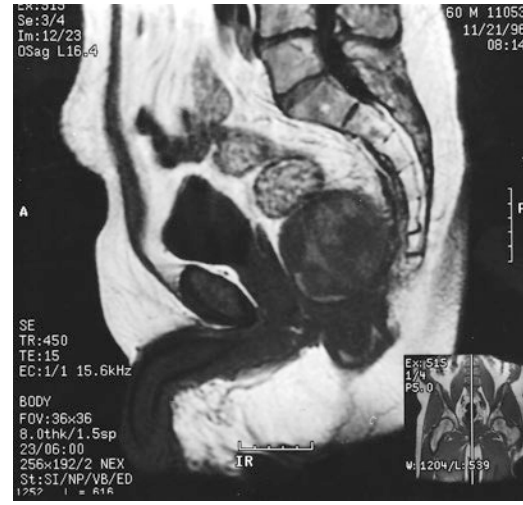


Fig. 26.7 MRI with contrast is more sensitive in evaluating soft tissue specifically, spinal imaging where it can demonstrate cord anomalies, thecal sac compression, osseous or nerve root involvement

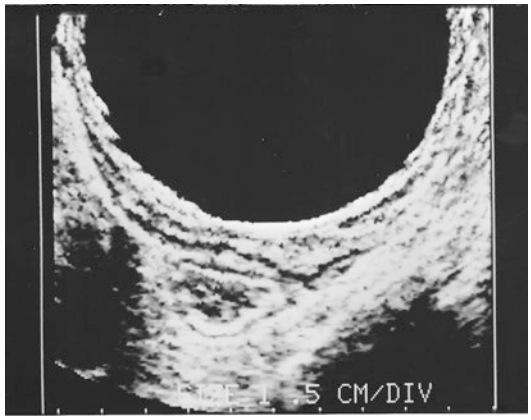


Fig. 26.8 Ultrasound can distinguish masses in the rectal wall from extramural lesions, determine the relationship of tumors to the muscular layers of the rectum and the anal sphincters as well as differentiate between cyctic and solid lesions

mining level and extent of resection and can assist in determining the appropriate surgical approach [22].

Endorectal ultrasound, while used less, and less can provide further anatomic delineation of retrorectal tumors. Ultrasound can distinguish masses in the rectal wall from extramural lesions, determine the relationship of tumors to the muscular layers of the rectum and the anal sphincters as well as differentiate between cyctic and solid lesions (Fig. 26.8). Tumor involvement of the rectal wall arising outside the rectum requires resection.

Preoperative Biopsy

The role of preoperative biopsy in diagnosis and management of retrorectal tumors is controversial. Historically, preoperative biopsy was contraindication in any potentially resectable presacral tumor for fear of increased local recurrence. In solid tumors, the concern that biopsy may cause seeding of malignant cells in the biopsy tract was frequently cited. These experts advocated that the best biopsy is en bloc operative excision. Preoperative biopsy was only acceptable if the lesion was considered to be inoperable or if clear that surgical excision cannot be undertaken without significant risk to the patient, a preoperative diagnosis using a biopsy would be necessary to prevent inappropriate therapy [21, 23]. These recommendations, however, do not take into account the availability of modern imaging, better knowledge of tumor biology, and opportunities for neoadjuvant therapy.

Data has emerged suggesting that solid or heterogeneous tumors should be biopsied preoperatively. Accurate preoperative diagnosis of these tumors improves outcomes as optimal management of benign and malignant lesions differs considerably. Surgically, a wide-margin is required for oncologic resection in malignant lesions. On the other hand, resection with close-margin is acceptable for benign lesions to spare function and avoid morbidity [24]. Additionally, neoadjuvant therapy assists in optimizing oncologic outcome in specific tumor subtypes including Ewing sarcoma, osteogenic sarcoma, neurofibrosarcomas, and desmoid tumors. Furthermore, preoperative biopsy of presacral tumors has been determined to be safe and more highly concordant with postoperative pathology in comparison with imaging alone.

Dozois et al. recommended several guiding principles when performing biopsies on solid or heterogenous retrorectal tumors. Prior to performing a biopsy, coagulation studies should be performed to minimize the risk of hematoma formation, which may contaminate the involved areas. The ideal approach is transperineal or parasacral as the biopsy tract must be within the field of the future surgical resection. Ideally, the CT guided biopsy is best performed by a radiologist experienced in the diagnosis and management of pelvic tumors, who is in direct consult with the primary surgeon regarding the biopsy's approach. Furthermore, transperitoneal, transretroperitoneal, transvaginal, and transrectal biopsies are to be avoided—the tract of the biopsy must be removed en bloc. Biopsies performed transrectally or transvaginally may also lead to infection, a more difficult complete excision, or increase the probability of postoperative complications and recurrence. Biopsy obtained via these routes necessitates either partial or complete proctectomy or vaginectomy to remove

the biopsy tract in continuity with the presacral tumor minimize recurrence [5, 10, 26].

Biopsy, however, has its limitations. Specifically, in the presence of a cystic lesion, biopsy may result in infection rendering its future complete excision more difficult and increasing the likelihood of postoperative complications and recurrence. More importantly, inadvertent transrectal needling of a meningocele may lead to disastrous sequelae, such as meningitis and even subsequent death.

Management

The Role of Neoadjuvant Therapy

The availability of neoadjuvant tumor irradiation and systemic chemotherapy have altered the management of patients with retrorectal tumors. These tumors exhibit a wide range of behaviors and can be large and locally advanced by the time they are diagnosed. Accurate preoperative diagnosis can facilitate the application of neoadjuvant chemoradiation therapies and improve patient outcomes. Neoadjuvant radiotherapy can decrease in the size of large radiosensitive tumors, including chordomas and intradural myxopapillary ependymomas, which may spare vital structures that would otherwise be resected to obtain wide margins. Regardless wide margins and en bloc resection are often difficult to achieve in large malignant tumors resulting in high local recurrence rates approaching 64%. Neoadjuvant radiotherapy may decrease the size of the field of radiation, preventing the morbidity associated with applying adjuvant radiation therapy to the entire surgical bed, previous tumor site, all contaminated surgical planes, and the sites of all skin incisions in those cases where wide margin and en bloc resection cannot be achieved [10].

Neoadjuvant chemotherapy is essential to the treatment of some retrorectal tumors such as Ewing sarcoma and osteogenic sarcoma. Chemotherapeutic agents such as imatinib have been shown promote progression-free survival in patients with advanced chordomas however, this data is limited and the role of chemotherapy in this population requires more rigorous analysis [25]. As the role of other agents are defined, their utilization may decrease recurrence rates and improve survival.

Surgical Approach

All presacral tumors should, unless the lesion is unresectable or there is evidence of systemic metastasis, should undergo en bloc resection. Approximately, 30–40% of lesions will be malignant and benign lesions may undergo malignant degeneration [27]. The utilization of a multidisciplinary team in the treatment of large and complex lesions is mandatory. The primary operative goal in the treatment of benign lesions is complete resection without tumor spillage while preserving surrounding tissues. For malignant lesions wide, en bloc removal of adjacent organs, soft tissue, and bone (if locally adherent) is the goal of resection. Only an experienced multidisciplinary surgical team consisting of a colorectal surgeon, orthopedic oncologic surgeon, spine surgeon, urologist, plastic surgeon, vascular surgeon, musculoskeletal radiologist, medical oncologist, radiation oncologist, and specialized anesthesiologist can appropriately evaluate and surgically treat tumors that are large and extend to or destroy the hemipelvis or the upper half of the sacrum [3].

The extent, location, and size of the tumor dictates the optimal approach (Fig. 26.9). The location, nature, and size of the lesion as well as the involvement of adjacent viscera, sacrum, or pelvic sidewalls appropriate surgical approach for retrorectal tumors is ascertained by appropriate imaging (CT and MRI). The extent of surgery is then determined by the of tumor characterictics: as previously stated, benign retrorectal tumors require complete gross resection, whereas malignant tumors will require radical resection, including en bloc resection of adjacent organs if involved. Incomplete resection in both benign and malignant tumors increases local recurrence [5]. The common approaches for resection of retrorectal tumors are the anterior (transabdominal) or combined abdominoperineal, the posterior (perineal) approaches and in rare instances transrectally.

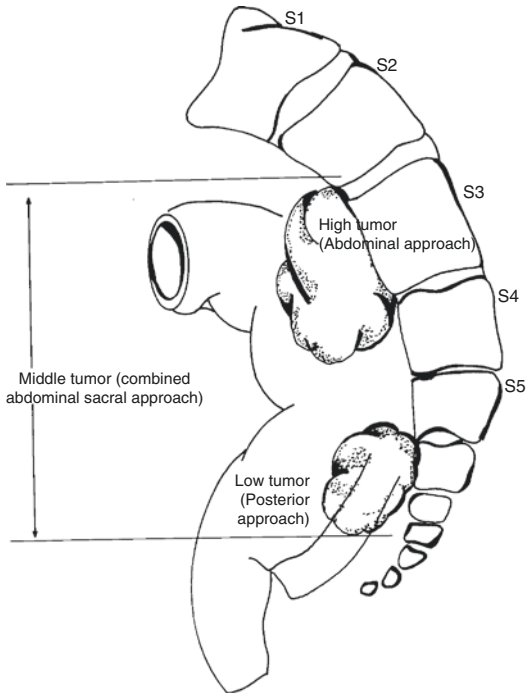


Fig. 26.9 The extent, location, and size of the tumor dictates the optimal approach to surgery for presacral tumors

Combined Abdominal and Perineal Approach

Although there are subsets of tumors that are appropriate for a purely abdominal approach, it is advisable to prepare the patient as if a combined abdominal approach is planned to allow for all contingencies. The anterior portion is performed when the most caudal portion of the lesion is above the level of S3–S4 based on preoperative imaging. Traditionally, these lesions have been approached through a laparotomy; however, advanced laparoscopic and robotic techniques have been described. A particular advantage of the anterior approach is that it allows the surgeon to gain wide exposure to major pelvic structures, including the pelvic viscera, vasculature, and ureters. During the transabdominal approach, the sigmoid colon is mobilized and the rectum is placed on stretch so that the pelvis can be examined. The rectorectal space is entered through the relatively avascular plane anterior to the sacrum. The mesorectum is then dissected from the anterior portion of the lesion. Prior to the removal of the tumor, the arterial supply to the lesion must be identified and ligated. The middle sacral vessels are often significantly enlarged and should be ligated before mobilization is attempted.

While attempt at preservation of nerve roots and other vital structures is key to meticulous dissection, malignancies involving the rectal wall or that are locally invasive will require en bloc resection. Depending on the extent of the neoplasm, completion of the operation may require the patient to be repositioned in either lithotomy or prone position so that the remainder of the excision can be carried out through a posterior or perineal approach. All biopsy tracts should be excised and should include the skin through which the biopsy was performed. Ideally, a 2 cm margin should be sought [20]. Various bony and nerve structures may be sacrificed, depending on the location of the lesion. The help of a neurosurgeon or orthopedic surgeon is invaluable in these circumstances.

Posterior Approach

The posterior approach is useful for lesions below S3. If the superior border of the tumor is palpable digital examination, the posterior approach should be considered. For lesions that extend more superiorly and on preop MRI show nerve involvement, the posterior approach provides better visualization.

The patient is placed in the prone jackknife position and A midline parasacrococcygeal, curvilinear, or horizontal incision is made and deepened to define the sacrum, coccyx, and anococcygeal ligament. The anococcygeal ligament is detached from the coccyx and displaced, revealing the levator ani muscle with the central decussating fibers passing from the rectum to the coccyx. Resection of the tumor may be facilitated by transection of the anococcygeal ligament and coccyx. The lesion can then be dissected from the surrounding tissues, including the rectal wall, in a plane between the retrorectal fat and the tumor mass itself. If necessary, the lower sacrum, coccyx or both can be excised en bloc with the lesion (Fig. 26.10).

A nerve sparing technique has been described by Dozios et al. [28] from the Mayo clinic. Their technique includes preoperatively localization

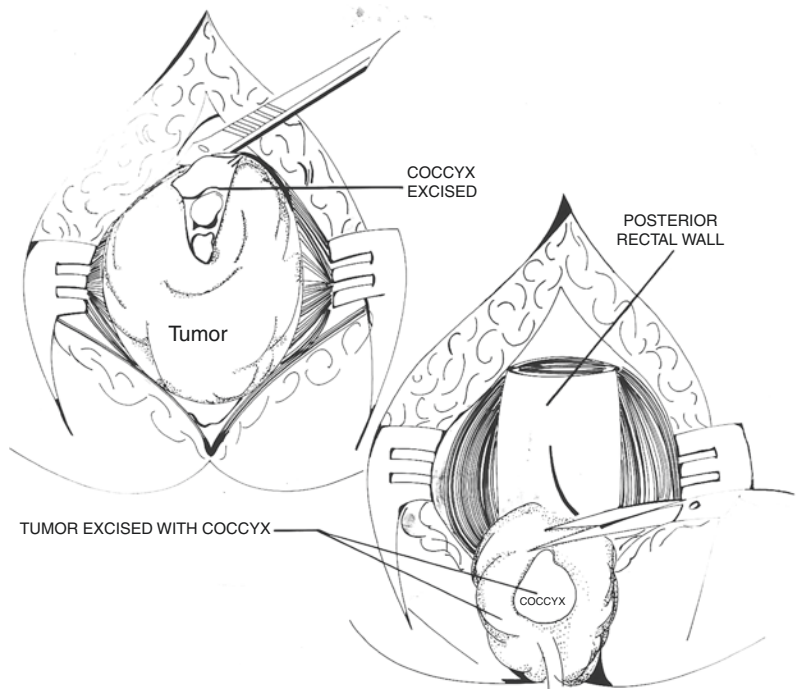


Fig. 26.10 If necessary, the lower sacrum, coccyx or both can be excised en bloc with the retrorectal lesion

with MRI is obtained in all patients to determine the precise location, extent, and nerve of origin of the tumor as well as imaging characteristics of the tumor and the involvement of surrounding structure. The use of lower extremity and/or sphincter electrodes, were used for intraoperative neurophysiological monitoring of spontaneous electromyographic (EMG) activity during surgical dissection, manipulation of nerve(s), or tumor resection. The operative approach is determined in the previously discussed fashion. In the case of using an anterior approach the iliac vessels, lower aorta, and inferior vena cava are mobilized, presacral space entered at the level of the promontory, and the avascular plane posterior to the mesorectum is developed caudally providing adequate exposure. Of note the he hypogastric plexuses and associated sympathetic trunks are identified and avoided. The remainder of the dissection is performed by avoiding traction on the surrounding tissues using the EMG as a guide to prevent injury.

Major sacral resection generally is reserved for patients with malignant lesions. In a retrospective analysis of bowel and bladder function in patients having major sacral resection in a single institution during a 10-year period, patients who had unilateral sacrectomy, normal bowel and bladder function was retained in 87% and 89%, respectively. In patients who had bilateral S2–S5 nerve roots sacrificed, all had abnormal bowel and bladder function. In patients who had bilateral S3–S5 resection, normal bowel and bladder function was retained in 40% and 25%, respectively. In patients who had bilateral S4-S5 resection, with preservation of the S3 nerves bilaterally, normal bowel and bladder function was retained in 100% and 69%, respectively. In patients who had asymmetric sacral resections, with preservation of at least one S3 nerve root, normal bowel and bladder function was retained in 67% and 60%, respectively. These results show that unilateral resection of sacral roots or preservation of at least one S3 root in bilateral resection preserves bowel and bladder function in the majority of patients [18, 28].

Outcomes

Malignant Lesions

Studies identifying the outcomes regarding resection of malignant lesions the are limited as the nature of these diseases due to their rarity and thus reports are limited to case series and observational studies. The biologic nature of the lesion and the extent of resection and therefore varies

among studies; however, the recurrence rates are higher and outcomes poorer among tumors classified as malignant. The risk of local recurrence after a poor oncologic resection approaches 70% with decreased long-term survival prospects. In the Glasgow et al. [1] report, seven of seven patients with malignant presacral tumors developed recurrence of their disease despite adequate resection and had a median survival of 61 months. Lev-Chelouche et al. [21] reported an 80% complete resection rate in 12 patients with presacral tumors other than chordomas with a 67% local recurrence and 50% survival. Wang et al. [29] reported their series of 22 patients with malignant retrorectal tumors that included five chordomas and seven leiomyosarcomas. No preoperative biopsy was obtained and no neoadjuvant therapy was attempted. Despite the use of postoperative chemotherapy and radiotherapy on selected patients the 5-year survival rate was 41%.

Chordomas are the most common malignant preseacral tumor. The most significant prognostic factor for patients with chordoma is the surgical margins. Despite adequate surgical resection a significant proportion of patients develop locally recurrent disease indicating the need for improved adjuvant therapies. In a report published in 1985, Jao et al. [2] reported a 5-year survival rate of 75% for chordomas; the same group has recently found a 5- and 10-year survival rate of 80% and 50%, respectively, for these patients. McMaster et al. [17] evaluated 400 cases of chordomas reported to nine population-based registries within the National Cancer Institute's Surveillance, Epidemiology and End Result (NSEER) program over a 22-year period from 1973 to 1995. The 5- and 10-year survival rate for sacral chordomas in the NSEER database was found to be 74% and 32%, respectively, and more likely represents the population-based incidence and outcome of these lesions.

Benign Lesions

Despite limited reports the overall survival for completely resected benign lesions is uniformally associated with low recurrence rates and complete remission. However, incompletely resected tumors are prone to recurrence. In a series by Glasgow et al. [1] none of the 26 patients with benign presacral tumors developed recurrence after a median follow-up of 22 months. Lev-Chelouche et al. [21] reported a 100% survival and no recurrences after complete resection in their experience with 21 benign presacral tumors.

References

1. Glasgow SC, Birnbaum EH, Lowney JK, Fleshman JW, Kodner IJ, Mutch DG, Lewin S, Mutch MG, Dietz DW. Retrorectal tumors: a diagnostic and therapeutic challenge. Dis Colon Rectum. 2005;48(8):1581–7.
2. Jao SW, Beart RW Jr, Spencer RJ, Reiman HM, Ilstrup DM. Retrorectal tumors. Dis Colon Rectum. 1985;28(9):644–52.
3. Neale JA. Retrorectal tumors. Clin Colon Rectal Surg. 2011;24(03):149–60.
4. Uhlig BE, Johnson RL. Presacral tumors and cysts in adults. Dis Colon Rectum. 1975;18(7):581–96.
5. Dozois EJ, Jacofsky DJ, Dozois RR. Presacral tumors. In: The ASCRS textbook of colon and rectal surgery. New York: Springer; 2007. p. 501–14.
6. Hobson KG, Ghaemmaghami V, Roe JP, Goodnight JE, Khatri VP. Tumors of the retrorectal space. Dis Colon Rectum. 2005;48(10):1964–74.
7. Baek SK, Hwang GS, Vinci A, Jafari MD, Jafari F, Moghadamyeghaneh Z, Pigazzi A. Retrorectal tumors: a comprehensive literature review. World J Surg. 2016;40:2001–5.
8. Dunn KB. Retrorectal tumors. Surg Clin N Am. 2010;90(1):163–71.
9. Singer MA, Cintron JR, Martz JE, Schoetz DJ, Abcarian H. Retrorectal cyst: a rare tumor frequently misdiagnosed. J Am Coll Surg. 2003;196(6):880–6.
10. Mathis KL, Dozois EJ, Grewal MS, Metzger P, Larson DW, Devine RM. Malignant risk and surgical outcomes of presacral tailgut cysts. Br J Surg. 2010;97(4):575–9.
11. Izant RJ, Filston HC. Sacrococcygeal teratomas: analysis of forty-three cases. Am J Surg. 1975;130(5):617–21.
12. Kovalcik PJ, Burke JB. Anterior sacral meningocele and the scimitar sign: report of a case. Dis Colon Rectum. 1988;31:806–7.
13. Oren M, Lorber B, Lee SH, Truex RC Jr, Gennaro AR. Anterior sacral meningocele: report of five cases and review of the literature. Dis Colon Rectum. 1977;20(6):492–505.
14. Dozois EJ, Marcos MD. Presacral tumors. In: The ASCRS textbook of colon and rectal surgery. New York: Springer; 2011. p. 359–74.
15. Waldhausen JA, Kolman JW, Vellios F, Battersby JS. Sacrococcygeal teratoma. Surgery. 1963;54:933–49.
16. Hickey RC, Martin RG. Sacrococcygeal teratomas. Ann N Y Acad Sci. 1964;114(2):951–7.

17. McMaster ML, Goldstein AM, Bromley CM, Ishibe N, Parry DM. Chordoma: incidence and survival patterns in the United States, 1973–1995. Cancer Causes Control. 2001;12(1):1.
18. Gunterberg B, Kewenter J, Petersen I, Stener B. Anorectal function after major resections of the sacrum with bilateral or unilateral sacrifice of sacral nerves. Br J Surg. 1976;63(7):546–54.
19. Bergh P, Kindblom LG, Gunterberg B, Remotti F, Ryd W, Meis-Kindblom JM. Prognostic factors in chordoma of the sacrum and mobile spine. Cancer. 2000;88(9):2122–34.
20. Gordon PH, Nivatvongs S. Principles and practice of surgery for the colon, rectum, and anus. Förlag: CRC Press; 2007.
21. Lev-Chelouche D, Gutman M, Goldman G, Even-Sapir E, Meller I, Issakov J, Klausner JM, Rabau M. Presacral tumors: a practical classification and treatment of a unique and heterogenous group of diseases. Surgery. 2003;133(5):473–8.
22. Hosseini-Nik H, Hosseinzadeh K, Bhayana R, Jhaveri KS. MR imaging of the retrorectal–presacral tumors: an algorithmic approach. Abdom Imaging. 2015;40(7):2630–44.
23. Luken MG, Michelsen WJ, Whelan MA, Andrews DL. The diagnosis of sacral lesions. Surg Neurol. 1981;15(5):377–83.
24. Messick CA, Hull T, Rosselli G, Kiran RP. Lesions originating within the retrorectal space: a diverse group requiring individualized evaluation and surgery. J Gastrointest Surg. 2013;17(12):2143–52.
25. Casali PG, Messina A, Stacchiotti S, Tamborini E, Crippa F, Gronchi A, Orlandi R, Ripamonti C, Spreafico C, Bertieri R, Bertulli R. Imatinib mesylate in chordoma. Cancer. 2004;101(9):2086–97.
26. Cody IIIHS, Marcove RC, Quan SH. Malignant retrorectal tumors: 28 years' experience at Memorial Sloan-Kettering Cancer Center. Dis Colon Rectum. 1981;24(7):501–6.
27. Merchea A, Larson DW, Hubner M, Wenger DE, Rose PS, Dozois EJ. The value of preoperative biopsy in the management of solid presacral tumors. Dis Colon Rectum. 2013;56(6):756–60.
28. Hébert-Blouin MN, Sullivan PS, Merchea A, Léonard D, Spinner RJ, Dozois EJ. Neurological outcome following resection of benign presacral neurogenic tumors using a nerve-sparing technique. Dis Colon Rectum. 2013;56(10):1185–93.
29. Wang JY, Hsu CH, Changchien CR, Chen JS, Hsu KC, You YT, Tang R, Chiang JM. Presacral tumor: a review of forty-five cases. Am Surg. 1995;61(4):310–5.

27 Sexually Transmitted and Infectious Diarrheal Diseases

Reza Arsalani-Zadeh, Christina Cellini, and Lester Gottesman

Introduction

Infectious diseases of the anorectum include those transmitted sexually and by other mechanisms. This chapter covers sexually transmitted and infectious diarrheal diseases. Sexually transmitted infections (STIs) have increased at an alarming rate and have expanded from a narrow group of "classic" venereal diseases to include more than 25 infectious bacterial, fungal, protozoan, and viral agents. In the past three decades, more than 50 organisms or syndrome combinations have been identified as sexually transmitted.

To put into context, the United States has the world's highest rates of STIs. The annual incidence of STIs in the United States is estimated to be around 19.7 million. Yet, the reported disease rate likely underestimates the true burden of the disease [1]. Many STIs are asymptomatic; in addition, there is reluctance, even among physicians, to discuss STIs, leaving them unrecognized and untreated.

R. Arsalani-Zadeh
Department of Colorectal Surgery, University of Rochester Medical Center, Rochester, NY, USA

C. Cellini
Department of Surgery, University of Rochester Medical Center, Rochester, NY, USA
e-mail: christina_cellini@urmc.rochester.edu

L. Gottesman (✉)
Division of Colon and Rectal Surgery, Department of Surgery, Mount Sinai, New York, NY, USA

Surveys have produced widely varying estimates of the prevalence of anal intercourse. The anorectum has been used with increasing frequency for sexual fulfillment over the past several decades [2], resulting in an explosive growth in the incidence of STIs which affect the anorectum. Anal intercourse appears to be practiced, at least occasionally, by a substantial proportion of the sexually active population. Peterson et al. [3] reported that 73% of adult homosexual and bisexual black men surveyed in 1990 had engaged in anal intercourse within the past 6 months. This practice is not confined to the homosexual population. Among sexually active adolescents, surveys have estimated the proportion having practiced anal intercourse to be as high as 27% of men and 35% of women [4]. A survey of sexually active college students in Canada reported that 14% of men and 19% of women had anal intercourse at some time in their lives [5]. Approximately 2–2.5 million British citizens regularly use the anorectum for sexual fulfillment [6]. The National Health and Social Life Survey conducted in 1992 estimated that 26% of men and 20% of women ages 18–59 had engaged in anal intercourse during their lifetimes [7]. Of greatest concern is that in several populations studied, the majority of those who practiced anal intercourse used condoms inconsistently or not at all [8], placing them at increased risk for HIV and other STIs. STIs acquired through anal intercourse are usually confined to the lower rectum. The frequency of

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_27

sexually transmitted proctocolitis has declined over the past decade, possibly due to effect of the safer sex campaigning. There are however concerns that we are facing a new rise in the incidence of STIs. Due to highly active antiretroviral therapy (HAART), the rate of high risk sexual behavior has been increasing in the United Stated and other developed nations. The rates of early syphilis, gonorrhea and chlamydia have also been on the rise [9].

STIs often present with non-specific symptoms. STIs involving the anal canal typically present with pain, mainly due to extensive sensory innervation of the anal canal. Pain in turn can cause reflexive anal sphincter spasm and therefore constipation and tenesmus. STIs involving the rectum usually present with bloody or mucopurulent discharge.

Unfortunately, the clinical examination is often inaccurate in diagnosing STIs. The majority of genital or anal ulcers in young sexually active patients are due to syphilis or herpes. Accurate diagnosis of sexually transmitted and infectious disease of the anorectum is difficult because patients commonly harbor multiple organisms. The global epidemic of HIV and AIDS has complicated the diagnosis and treatment of anorectal STIs, even further. It is therefore of paramount importance that physicians have a working knowledge of each of these disorders and be familiar with the incidence of different type of STIs in their community. Laboratory evaluation of genital, anal or perianal ulcers should include syphilis serology or PCR testing, culture and PCR testing for genital herpes and serologic testing for HSV antibody. In addition, HIV testing should be performed on everyone with unknown HIV status. Unusual looking ulcers or those not responding to initial therapy should be biopsied.

Empirical therapy of STIs based on the clinical findings and epidemiologic setting is recommended. Even after a complete diagnostic evaluation up to 25% of patients will have no laboratory confirmed diagnosis [9, 10].

Tables 27.1 and 27.2 list the diseases covered in this chapter and include a summary of the presenting symptoms, physical findings, suggested diagnostic tests, and accepted treatment modalities.

Sexually Transmitted Anorectal Disorders

Bacterial Infections

Gonorrhea

Gonorrhea, caused by *Neisseria gonorrhea*, a gram-negative intracellular diplococcus, is probably the most common venereal disease affecting the anorectum with an estimated 820,000 new cases annually [9, 11]. The overall prevalence of gonorrhea has shown a steady increase since 2009, resulting in a dangerously prevalent reservoir of disease carriers in the community [9, 12]. Women who have primarily gynecologic gonorrhea also will have the anorectum infected in 36–63% of cases [13]. The anorectum will be the exclusive site of infection in 40–50% of homosexual men and in 4% of women [14]. The incubation period is usually from 5 to 7 days after exposure, but may be as long as 30 days.

At least half the male patients and up to 95% of female patients with rectal gonorrhea are asymptomatic. Symptomatic infections vary in severity. Anorectal inoculation usually produces proctitis and/or cryptitis and presents with nonspecific symptoms including pruritus, tenesmus, and bloody or mucopurulent rectal discharge. If untreated, the initial infection can progress to more advanced conditions such as perihepatitis, meningitis, endocarditis, pericarditis, and gonococcal arthritis. Gonococcal arthritis tends to be a unilateral migratory purulent arthritis of large joints.

The perineum is generally not involved in gonococcal proctitis. A thick yellow mucopurulent discharge with or without proctitis is diagnostic of gonorrhea (Fig. 27.1). One classic finding is the ability to express the purulent material from the anal crypts by applying gentle external pressure while the anoscope is in place [15]. Sigmoidoscopy often reveals diffuse congestion and edema of the mucosa extending 8–9 cm above the anal verge. The mucosa is frequently covered by thick, creamy, tenacious pus, which often exudes from inflamed crypts at the dentate line. This discharge may be mistaken for ulcerative or nonspecific proctitis or other infectious agents. Fistulae and abscesses are an uncommon complication.

Table 27.1 Sexually transmitted anorectal disorders

Organism	Symptoms	Physical findings	Diagnostic tests	Treatment
Gonorrhea (*Neissera gonorrhea*)	Rectal discharge	Proctitis, muco- purelent discharge	NAAT, Thayer-Mayer culture of discharge	Ceftriaxone 250 mg IM for 1 day and Azithromycin 1 g PO or doxycycline 100 mg PO BID for 7 days
Chlamydia and lymphogranuloma venereum (LGV)	Tenesmus	Friable, often ulcerated rectal mucosa ± rectal mass	NAAT, Serologic antibody titer, Biopsy for culture	Azithromycin 1 g PO or doxycycline 100 mg PO BID for 7 days
Chancroid Hemophilus ducreye	Anal pain	Anorectal abscesses and ulcers	Culture	Azithromycin 1 g PO or Ceftriaxone 250 mg IM for 1 day
Donovanosis *Klebsiella granulomatis*	Perianal mass	Hard, shiny perianal masses	Biopsy of mass	Trimethoprim-sulfamethoxazole (DS) PO BID for 7 days and Azithromycin 1 g PO for 21 days
Syphillis	Rectal pain	Painful anal ulcer	Dark-field exam of fresh scrapings, serologic tests	Benzathine penicillin 2.4 million units IM
Herpes simplex	Anorectal pain, pruritus	Perianal erythema, vesicles, ulcers, diffusely inflamed, friable rectal mucosa	Cytologic exam of scrapings or viral culture of vesicular fluid	Acyclovir 200 mg five times daily for 5 days
Human papillomavirus (HPV) (condylomata acuminata)	Pruritus, bleeding, discharge, pain	Perianal warts	Excisional biopsy with viral analysis	Destruction. See Chap. 9
Mulluscum contagiosum	Painless dermal lesions	Flattened round umbilicated lesions	Excisional biopsy	Excision, cryotherapy
Human immunodeficiency virus (AIDS)	See text	See text	Western blot	AZT, HAART

NAAT nucleic acid amplification test, *IM* intramuscular, *PO* orally, *BID* twice a day, *QID* four times a day

Swabs should be taken of the discharge for both culture and grams stain. Gram stain typically shows intracellular Gram-negative diplococci, however, it is often unreliable and falsely negative. Swabbing the mucous under direct visualization raises the positive yield from 34% to 79%. Lubrication of the anoscope or proctoscope with anything other than water is not advisable since many lubricants and creams contain antibacterial agents. Biopsies are often normal and non-diagnostic. Empirical therapy is highly recommended. Nucleic Acid Amplification Test (NAAT) has a higher sensitivity (100%) and equivalent specificity in comparison to culture and is the recommended diagnostic test. According to CDC guidelines treatment of gonococcal proctitis is similar to gonococcal urethritis or cervicitis. All patients should also be tested and empirically treated for presumed concomitant chlamydial infection. The current CDC recommendations are ceftriaxone 250 mg in a single intramuscular dose plus azithromycin 1 g oral in a single dose. If ceftriaxone is not available an alternative regimen of cefixime 400 mg orally as a single dose plus azithromycin 1 g orally as a single dose, can be used. Due the high prevalence of tetracycline resistance in the United States, doxycycline is no

Table 27.2 Infectious diarrheal disorders

Organism	Symptoms	Physical findings	Diagnostic tests	Treatment
Campylobacter jejuni	Diarrhea, cramps, bloating	Erythema, edema, grayish-white ulcerations of rectal mucosa	Culture stool using selective media	Erythromycin 500 mg PO QID for 7 days
Yersinia	Non-bloody diarrhea, vomiting, tenesmus, fever	RLQ tenderness, mass	Stool culture	Trimethoprim-sulfamethoxazole (DS) PO
Salmonella	Non-bloody diarrhea, abdominal pain, fever	Mucosal hyperemia and petechiae	Stool culture	Fluid and electrolyte replacement (ampicillin if severe)
Shigella	Abdominal cramps, fever, tenesmus, bloody diarrhea	Erythema, edema, grayish-white ulcerations of rectal mucosa	Stool culture	Ciprofloxacin 500 mg PO BID for 7 days
Mycobacterium avium-intracellulare	Watery diarrhea	Friable mucosa ± ulceration	Acid-fast stain of stool, endoscopic biopsy	Quinolones, macrolide antibiotics
Cytomegalovirus (CMV)	Rectal bleeding	Multiple small white ulcers	Biopsy, viral culture, antigen assay of ulcers	Intravenous ganciclovir
Amebiasis *Entomeoboa histolytica*	Bloody diarrhea	Friable rectal mucosa; shallow ulcers with yellowish exudate and ring of erythrema	Fresh stool exam (microscopy)	Metronidazole 750 mg PO TID for 10 days, then dilodohydroxy-guinine 650 mg PO TID for 20 days
Cryptosporidia	Profuse bloody mucoid diarrhea	Normal mucosa	Rectal biopsy (oocytes)	Hydration, nutritional support (spiramycin)
Giardia lamblia	Nausea, bloating, cramps, diarrhea	Normal mucosa	Fresh stool exam (microscopy)	Mitronidazole 250 mg PO TID for 7 days
Isospora	Vomiting, fever, abdominal pain	Normal mucosa	Acid-fast stain of stool; endoscopic biopsy	Trimethoprim- sulfamethoxazole (double strength) PO BID for 7 days

PO per os, *RLQ* right lower quadrant

longer recommended as a second antimicrobial treatment regimen. Treatment does not differ in HIV-positive patients [1, 9].

Routine follow-up is not necessary after treatment for gonorrhea, as therapy is usually effective. In the case of recurrent symptoms, a full history regarding compliance and re-exposure should be obtained and the patient should be re-examined. Suspected treatment failures first should be retreated routinely with the recommended as reinfections are more likely than actual treatment failures. If treatment failure is highly suspected, specimens should be obtained for culture (preferably with simultaneous NAAT) and antimicrobial susceptibility testing performed before retreatment. Dual treatment with single doses of oral gemifloxacin 320 mg plus oral azithromycin 2 g or dual treatment with sin-

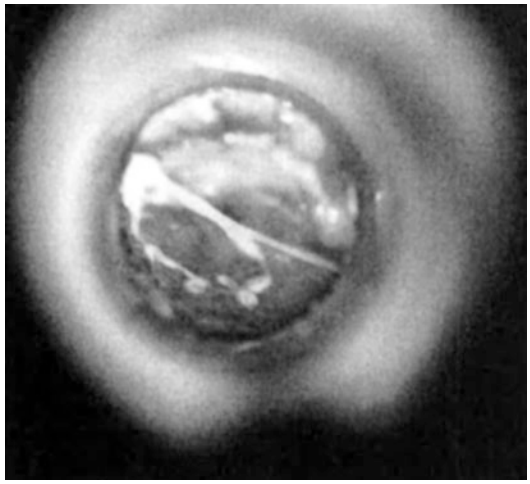


Fig. 27.1 The mucopurulent discharge of gonorrheal proctitis

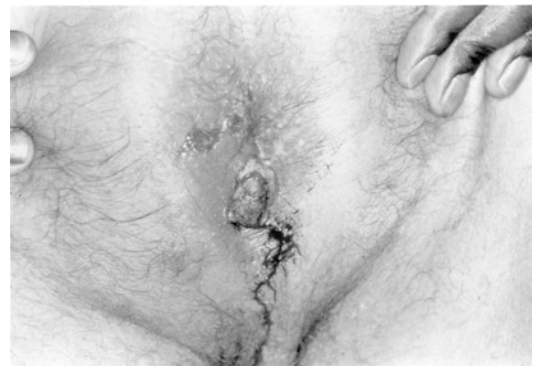


Fig. 27.2 Perianal LGV ulcer. With permission from [20] © Springer International Publishing AG 2018

gle doses of intramuscular gentamicin 240 mg plus oral azithromycin 2 g can be considered. A test-of-cure at relevant clinical sites should be obtained 7–14 days after retreatment.

Patient with urethritis are recommended to abstain from sexual activity for 7 days. There is no specific recommendation with regards to gonococcal proctitis. Clinicians should ensure that the patient's sex partners from the preceding 60 days are evaluated promptly with culture and presumptively treated using the same regimen used for the patient [9].

Chlamydia Trachomatis: Lymphogranuloma Venereum (LGV)

Chlamydia infection is the most common sexually transmitted bacterial infection in the world, with an estimated 50 million new cases occurring each year. In the United States chlamydia is also the most frequently reported bacterial STI with an annual incidence of 1.4 million [16]. Chlamydia is more common in young men and women. Pelvic inflammatory disease and infertility are significant sequelae of chlamydial infection in women. About 20% of women will be infertile as a result of chlamydial infection [9].

Chlamydia trachomatis is an obligate intracellular organism. The incubation period of chlamydial infection is between 5 to 14 days. Chlamydia proctitis typically occurs within 10 days of penetrating anal sexual contact and may co-exist with other STIs, especially gonorrhea. Prevalence of anorectal *Chlamydia trachomatis* has been reported to be as high as 24.4% among men who have sex with men (MSM) and 17.5% among women [17–19]. A large proportion of patients (43% of males and 79% of females) with chlamydial infection are asymptomatic.

Symptoms of patient with chlamydial infection vary depending on the serotype involved. Of the 15 known serotypes of *Chlamydia trachomatis*, serotypes D through K are responsible for proctitis, and serotypes L1, L2, and L3 are responsible for LGV. Patients with serotypes L1–L3 generally have a much more aggressive proctitis with perianal, anal and rectal ulceration, which may be difficult to distinguish from Crohn's disease (Fig. 27.2). Patients who remain untreated may develop perirectal abscesses, rectal strictures and/or rectovaginal fistulas [12, 21]. Non-LGV proctitis presents with pain, tenesmus, fever, and an erythematous rectal mucosa but rarely with mucosal ulcerations. The inguinal nodes may be enlarged and matted. LGV patients also have pain and tenesmus, but with associated mucosal and perianal ulcerations and a more pronounced friability resembling Crohn's proctitis. The inguinal lymphadenopathy plays an important role in differentiating LGV from Crohn's disease. The nodes may fuse into large, indurated masses with overlying erythema producing a clinical picture similar to syphilis. Chronic inflammation of the nodes may result in lymphedema. If untreated,

the disease may progress to ulcerations, rectovaginal or rectovesical fistulae, abscesses, and late rectal strictures.

Sigmoidoscopy in the non-LGV cases usually shows a mild inflammation of the distal rectal mucosa and anal crypts, whereas in LGV a more severe nonspecific granular proctitis is seen. The mucosa is erythematous, friable, and ulcerated**.** Biopsy of the inflamed rectal mucosa should be transported in sucrose phosphate media on ice for immediate tissue culture inoculation. Because chlamydia is an obligate intracellular pathogen, culture is usually unrewarding. Antichlamydial antibody titers are measured by complement fixation and should be 1:80 or greater in order establish the diagnosis. Unfortunately, the titer elevation often occurs more than 1 month after infection. The most sensitive serotyping test, the immunofluorescent antibody titer, is not universally available. NAAT has better sensitivity and specificity compared with cultures and is the diagnostic test of choice [22]. Treatment of chlamydial infection depends on the serotype. Patients with non-LGV proctitis should be treated with either azithromycin 1 g orally once or doxycycline 100 mg twice daily for 21 days. Non-RCTs for rectal C. *trachmotatis* raised some concern about the efficacy of azithromycin and recommend the development of a RCT between doxycycline and azithromycin specifically for rectal infections [8]. A recently published randomized trial has shown the efficacy of azithromycin is 97% vs. 100% for doxycycline. The non-inferiority of azithromycin in the setting of directly observed treatment was not established [23]. Persons treated for chlamydia should abstain from sexual activity for 7 days after single dose therapy or after 7 days of therapy. All the sexual partners of the person during 60 days preceding the onset of symptoms should be referred and treated for presumed chlamydia infection.

Treatment of LGV includes aspiration or incision of the lymph nodes to prevent scarring and 21-day course of doxycycline 100 mg twice daily [9]. Treatment of symptomatic strictures should initially include a 3-week course of appropriate antibiotics. Treatment of strictures is often complicated because these strictures may be multiple and of varying segments. A proximal diversion or sphincter-saving excisional surgery may be the only options for treatment failures [24].

Chancroid

Chancroid is caused by *Haemophilus ducreyi,* a short gram-negative, nonmotile, aerobic bacillus. This disease had been rarely encountered in developed countries. It has become more and more infrequently reported in the United States with only 6 cases reported in 2014 [12]. The incidence is usually low in women, except in high-risk groups such as prostitutes. The incubation period is 1–5 days. The disease is characterized by, multiple perianal abscesses, tender genital or anorectal ulcers, and inguinal adenopathy that are usually unilateral, painful, tender, and may suppurate.

The diagnosis of chancroid is difficult. A recent study during an outbreak of chancroid in New Orleans demonstrated that only on third of patients present with the classic clinical findings [10]. Gram stain of ulcer exudates is only sensitive in 40–60% of cases, and culturing H. *ducreyi* requires a special media that is not readily available [9]. There is no FDA-approved PCR test, but it is available in some commercial laboratories. The CDC considers chancroid to be the probable diagnosis when the following criteria are met: a patient has more than one painful genital ulcer, no evidence of T. *pallidum* infection by dark field examination of the ulcer exudate or by a serologic test for syphilis performed at least 7 days after appearance of ulcers, and the absence of HSV from the ulcer exudate [9].

The CDC recommends the following treatment for chancroid: azithromycin 1 g for one dose, ceftriaxone 250 mg intramuscularly for one dose, ciprofloxacin 500 mg twice daily for 3 days or erythromycin 500 mg four times a day for 7 days [9]. Antibiotic susceptibility of this organism is unpredictable. Generally, response is seen in 3 days, with resolution of the ulcers by day seven. However, uncircumcised individuals or HIV positive cases typically do not respond as rapidly. If clinical improvement is not seen after the initial course of therapy, an alternative antibiotic should be administered. Resolution of adenopathy usually lags behind that of the ulcers.

Granuloma Inguinale

Granuloma inguinale, also known as donovanosis, is believed to be caused by *Calymmatobacterium granulomatis*, a gram-negative encapsulated bacillus. It is rarely encountered in the United States, but is seen more commonly in tropical climates, such as Papua New Guinea, South Africa, India, Brazil and within the Aboriginal community in Australia. It is chronic and progressive, transmitted by sexual and nonsexual trauma to genital, anal, and inguinal tissues. It requires repeated exposures in order to be transmitted. The incubation period is from a few days to months.

Beginning as a small, innocuous papule, the lesion progresses with four subtypes: ulcerogranulomatous variant with ulceration and slow progression to a rather florid, beefy-red granulation tissue; hypertrophic or verrucous ulcers; necrotic lesions or dry sclerotic ulcers with associated fibrosis and scar formation. Scarring may lead to significant stenosis of the anorectum. Diagnosis is confirmed by biopsy demonstrating the typical Donovan bodies in large mononuclear cells. Tissue should be crushed between glass slides and stained with Wright-Giemsa stain. In addition, PCR techniques are now available.

The most recent CDC recommendation is azithromycin 1 g orally, 1 g orally once per week or 500 mg daily for at least 3 weeks. Alternative regimens include doxycycline 100 mg twice a day for 3 weeks, trimethoprim-sulfamethoxazole one double-strength (160 mg/800 mg) tablet orally twice a day for at least 3 weeks, ciprofloxacin 750 mg orally twice a day for at least 3 weeks or erythromycin base 500 mg orally four times a day for at least 3 weeks [9]. Treatment should be continued and patient should be followed up until signs and symptoms have resolved. The disease is autoinoculable and may spread if surgical excision is mistakenly undertaken. Relapse can occur up to 18 months after treatment.

Syphilis

Primary anal syphilis is largely a disease of homosexual men. Caused by the spirochete *Treponema pallidum*, syphilis can present in the primary form (chancre or proctitis), secondary stage (condyloma lata), or tertiary form (gumma). The national rate of primary and secondary syphilis cases in 200 and 2001 was 2.1 cases per 10,000 population, which is the lowest rate since the beginning of reporting in 1941.The incidence of syphilis however has increased almost every year since 2000–2001 with a total of 19,999 syphilis cases reported in 2014 [12].

The organism enters the anus during anal intercourse causing ulcers within 2–10 weeks. However, the incubation period can be as long as 6 months. In 10–20% of cases the primary chancre may be hidden within the anal canal. It often begins as a trivial-appearing maculopapular lesion that soon ulcerates and may be mistaken for a common anal fissure. Unlike the classic painless chancre, which appears on the genitalia, chancres in the anal canal are usually painful. Certain features should help to distinguish these lesions from idiopathic anal fissures including location off the midline, peripheral placement on the perianal skin, or location proximal to the dentate line. In addition, these lesions are often irregular (Fig. 27.3a), multiple, and appear opposite each other in a "mirror image" or "kissing" configuration. Proctitis in the absence of anogenital lesions has been reported. Unilateral or bilateral inguinal adenopathy may confuse the diagnosis with lymphoma, which may also present with rubbery adenopathy and submucosal rectal irregularities.

If untreated, the lesion usually regresses spontaneously in 4–8 weeks. Secondary lesions may develop 2–12 weeks later. Secondary syphilis can present with systemic symptoms such as fever, malaise, arthralgia, sore throat and headache. A diffuse red maculopapular rash, classically on the palms of the hands and soles of the feet, has histopathological features of hyperkeratosis of the epidermis, capillary proliferation, and transmigration of polymorph nuclear leukocytes. The spirochete may be found in the aqueous humor of the eye and cerebrospinal fluid.

Secondary syphilis can also present as pale brown or pink, flat verrucous lesion called condyloma latum (Fig. 27.3b). Many smooth, raised warts may coalesce and secrete mucus causing pruritus and a foul odor. Spirochetes can be demonstrated on dark field examination as

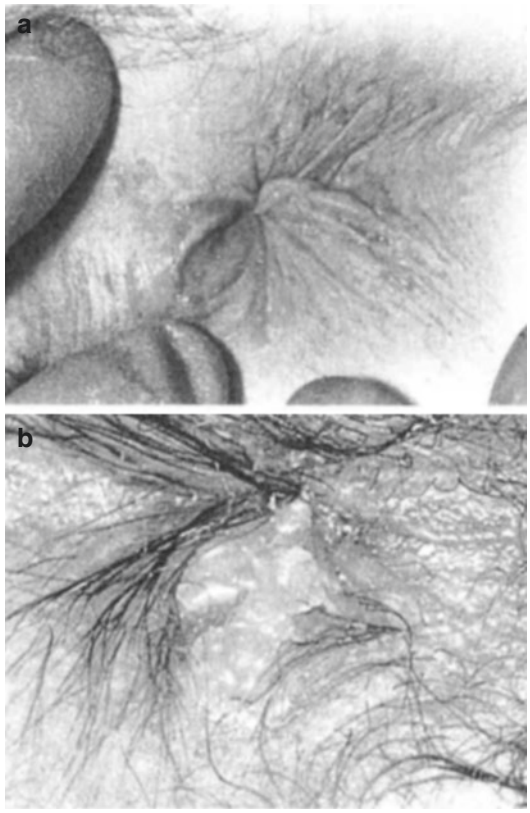


Fig. 27.3 Anal syphilis. (**a**) Primary anal chancre. (**b**) Condyloma latum

corkscrew-shaped, motile, fluorescent, yellow-green organisms. Biopsy of rectal lesions may show spirochetes on Warthin-Starry silver stain. Both primary and secondary lesions are infectious.

Tertiary syphilis is rare in developed countries. Tertiary lesions are caused by obliterative small vessel arteritis and can affect the cardiovascular or central nervous systems and cause syphilitic renal or hepatic dysfunction. Although rarely seen in the United States, tabes dorsalis can produce anal sphincter paralysis and severe perianal pain. Of patients with anal syphilis, one third proceed to spontaneous cure, one third have latent disease, and one-third progress to late or tertiary disease.

In untreated primary syphilis, the Venereal Disease Research Laboratory (VDRL) assay is reactive in about 75% of cases. In the secondary stage, 100% should react. The fluorescent treponemal antibody absorption test (FTA-ABS) usually becomes positive 4–6 weeks after infection and remains positive for life. Titers do not correlate with disease activity. Serological tests in most HIV-infected patients are accurate and reliable for the diagnosis of syphilis. Dark field examination and direct fluorescent antibody tests of tissue or exudate from the lesion are considered to be the definitive tests.

The treatment is a single dose of long-acting benzathine penicillin (Bicillin, Wyeth Pharmaceutical, Philadelphia, PA), 2.4 million units, given intramuscularly. There is no strong evidence to support prolonged or augmented therapy in treating syphilis in patients who are HIV positive [1, 25]. Erythromycin or tetracycline can be used in penicillin-allergic patients. All sexual contacts within 90 days of the diagnosis of the index case should be prophylactically treated and patients must abstain from all sexual activity until proven noninfectious by low titers. Follow-up testing with VDRL or RPR should be done at 3-month intervals for 1 year. As the spirochetes are destroyed, patients may manifest fever, skin lesions, arthralgia, and adenopathy known collectively as the Jarisch-Hexheimer reaction. This is self-limiting and best treated with analgesics.

Viral Infections

Herpes Simplex

Herpes simplex type I and II are very common STIs in the United States. The majority of anorectal herpes infections are caused by HSV-2, with only 10% caused by HSV-1 [26]. Seropositivity rate for HSV 2 decreased between 1988–1994 and 2007–2010, from 21.2% to 15.5%. However, the prevalence of HSV-I is increasing especially among young women and MSMs [9]. Serologic tests indicate that more than 95% of male homosexual patients may have been infected with herpes simplex virus type 2 (HSV-2).

Transmission occurs through autoinoculation or direct contact with an infected person. In the normal human, only mucocutaneous sites and the neuronal nuclei of sensory ganglion are affected. After local inoculation, the virus is transported

along peripheral nerves to the neuron's nucleus. The viral invasion of neurons leads to a latency state [27].

A primary infection may cause an initial tingling sensation at the viral entry point with subsequent eruption of one or more pruritic vesicles in a cluster on any mucous membrane surface or skin area within 24 h. The normal incubation period averages 6 days. Cell-mediated responses appear to be important in controlling the severity of mucocutaneous outbreaks of the virus, which explains the severity of HSV infections in HIV-positive patients. The majority of patients with genital herpes however do not report classic symptoms of infection [28]. Prior infection with HSV in any site modifies the clinical manifestations of subsequent exposures, which is usually most severe at the time of initial infection. The risk of recurrence after primary infection with genital herpes is greater than 80% and may be frequent despite high antibody titers.

HSV is the second most common STI affecting the anorectal area. HSV infection may begin 4–21 days after anorectal intercourse. The prodromal symptoms may be minor and include mild local irritation, burning and paresthesia in the anorectal area. Within a short period of time the pain becomes increasingly intense. A sacral root radiculitis, manifested by pain involving the buttocks, posterior thighs and perineum, together with constipation, tenesmus, urinary retention, and temporary impotence is quite characteristic. The symptoms of radiculopathy and deep pelvic pain often outlast the active clinical infection [29]. Anal itching, bleeding, and mucopurulent anorectal discharge are common symptoms. Systemic manifestations include fever, chills, and malaise. Bilateral tender inguinal lymphadenopathy may sometimes occur. Recurrent episodes are generally milder, lasting 4.5 days on average. The median time to first recurrence is shorter in HSV-2 compared to HSV-1, 49 and 330 days respectively [29]. Nearly all men and 85% of women will experience recurrent HSV-2 infection within the first year, with an estimate of continuous 4–5 recurrences annually.

The initial herpetic lesion is a small vesicle surrounded by a red areola, usually scattered or in clusters in the perianal skin, anal canal, and perineum. Carefully spreading the buttocks for inspection may reveal acute lesions ranging from these small vesicles to larger ruptured vesicles, which have coalesced (Fig. 27.4). Shallow perianal ulcers may coalesce and extend to the sacrococcygeal region in a butterfly distribution [30, 31].

Anoscopy reveals friable epithelium, ulceration, and mucopurulent discharge. Viral culture of a suspicious vesicle is positive in up to 90% of clinical HSV-2 infections. Proctoscopy reveals friable mucosa, diffuse ulcerations, and occasional vesicles and pustules limited to the distal 10 cm of the rectum. Ulcerations in the anal canal may become secondarily infected, and appear as grayish crypts with erythematous borders. Crusting of the lesions is followed by healing within 2 weeks.

Presumptive diagnosis is based on the clinical examination, finding multinucleated giant cells with intranuclear inclusion bodies in Papanicolaou

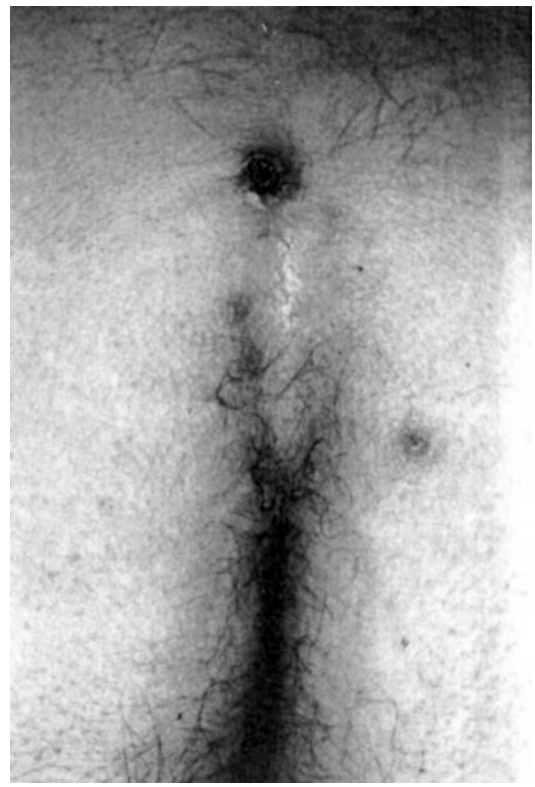


Fig. 27.4 Perianal herpes simplex virus

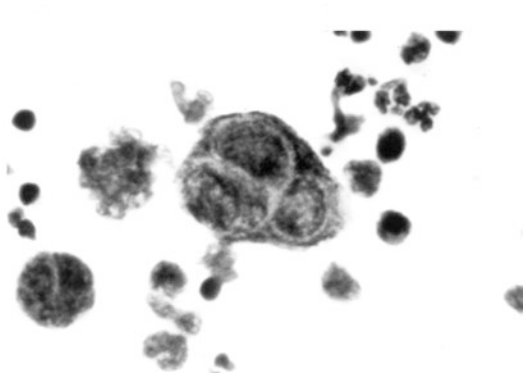


Fig. 27.5 Microscopic identification of multinucleate giant cells from cytologic scraping of a perianal ulcer

(Pap) smear or other similar cytological stain, or a positive culture test. Test kits for easy detection of selected antibodies by monoclonal antibody techniques are now available [32]. A positive viral culture, best taken from lesions in the vesicular phase, is diagnostic. Cytological scraping or biopsies taken from the bed of an ulcer and stained with Giemsa stain will reveal the multinucleated giant cells typical of herpetic infection (Tzanck preparation) (Fig. 27.5). Crypt abscesses and lamina propria neutrophils occur in about half of all specimens. In patients with clinical suspicion of genital HSV infection and negative culture, type specific antibody testing can be useful. In addition, serologic testing is useful in detecting discordance of HSV seropositivity in couples in a monogamous relationship, as many HSV positive people have subclinical disease. If serology confirms that they are discordant, ways to minimize transmission can be discussed. Serology testing is also recommended in pregnant women who have a HSV positive partner. Genital HSV infection during pregnancy can be life threatening for newborns. The seropositivity can occur 21–40 days after the initial infection and therefore diagnosis should be based on clinical suspicion and other diagnostic modalities. If clinical suspicion still exists serology test should be repeated in 3–4 months [33]. Cross reactivity between HSV-1 and 2 is common. Assays based on Glycoprotein G can be used to differentiate between HSV 1 and 2 and have been approved by FDA [34, 35].

Traditional treatment was symptomatic only using Sitz baths, lidocaine ointment, cool compresses, stool softeners, and oral analgesics. Treatment offers no cure, but randomized trials have indicated that three antiviral medications provide clinical benefit for genital herpes: acyclovir, valacyclovir, and famciclovir [9]. The different antivirals (valacyclovir 500 or 1000 mg twice daily; famciclovir 125, 250 or 500 mg three times a day; acyclovir 200 mg 5 times a day) taken for a period of 10 days have been shown to be equally effective in randomized trials for patients with their first episode 50; used for 5 days they have been shown to decrease viral shedding and lessen duration of lesions in patients requiring episodic treatment for recurrent herpes. There is only one randomized trial evaluating acyclovir treatment in HSV proctitis in MSM, demonstrating fewer days of viral shedding and more rapid ulcer healing. Symptoms such as anal discomfort, paresthesia and impotence were not different between treatment and placebo group.

HSV infection in HIV-positive patients tends to recur more and last longer. Treatment of HSV infection in HIV positive patients is not different, although the response rate is generally slower. Episodic therapy with oral antiviral agents is effective in improving clinical manifestation of HSV. However, it does not reduce the risk of HSV transmission.

Stamm and associates [36] and Holmberg and associates [37] have independently reported a statistically significant correlation between HSV-2 infection and subsequent HIV infection. The HSV-2 must be recognized not only as an ulcerative pathogen but as a harbinger of HIV infection. All patients with anorectal herpes should be counseled regarding HIV testing. Ulcerative perianal HSV-2 disease, if present for at least 1 month in a patient who has no other identifiable cause of immunodeficiency or who has laboratory evidence of HIV infection, is diagnostic of AIDS.

In order to prevent transmission of HSV, abstinence during an acute episode of infection is recommended. However asymptomatic shedding continues and partner of HSV infected individuals have a very high risk of seroconversion.

HPV Infection

As the name suggests, human papilloma virus is restricted to humans. Human papillomavirus is the most common STI, however, around 90% of infections are asymptomatic and self-limiting. The immune system clears most HPV infections within 2 years [38]. The virus inhabits in the basal layer and then migrates upwards into the dermis, ending up in the keratin layer and therefore hidden from the immune system.

There are more than 40 different types of HPVs that can cause STIs. Chronic infection with specific types can cause benign and malignant diseases of anal canal or genital tract. For example, types 16 and 18 account for more than two thirds of cervical cancer worldwide [39, 40]. Types 6 and 11 are responsible for 90% of genital warts [41, 42]. The oncogenic subtypes appear to have the capacity to activate proteins causing an oncogenic cascade, possibly through manipulation of the p53 gene, and HIV may potentiate this process. This perhaps explains the rationale for HPV subtyping to assess the malignant potential of the HPV lesion and to identify those patients who may require closer surveillance. This is a theoretical consideration but is not often implemented in clinical practice. In genital carcinoma, in which the HPV has been isolated, the viral genome is integrated into the malignant cell's chromosome. It has been observed that homosexual men, in whom HPV is prevalent, are at increased risk for the development of invasive anal cancer.

Condyloma acuminata (anal and perianal warts) are the most common sexually transmitted disease seen by the colon and rectal surgeon. The Centers for Disease Control have reported a 500% increase in the incidence of condyloma between 1966 and 1981. Identified in increasing frequency, the human papilloma virus (HPV) is considered one of the most common STIs with 10–15 million infected individuals in this country and 2–3 million new cases reported annually. Because subclinical, latent, and minimally symptomatic infections occur, visible anogenital warts represent only 10% or less of the total spectrum of HPV infections. The typical patient is a sexually active homosexual or bisexual man, although lesions in the perianal region may be seen in heterosexual men, women, or even children. Several investigators have reported that 83–90% of patients with anal condyloma are homosexual. As many as 50–75% of asymptomatic homosexual men may harbor anal condyloma. Fifty percent of sexually active college women may be infected with HPV. These statistics account for the increasingly prevalent nature of this disease.

Anogenital warts present with the presence of raised lesions, rectal bleeding or discharge, pain, and/or pruritus. On examination lesions have been described as cauliflower-like, grey or pink fleshy growths externally and may extend to the anal canal (Fig. 27.6). A variant of anal condyloma is the giant condyloma or Buschke-Loewenstein tumor (verrucous carcinoma) (Fig. 27.7). This appears as a rapidly growing, fungating, squamous cell carcinoma that histologically shows no sign of invasion. The aggressive nature of the lesion may cause multiple

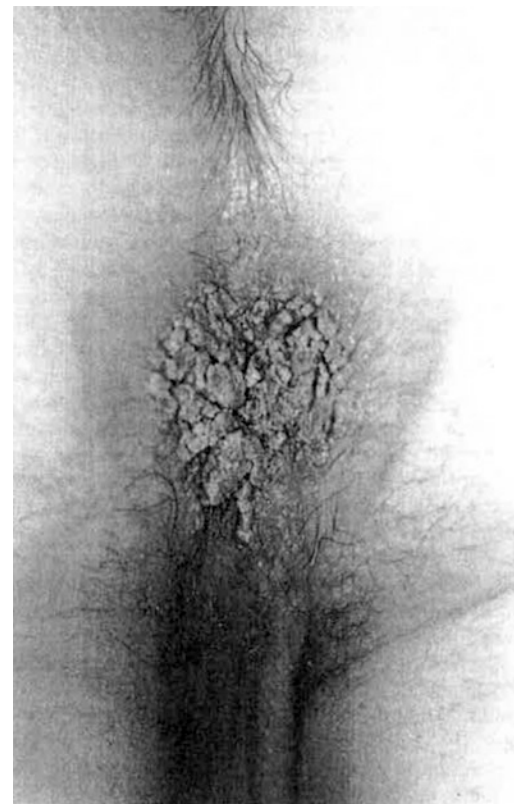


Fig. 27.6 Perianal condylomata acuminatum

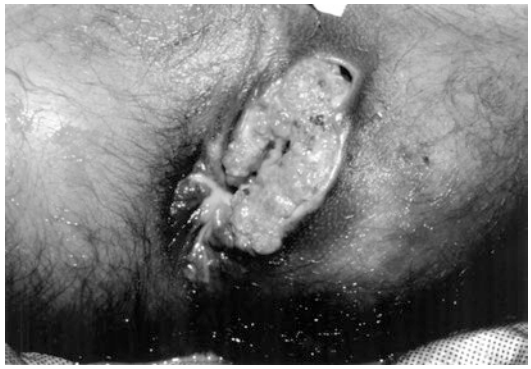


Fig. 27.7 Florid condylomata acuminata with carcinoma in situ

sinuses or fistulous tracts that may invade fascia, muscle, or rectum. This may result in inflammation, infection, or hemorrhage. Microscopically, the lesion is very similar to condyloma acuminata. There is no evidence of lymphatic or angioinvasion. The treatment is surgical, employing wide local excision with clear margins. Abdominoperineal resection is advocated if the anal sphincter is involved. HPV DNA type 6 has been isolated from these lesions. These lesions often contain foci of in situ or invasive squamous cell carcinoma (SCC) leading to speculation that they represent the continuum between condyloma and SCC. Diagnoses can be made by inspection or biopsy if uncertain or if lesions do not respond to therapy. A high index of suspicion for malignancy should be maintained in high-risk groups

The primary mode of transmission of anogenital HPV infection is sexual intercourse, although spread may occur through intimate nonsexual contact, thus accounting for the rare occurrence of this disease in virginal women or children in whom sexual abuse has been ruled out. This is accomplished by fluid transfer, which contain shed viral particles form someone with clinical anal condylomata. In addition to sexual penetration these particles can be spread by touch or oral-anal transfer. Up to 30% of sexually active people harbor HPV under fingernails as one mode of spread [43]. Traumatic inoculation of the anal epithelium during intercourse allows entry of the HPV into the basal cell layers; the basal cells proliferate and viral replication occurs within the nucleus. As the cells migrate toward the more superficial layers,

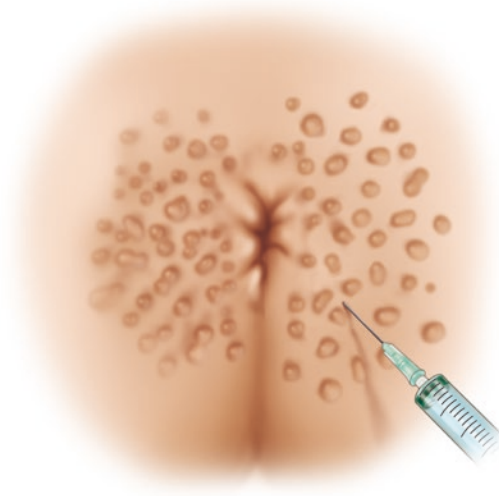


Fig. 27.8 Epinephrine solution injected subdermally elevates and separates warts (right)

infective particles are released in the form of visible warts. Mature infectious particles are found in the surface layers of the lesions.

Anal and perianal warts are notorious for recurrence mandating vigilant follow-up examinations. Reported recurrence rates range from 10% to 75%. All patients should undergo anoscopy, proctosigmoidoscopy, and a genital examination. Counseling regarding sexual activity and how to avoid reinfection is needed. Appropriate treatment options include excisional therapy, destructive therapy, and immunotherapy. Treatment modality is influenced by size, number and anatomic location of the lesion in addition to patient preference and the provider experience.

Condyloma can be excised with either local anesthesia or a regional block depending on their extent and the patient's ability to cooperate. A solution of 0.5% to 1% lidocaine is injected subcutaneously and submucosally (Fig. 27.8). This elevates and separates the warts allowing for maximal preservation of normal skin and mucosa anal stenosis can result from the removal of excessive anal and perianal skin. The individual warts can then be excised with a pair of fine-pointed scissors and fine-toothed forceps (Fig. 27.9). In the vast majority of patients, all the lesions can be excised in a single session. The most frequent complica-

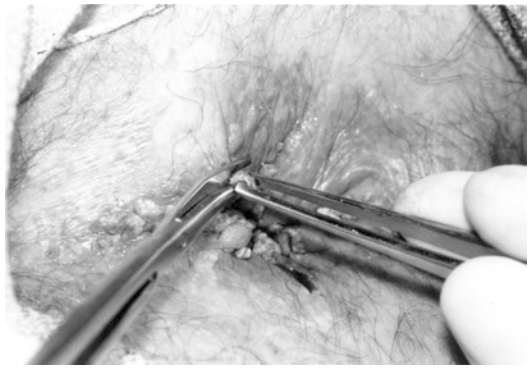


Fig. 27.9 Excision of individual warts with fine scissors

tion is postoperative bleeding. Patients are given a mild analgesic, instructed to take a fiber supplement twice a day, and sitz baths twice a day. Overall clearance rates for surgical techniques range from 60 to 90% with recurrence rates of 20–30% [31, 44]. Electrocautery is a rapid and effective means of treating multiple small lesions and can be combined with scissor excision of larger lesions. Generally, this technique can be performed in an office setting using local anesthesia. The goal is to produce a white coagulum, which is the equivalent of a superficial partial thickness burn. Fibrous scarring can result if the burn is allowed too deep potentially creating subsequent anal stenosis. Pain and sphincter spasm may occur during and after the procedure requiring oral analgesics. Recurrence rates range from 10% to 25%. Cases of respiratory papillomas in medical care providers using laser therapy for anal condyloma have been reported. Special filters and smoke evacuation devices are advocated. Usual follow-up is every 2 months until the patient is disease free for 1 year.

A variety of topical agents are currently used to treat condyloma such as podofilox (podophyllotoxin), imiquimod and sinecatechins. Podofilox is an antimitotic drug that can be applied to the affected area either in the form of a solution or gel. The treatment regimen consists of twice daily application of podofilox for 3 days, with 4 days of no treatment. The treatment can be repeated up to four times. Podofilox cannot be used in pregnancy because of the teratogenic effects.

Imiquimod modifies the local immune response by increasing the local production of interferon and sequestration of activated T lymphocytes into the infected area. It is applied three nights per week to the perianal area over a 16-week period. The compliance may be low due to skin irritation. Use of imiquimod following destruction of lesions has been show to decrease recurrence [44, 45].

Sinecatechins is a green tea extract with cathechins as the active product. It is available in 15% ointment form and should be applied to the affected are three times daily until complete clearance of lesion, but not longer than 16 weeks. Sinecatechins can cause erythema, rash, induration and ulceration of the skin. Destruction of lesions can also be achieved using cryotherapy. Cryotherapy uses liquid nitrogen and causes thermal induced cytolysis. This modality should only be used by trained providers. Treatment of anal warts in certain clinical conditions requires special considerations. In pregnancy, podofilox, podophyllin and sineachetins are contraindicated. Imiquimod appears to be safe, however further data is required. Anal warts treatment should be best delayed till after the pregnancy. Routine C-section is not recommended in the setting of anogenital warts, unless concerns about pelvic outlet obstruction or excessive bleeding.

Anal warts may present in a more extensive form in patients with HIV or otherwise immunosuppressed patients. Treatment failure and recurrence of the disease are also more frequent. Special consideration needs to be given to the patient in whom multiple perianal and/or intra-anal biopsies or excised condylomata have revealed intraepithelial neoplasia. We believe that the finding of AIN alone does not necessitate aggressive surgical treatment, but these patients must be closely followed up as the optimal management is unclear.

Anal cancer is strongly linked to HPV infection. Although the overall incidence of anal cancer is low (~2 in 10,000), there has been a constant increase in its incidence over the last decades by about 2% per year. HIV infection and other immunosuppressed patients such as solid organ recipients are at increased risk of anal cancer. Anal cancer thought to

be caused by oncogenic HPV (including strains 16 and 18), which immortalizes cells and transforms them through what is called low grade squamous intraepithelial lesion (LSIL) and then high-grade squamous intraepithelial lesion (HSIL) which is identifiable using high resolution anoscopy (HRA). The clinical benefit of screening for HSIL in order to prevent invasive anal cancer is not clear. The NIH-supported ANCHOR study (Anal Cancer/HSIL Outcomes Research) will hopefully provide some useful answers.

The most specific test to identify HSIL is HRA using 5% acetic acid. However, this modality requires well trained clinicians and is expensive. Anal pap smear compared to HRA has 70% sensitivity and a positive predictive value of 97% for atypical cells [46]. Anal pap smear can therefore be used as test to trigger further evaluation by a trained colorectal surgeon. Treatment of HSIL can be challenging. HSIL is frequently multifocal and therefore complete clearance is difficult and retreatment is often necessary. Goldstone et al predicted a rate of recurrence 1 year after the first ablation for HIV-positive and -negative patients of 53% (95% CI, 49%–58%) and 49% (95% CI, 43%–55%). At 2 and 3 years, the rate of recurrence was 68% (95% CI, 63%–73%) and 77% (95% CI, 72%–82%) for HIV-positive patients and 57% (95% CI, 51%–64%) and 66% (95% CI, 59%–73%) for HIV-negative patients [47]. However, ablation treatment of anal HSIL has yet to predictably prevent the occurrence of anal cancer and can incur substantial cost. In response to the dearth of data demonstrating the success of HSIL screening, a recent NIH supported study known as ANCHOR (Anal Cancer/HSIL Outcomes Research) (www.ANCHORstudy.com) was initiated [48]. Recent data shows that quadrivalent human papillomavirus vaccination in men who have sex with men (MSM) who have a history of high-grade anal intraepithelial neoplasia (HGAIN) was associated with a 50% reduction in the risk of recurrent HGAIN [49].

Molluscum Contagiosum

Molluscum contagiosum is caused by a pox virus and is transmitted by direct body contact. The incubation period is 2–6 weeks. It presents in perianal skin as painless, flattened, raised, smooth, umbilicated papules usually 2–5 mm in diameter (Fig. 27.10). The disease is benign and self-limiting but treatment with phenol or trichloroacetic acid, surgical excision, electrocautery, or cryotherapy is used to prevent spread and for cosmetic reasons.

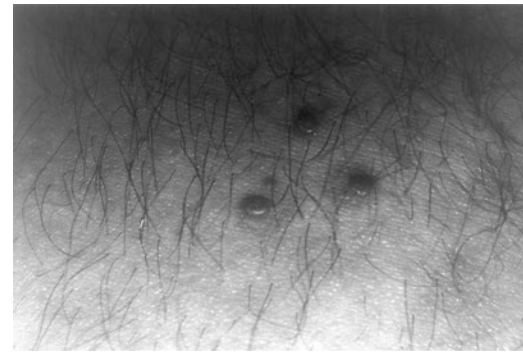


Fig. 27.10 Dermal lesions of Molluscum contagiosum

In AIDS patients, extensive lesions may be seen involving the face and neck [50]. These are difficult to treat and tend to recur rapidly despite adequate treatment. Cutaneous cryptococcal infections in AIDS patients may mimic molluscum contagiosum, delaying adequate treatment [51].

Human Immunodeficiency Virus

Human Immunodeficiency Virus (HIV) is an RNA retrovirus that infects human T-lymphocytes. The virus is spread by contaminated body fluids, and after a variable latent period of up to 2 years, it produces diminished immunologic function [52]. In 2016, an estimated 39,772 people were diagnosed with HIV infection in the United States and more than 1.1 million Americans are living with HIV [53]. Proctologic conditions are common in HIV patients, and in the absence of routine screening these complaints may be the patient's primary reason for seeking medical help.

HIV has been around now for almost 30 years and is remote from the death sentence that was faced by patients in the past. Due to advances in treatment with the newer antiviral agents, HIV is now considered a chronic disease and is frequently lumped in the category of "diabetes".

Antivirals used before sexual encounters, called PrEP, offers good protection from HIV in

unprotected sex but none to sexually transmitted infections (STI). Similarly, serosorting, where a HIV positive person has unprotected sex with another HIV positive person is also increasing the number of STI's in MSM [54].

STI's, by both causing breaks in the epithelium of the anoderm and aggregations of immune cells that may be targeted for HIV infection, enhance the spread of HIV. In the setting of HIV, the clinician should consider modifying treatment of STI's. Concern about the partner and preemptive treatment, called expedited partner therapy [55], is commonly employed.

Retesting for all STD's is critical to ensure efficacy of treatment. Gonorrhea and chlamydia rectal swabs should be repeated 3 months after treatment. Patients diagnosed with syphilis should have follow up at 3–6 months after treatment [56].

Diseases that are now more of a curiosity than before the current antivirals include Kaposit's sarcoma (KS) and Mycobacterium avium. KS, in the HIV setting, is caused by HHV-8 (a sexually transmitted herpes virus) and typically causes lesions on the skin and gastrointestinal tract. It can be the source of rectal bleeding, obstructive symptoms, and intussusception [57]. Mycobacterium avium can cause severe intra-abdominal lymphadenopathy and symptoms arising from obstruction and pain but currently is found predominantly in anorectal fistulae in patients with AIDS and should be medically treated. All HIV patients with any perirectal suppuration should be evaluated for MAI by acid fast stain and culture [58].

"Immune reconstitution inflammatory syndrome" [59] is a current phenomenon and occurs when HAART therapy causes reactivation of foci of immune cells to "hyper-proliferate" against antigens. It can cause a unique hypertrophic herpes infection that is treated by antivirals, imiquimod, or excision. It may be culture negative and the diagnosis is made by biopsy and histology [60].

For the practicing colorectal surgeon, the challenge going forward in HIV patients includes the ongoing influence of HPV on the epithelium of the anal canal. Reconstitution of the immune system, as mentioned previously, causes ongoing inflammation of latent HPV infected cells. Ongoing inflammation is one of the causes of cancer in patients with ulcerative colitis. It is postulated that the inflammation due to HPV may accelerate neoplastic transformation in the anal canal. Surveillance of the anal canal in all men who have sex with men (MSM) is imperative to avoid a possible epidemic of SCC. Whether this is done by high resolution anoscopy or by routine exam is yet to be determined.

Infectious Diarrheal Disorders

Bacterial Infections

Campylobacter

Campylobacter jejuni is now recognized as a common cause of infectious diarrhea transmitted by the ingestion of infected milk or meat. Although no proof of sexual transmission exists, this bacterial infection is seen in homosexual men more frequently than in matched heterosexual controls. Fecal-oral contact during male homosexual activity, especially analingus, accounts for their venereal transmission. *Campylobacter* has been cultured in 3% of asymptomatic homosexual men and in 6% of those with gastrointestinal symptoms.

The responsible organism is a curved, motile, non-spore-forming gram negative rod which can infect the small bowel or colon to produce an enterocolitis. The most common symptoms are diarrhea (bloody or non-bloody), abdominal pain, and fever. Stool culture is the only means of establishing the diagnosis. Sigmoidoscopy may show nonspecific edema, erythema, and apthous ulcerations. The disease is usually self-limited but treatment is reasonable in toxic-appearing or high-risk patients. The preferred treatment is oral erythromycin 500 mg four times a day for 1 week. Tetracycline, gentamicin, clindamycin, and ciprofloxacin have all been used.

Yersinia

Yersinia enterocolitica and pseudotuberculosis can cause an enterocolitis which mimics appendicitis. Transmission is most commonly from ingestion of

contaminated food or water but spread by direct patient contact can also occur. Clinical symptoms are usually seen within 1 week of infection and include nonbloody diarrhea, abdominal pain, and fever. The presentation can be confused with appendicitis in up to 40% of cases as the terminal ileum is the region most commonly infected [61]. The disease is usually self-limited but can progress to toxic megacolon and perforation. Effective antibiotics include trimethoprim-sulfamethoxazole, aminoglycosides, tetracycline, and most third-generation cephalosporins.

Salmonella

Salmonella are motile, gram-negative rods, which can invade the small bowel and colonic mucosa to produce an enterocolitis. An endotoxin is elaborated which increases the local inflammatory response in areas of local invasion. Transmission is usually via ingestion; fecal-oral spread is common. Symptoms occur within 48 h of inoculation and include non-bloody diarrhea, nausea, vomiting, tenesmus, fever, chills, and colicky abdominal pain. Sigmoidoscopy reveals hyperemia of the mucosa and petechial lesions. Definitive diagnosis is made by stool culture. Because the disease is self-limited, antimicrobial therapy is generally unnecessary.

Shigella

The first reports of *Shigella flexneri* as an infection common in homosexual men who lived in major US cities were published in 1974 [61–64]. Forty percent of asymptomatic homosexual men harbor at least one enteric pathogen and shigella is almost endemic. Thirty to 50% of reported cases of shigellosis are in homosexual males [65]. Sexual transmission is by direct or indirect fecal-oral contamination. In some urban areas, a majority of food handlers are homosexual males, resulting in a challenging public health situation, particularly since only a small inoculum (as few as 10 organisms) is needed to transmit the disease.

Shigellosis should be suspected whenever an acute diarrheal illness productive of bloody mucoid stools lasts longer than 2 days. The diagnosis is made by stool culture. Techniques for immunofluorescent antibody labeling are also used. Sigmoidoscopy reveals inflamed, ecchymotic, friable or ulcerated mucosa. The illness is usually self-limited but treatment with antibiotics shortens the clinical course and limits the time of active shedding of the organisms. Untreated patients can shed viable organism for up to 1 month after the resolution of symptoms. The antibiotic of choice is oral double-strength trimethoprim-sulfamethoxazole twice a day for 7 days.

Mycobacterium Avium-Intracellulare (MAI)

This normally nonvirulent organism is an opportunistic microbial pathogen causing severe widely disseminated infection in immunocompromised patients. It is noted in virtually 100% of AIDS patients at autopsy [66, 67]. Patients may remain asymptomatic or can develop a severe wasting syndrome, characterized by fever, malaise, weight loss, watery diarrhea, dehydration, malabsorption, and severe abdominal pain. Sigmoidoscopy reveals edematous, erythematous, friable mucosa with ulcerations. The stool should be sent for acid fast stains. In patient suspicious for MAI, a negative acid fast stain should be followed by ileocolonic biopsy. AFB-laden macrophages are diagnostic. Granuloma formation is rare because of the lack of cell-mediated immunity in these patients. Biopsies may also show blunting of the villi, which are widened and shortened by a histiocytic infiltrate. These findings resemble those seen in Whipple's disease and account for the profound malabsorption that is often seen [68].

Radiologic findings of ileal narrowing and ulceration may suggest Crohn's disease preoperatively. CT scan findings include diffuse bowel wall thickening, enlarge lymph nodes which may be matted to masses of significant size, and marked hepatic and splenic enlargement.

Complications of abdominal MAI infections include obstruction (30%), fistulae (2%–20%), perforation (5%), and bleeding (20%) [69]. Medical treatment of intra-abdominal MAI is discouraging. These organisms are often resistant to standard antituberculosis agents. Newer classes of drugs such as the quinolones and macrolide antibiotic are being used but their clinical efficacy has yet to be documented. Surgery is more likely to be indicated in those patients who

present with abdominal pain, usually secondary to lymphadenopathy, than in those with other symptoms [70] and the decision if and when to operate must be based on clinical suspicion as culture confirmation may take up to 6 weeks. The one-year survival is contingent on the presence or absence of coexistent opportunistic infections, but has been reported as high as 66%.

Viral Infections

Cytomegalovirus (CMV)

Although almost all gay males and many heterosexual persons of both sexes have CMV antibodies, clinically apparent intestinal disease caused by this organism is generally confined to those who are immunocompromised, particularly AIDS patients. Cytomegalovirus is ubiquitous in the homosexual AIDS population. Greater than 90% of healthy homosexual men are seropositive for CMV [71]. In these patients CMV can cause disease anywhere in the gastrointestinal tract resulting in esophagitis, gastritis, enteritis, or colitis. It can also cause discrete perioral lesions and possibly anorectal ulcerations that may resemble herpetic lesions. The condition may progress rapidly, resulting in toxic megacolon, gastrointestinal hemorrhage, bowel necrosis and/or perforation.

Symptomatic ileocolitis is the most common intestinal infection, occurring in at least 10% of AIDS patients. Symptoms include abdominal pain, diarrhea (often bloody), weight loss, anemia, melena, and hematochezia. Sigmoidoscopy or colonoscopy findings may be nonspecific, including patchy submucosal erythema with intervening normal mucosa, violaceous hemorrhagic submucosal lesions (which may be confused with Kaposi's sarcoma), multiple discrete ulcers, or diffuse necrosis. Mucosal CMV infection causes inflammation and tissue necrosis with vascular endothelial involvement and subsequent ischemic mucosal injury [72]. Biopsy may show the characteristic basophilic intranuclear inclusion bodies surrounded by acute and chronic inflammatory cells and associated intracytoplasmic inclusions (Fig. 27.11). As the diseases progresses, cell death occurs and the inclusions become less distinct. A typical purplish "sludge" can be seen and is highly suggestive of CMV. Confirmation of the diagnosis can be made by viral tissue culture.

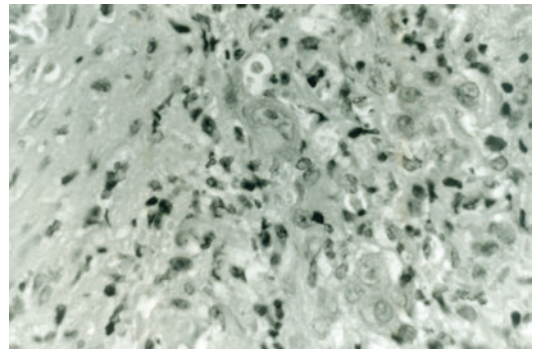


Fig. 27.11 Biopsy of an anal CMV ulcer showing basophilic intranuclear inclusion bodies

The two recognized drugs for treatment are foscarnet and ganciclovir (DHPG), both of which are typically administered intravenously. Oral administration of ganciclovir has recently been initiated. Foscarnet can cause irreversible renal failure and complex changes in calcium homeostasis. Ganciclovir, given 5 mg/kg IV, has produced promising results but can cause bone marrow suppression, which may be accentuated in patients taking AZT. Relapse is common after the drugs are discontinued since both are virustatic. Consequently, life-long maintenance therapy may be required.

Parasitic-Protozoan Infections

Amebiasis

Entamoeba histolytica is a protozoan that commonly infects humans and can be transmitted by sexual activity. It is the most common cause of parasitic colitis seen by surgeons in the United States. Forty percent of all cases of amebiasis in the US between the years of 1958 and 1978 occurred in New York City, 80% being in males in Manhattan [73]. Twenty to 32% of homosexual and bisexual men are infected with *E. histolytica* [74], and one or more protozoan organisms are found in 26%–70% of homosexual men with diarrhea [75]. Interestingly, symptomatic disease

develops in only a small percentage of carriers [76]. Toxic megacolon or hemorrhage secondary to amebic colitis may require surgery.

The specific treatment depends on the severity of the disease. Metronidazole is the drug of choice, providing amebicidal concentrations both systemically and lumenally. If the patient cannot tolerate oral intake, intramuscular agents are available but have significant adverse cardiac effects. Regardless of the agent used, a course of iodoquinol is necessary following primary therapy in order to fully eradicate the amebic cysts from the colonic lumen.

Cryptosporidiosis

Cryptosporidium is a small, coccydial protozoan that is present in the feces of 4% of immunologically competent hospitalized patients with gastroenteritis, in whom it causes a self-limited infection [77]. In AIDS patients, however, it can produce a life-threatening colitis. The diarrhea is usually watery, bloody or mucoid and profuse; an excess of 5–10 L/day has been reported [78]. Consequently, severe electrolyte imbalance, dehydration, and hypovolemic shock can ensue.

The diagnosis can be established from histopathologic examination of rectal biopsy specimens which demonstrate the characteristic oocysts. Modified acid-fast (Kinyoun) stain may show the oocysts in the stool but the tissue forms are not acid-fast. Treatment is largely supportive providing intravenous hydration and nutritional support. There is no specific effective treatment at this time, although spiramycin, 1 g every 8 h, has shown some benefit [79].

Giardiasis

Giardiasis is caused by intestinal flagellates, which inhabit the upper small intestine and biliary tract of infected individuals and is transmitted by sexual activity with an infected partner. The incidence is between 4% and 18% in the male homosexual population [65]. Although the lower gastrointestinal tract is not affected patients may present with lower abdominal cramps, bloating, anorexia, weight loss, and malabsorption causing frequent foul-smelling, greasy loose stools. Diagnosis can be made by identifying the characteristic trophozites in fresh stool specimens, jejunal biopsies, or scrapings from the base of an ulcer. Concentration of the organism in the stool is variable. CDC recommends fecal immunoassay as the most sensitive and specific test for detection of giardia infection. The recommended treatment is with a 7-day course of metronidazole.

Isosporiasis

Isospora belli is a large, oval coccidial protozoan, which can also cause chronic, profuse diarrhea and malabsorption but has a much lower prevalence than *Cryptosporidium.* The clinical manifestations are similar but the quantity of diarrhea tends to be much lower resulting in less weight loss and malnutrition [80]. The diagnosis may be made using the modified acid-fast stain on a fresh stool specimen. The oocytes are difficult to see and may be more readily seen on small bowel biopsy. Isosporiasis, in contrast to cryptosporidiasis, responds well to antiprotozoal therapy. Eradication of the organism is usually achieved within 7 days of treatment with combined trimethoprim-sulfamethoxazole. Relapses are common and prophylaxis with a nightly dose of double-strength trimethoprim-sulfamethoxazole has been recommended.

Conclusion

The increase in incidence and variety of sexually transmitted infections, and particularly in the male homosexual population, in recent decades is likely the result of relaxed legal and social constraints on sexual behavior. Although previously considered a rare site for venereal disease, the anorectum is now recognized as a common reservoir of a wide variety of sexually transmissible agents. Because the AIDS epidemic has encouraged many individuals to practice “safe sex” the incidence of some sexually transmitted diseases has been reduced. The clinician who treats anorectal and intestinal disease must be aware of the common diseases, presence of multiple pathogens, and the need for behavioral counseling. All sexual partners must be adequately screened and treated in order to eradicate these diseases.

References

1. Workowski KA. Centers for disease control and prevention sexually transmitted diseases treatment guidelines. Clin Infect Dis. 2015;61(Suppl 8):S759–62.
2. Turner CF, Danella RD, Rogers SM. Sexual behavior in the United States 1930-1990: trends and methodological problems. Sex Transm Dis. 1995;22(3):173–90.
3. Peterson JL, Coates TJ, Catania JA, Middleton L, Hilliard B, Hearst N. High-risk sexual behavior and condom use among gay and bisexual African-American men. Am J Public Health. 1992;82(11):1490–4.
4. Moscicki AB, Millstein SG, Broering J, Irwin CE Jr. Risks of human immunodeficiency virus infection among adolescents attending three diverse clinics. J Pediatr. 1993;122(5 Pt 1):813–20.
5. MacDonald NE, Wells GA, Fisher WA, Warren WK, King MA, Doherty JA, et al. High-risk STD/HIV behavior among college students. JAMA. 1990;263(23):3155–9.
6. Willcox RR. The rectum as viewed by the venereologist. Br J Vener Dis. 1981;57:1):1–6.
7. Markland AD, Dunivan GC, Vaughan CP, Rogers RG. Anal intercourse and fecal incontinence: evidence from the 2009-2010 National Health and Nutrition Examination Survey. Am J Gastroenterol. 2016;111(2):269–74.
8. Silverman BG, Gross TP. Use and effectiveness of condoms during anal intercourse. A review. Sex Transm Dis. 1997;24(1):11–7.
9. Workowski KA, Bolan GA. Sexually transmitted diseases treatment guidelines, 2015. MMWR Recomm Rep. 2015;64(Rr-03):1–137.
10. DiCarlo RP, Martin DH. The clinical diagnosis of genital ulcer disease in men. Clin Infect Dis. 1997;25(2):292–8.
11. Satterwhite CL, Torrone E, Meites E, Dunne EF, Mahajan R, Ocfemia MC, et al. Sexually transmitted infections among US women and men: prevalence and incidence estimates, 2008. Sex Transm Dis. 2013;40(3):187–93.
12. CDC. Sexually transmitted disease surveillance 2014–2015.
13. Klein EJ, Fisher LS, Chow AW, Guze LB. Anorectal gonococcal infection. Ann Intern Med. 1977;86(3):340–6.
14. Janda WM, Bohnoff M, Morello JA, Lerner SA. Prevalence and site-pathogen studies of Neisseria meningitidis and N gonorrhoeae in homosexual men. JAMA. 1980;244(18):2060–4.
15. Modesto VL, Gottesman L. Sexually transmitted diseases and anal manifestations of AIDS. Surg Clin North Am. 1994;74(6):1433–64.
16. Geisler WM. Diagnosis and management of uncomplicated chlamydia trachomatis infections in adolescents and adults: summary of evidence reviewed for the 2015 centers for disease control and prevention sexually transmitted diseases treatment guidelines. Clin Infect Dis. 2015;61(Suppl 8):S774–84.
17. Bazan JA, Carr Reese P, Esber A, Lahey S, Ervin M, Davis JA, et al. High prevalence of rectal gonorrhea and Chlamydia infection in women attending a sexually transmitted disease clinic. J Womens Health. 2015;24(3):182–9.
18. van Liere GA, Hoebe CJ, Dukers-Muijrers NH. Evaluation of the anatomical site distribution of chlamydia and gonorrhoea in men who have sex with men and in high-risk women by routine testing: cross-sectional study revealing missed opportunities for treatment strategies. Sex Transm Infect. 2014;90(1):58–60.
19. van Liere GA, van Rooijen MS, Hoebe CJ, Heijman T, de Vries HJ, Dukers-Muijrers NH. Prevalence of and factors associated with rectal-only chlamydia and gonorrhoea in women and in men who have sex with men. PLoS One. 2015;10(10):e0140297.
20. Passos MRL. Lymphogranuloma venereum: LGV. In: Passos M, editor. Atlas of sexually transmitted diseases. Cham: Springer; 2018.
21. Schachter J. Chlamydial infections (first of three parts). N Engl J Med. 1978;298(8):428–35.
22. CDC Rftl-bdoCtaNg-, MMWR-Recommendations and Reports 63(2).
23. Geisler WM, Uniyal A, Lee JY, Lensing SY, Johnson S, Perry RC, Kadrnka CM, Kerndt PR. Azithromycin versus doxycycline for urogenital chlamydia trachomatis infection. N Engl J Med. 2015;373(26):2512–21.
24. Safavi A, Gottesman L, Dailey TH. Anorectal surgery in the HIV+ patient: update. Dis Colon Rectum. 1991;34(4):299–304.
25. Blank LJ, Rompalo AM, Erbelding EJ, Zenilman JM, Ghanem KG. Treatment of syphilis in HIV-infected subjects: a systematic review of the literature. Sex Transm Infect. 2011;87(1):9–16.
26. Jacobs E. Anal infections caused by herpes simplex virus. Dis Colon Rectum. 1976;19(2):151–7.
27. Corey L, Spear PG. Infections with herpes simplex viruses (2). N Engl J Med. 1986;314(12):749–57.
28. Fleming DT, McQuillan GM, Johnson RE, Nahmias AJ, Aral SO, Lee FK, et al. Herpes simplex virus type 2 in the United States, 1976 to 1994. N Engl J Med. 1997;337(16):1105–11.
29. Baringer JR. Recovery of herpes simplex virus from human sacral ganglions. N Engl J Med. 1974;291(16):828–30.
30. Benedetti J, Corey L, Ashley R. Recurrence rates in genital herpes after symptomatic first-episode infection. Ann Intern Med. 1994;121(11):847–54.
31. Assi R, Hashim PW, Reddy VB, Einarsdottir H, Longo WE. Sexually transmitted infections of the anus and rectum. World J Gastroenterol. 2014;20(41):15262–8.
32. Munro CL. The impact of recent advances in microbiology and immunology on perinatal and women's health care. J Obstet Gynecol Neonatal Nurs. 1995;24(6):525–31.
33. Ashley-Morrow R, Krantz E, Wald A. Time course of seroconversion by HerpeSelect ELISA after acquisition of genital herpes simplex virus type 1 (HSV-1) or HSV-2. Sex Transm Dis. 2003;30(4):310–4.

34. Casper C, Krantz E, Taylor H, Dalessio J, Carrell D, Wald A, et al. Assessment of a combined testing strategy for detection of antibodies to human herpesvirus 8 (HHV-8) in persons with Kaposi's sarcoma, persons with asymptomatic HHV-8 infection, and persons at low risk for HHV-8 infection. J Clin Microbiol. 2002;40(10):3822–5.
35. Whittington WL, Celum CL, Cent A, Ashley RL. Use of a glycoprotein G-based type-specific assay to detect antibodies to herpes simplex virus type 2 among persons attending sexually transmitted disease clinics. Sex Transm Dis. 2001;28(2):99–104.
36. Stamm WE, Handsfield HH, Rompalo AM, Ashley RL, Roberts PL, Corey L. The association between genital ulcer disease and acquisition of HIV infection in homosexual men. JAMA. 1988;260(10):1429–33.
37. Holmberg SD, Stewart JA, Gerber AR, Byers RH, Lee FK, O'Malley PM, et al. Prior herpes simplex virus type 2 infection as a risk factor for HIV infection. JAMA. 1988;259(7):1048–50.
38. Ho GY, Bierman R, Beardsley L, Chang CJ, Burk RD. Natural history of cervicovaginal papillomavirus infection in young women. N Engl J Med. 1998;338(7):423–8.
39. Bosch FX, Manos MM, Munoz N, Sherman M, Jansen AM, Peto J, et al. Prevalence of human papillomavirus in cervical cancer: a worldwide perspective. International biological study on cervical cancer (IBSCC) Study Group. J Natl Cancer Inst. 1995;87(11):796–802.
40. Clifford GM, Smith JS, Plummer M, Munoz N, Franceschi S. Human papillomavirus types in invasive cervical cancer worldwide: a meta-analysis. Br J Cancer. 2003;88(1):63–73.
41. Garland SM, Steben M, Sings HL, James M, Lu S, Railkar R, et al. Natural history of genital warts: analysis of the placebo arm of 2 randomized phase III trials of a quadrivalent human papillomavirus (types 6, 11, 16, and 18) vaccine. J Infect Dis. 2009;199(6):805–14.
42. Gissmann L, Wolnik L, Ikenberg H, Koldovsky U, Schnurch HG, zur Hausen H. Human papillomavirus types 6 and 11 DNA sequences in genital and laryngeal papillomas and in some cervical cancers. Proc Natl Acad Sci U S A. 1983;80(2):560–3.
43. Sonnex C, Strauss S, Gray JJ. Detection of human papillomavirus DNA on the fingers of patients with genital warts. Sex Transm Infect. 1999;75(5):317–9.
44. Hoyme UB, Hagedorn M, Schindler AE, Schneede P, Hopfenmuller W, Schorn K, et al. Effect of adjuvant imiquimod 5% cream on sustained clearance of anogenital warts following laser treatment. Infect Dis Obstet Gynecol. 2002;10(2):79–88.
45. Schofer H. Evaluation of imiquimod for the therapy of external genital and anal warts in comparison with destructive therapies. Br J Dermatol. 2007;157(Suppl 2):52–5.
46. Nathan M, Singh N, Garrett N, Hickey N, Prevost T, Sheaff M. Performance of anal cytology in a clinical setting when measured against histology and high-resolution anoscopy findings. AIDS. 2010;24(3):373–9.
47. Goldstone SE, Johnstone AA, Moshier EL. Long-term outcome of ablation of anal high-grade squamous intraepithelial lesions: recurrence and incidence of cancer. Dis Colon Rectum. 2014;57(3):316–23.
48. Palefsky JM. Screening to prevent anal cancer: current thinking and future directions. Cancer Cythopathol. 2015;123(9):509–10.
49. Deshmukh AA, Chhatwal J, Chiao EY, Nyitray AG, Das P, Cantor SB. Long-term outcomes of adding HPV vaccine to the anal intraepithelial neoplasia treatment regimen in HIV-positive men who have sex with men. Clin Infect Dis. 2015;61(10):1527–35.
50. Katzman M, Carey JT, Elmets CA, Jacobs GH, Lederman MM. Molluscum contagiosum and the acquired immunodeficiency syndrome: clinical and immunological details of two cases. Br J Dermatol. 1987;116(1):131–8.
51. Miller SJ. Cutaneous cryptococcus resembling molluscum contagiosum in a patient with acquired immunodeficiency syndrome. Cutis. 1988;41(6):411–2.
52. Lifson AR, Rutherford GW, Jaffe HW. The natural history of human immnnodeficiencyvirus infection. J Infect Dis. 1988;158:1360–7.
53. https://www.cdc.gov/hiv/pdf/statistics/overview/cdc-hiv-us-ataglance.pdf. Accessed 6 July 2018.
54. Khosropour C, et al. Trends in serosorting and the association with HIV/STI risk over time among men who have sex with men. JAIDS. 2016;72(2):189–97.
55. Centeres for Disease Control and Prevention. Legal status of expedited partner therapy. http://www.cdc.gov/stod/ept/legal. Accessed 12 Sep 2016.
56. Workowski KA, Bolan GA. Sexually treamitted idsease treatment guidelines 2015. MMWR Recomm Rep. 2015;64(RR-03):1–137.
57. Nidimusili AJ, Eisa N, Shaheen K. Gastrointestinal Kaposi's sarcoma presenting as ileocolic intussusception. N Am J Med Sci. 2013;5(11):666–8.
58. Garg P. Nontuberculous mycobacteria in fistula-in-ano. A new findings and its implication. Int J Mycobaceteriol. 2016;5(3):276–9.
59. Muller M, Wandel S, Colebunders R, et al. Immune reconstitution inflammatory syndrome in patients starting antiretroviral therapy for HIV infection: a systemic review and meta-analysis. Lancet Infect Dis. 2010;10:251–61.
60. McKendry A, Naravana S, Browne R. Atypical presentations of genital herpes simplex virus in HIV-2 and HIV-2 effectively treated by imiquimod. Int J STDAIDS. 2015;26(4):441–3.
61. Vantrappen G, Ponette E, Geboes K, Bertrand P. Yersinia enteritis and enterocolitis: gastroenterological aspects. Gastroenterology. 1977;72(2):220–7.
62. Allason-Jones E, Mindel A. Sex and the bowel. Int J Color Dis. 1987;2(1):32–7.
63. Dritz SK, Back AF. Letter: shigella enteritis venereally transmitted. N Engl J Med. 1974;291(22):1194.

64. Drusin LM, Genvert G, Topf-Olstein B, Levy-Zombek E. Shigellosis. Another sexually transmitted disease? Br J Vener Dis. 1976;52(5):348–50.
65. William DC, Felman YM, Marr JS, Shookhoff HB. Sexually transmitted enteric pathogens in male homosexual population. N Y State J Med. 1977;77(13):2050–2.
66. Hawkins CC, Gold JW, Whimbey E, Kiehn TE, Brannon P, Cammarata R, et al. Mycobacterium avium complex infections in patients with the acquired immunodeficiency syndrome. Ann Intern Med. 1986;105(2):184–8.
67. Wolke A, Meyers S, Adelsberg BR, Bottone EJ, Damsker B, Schwartz IS, et al. Mycobacterium avium-intracellulare-associated colitis in a patient with the acquired immunodeficiency syndrome. J Clin Gastroenterol. 1984;6(3):225–9.
68. Santangelo WC, Krejs GJ. Gastrointestinal manifestations of the acquired immunodeficiency syndrome. Am J Med Sci. 1986;292(5):328–34.
69. Haddad FS, Ghossain A, Sawaya E, Nelson AR. Abdominal tuberculosis. Dis Colon Rectum. 1987;30(9):724–35.
70. Rosengart TK, Coppa GF. Abdominal mycobacterial infections in immunocompromised patients. Am J Surg. 1990;159(1):125–31.
71. Lange M, Klein EB, Kornfield H, Cooper LZ, Grieco MH. Cytomegalovirus isolation from healthy homosexual men. JAMA. 1984;252(14):1908–10.
72. Foucar E, Mukai K, Foucar K, Sutherland DE, Van Buren CT. Colon ulceration in lethal cytomegalovirus infection. Am J Clin Pathol. 1981;76(6):788–801.
73. Pomerantz MB, Marr JS, Goldman WD. Amebiasis in New York City 1958DOUBLEHYPHEN1978: identification of the male homosexual high risk population. Bull N Y Acad Med. 1980;56(2):232–44.
74. William DC, Shookhoff HB, Felman YM, DeRamos SW. High rates of enteric protozoal infections in selected homosexual men attending a venereal disease clinic. Sex Transm Dis. 1978;5(4):155–7.
75. Phillips SC, Mildvan D, William DC, Gelb AM, White MC. Sexual transmission of enteric protozoa and helminths in a venereal-disease-clinic population. N Engl J Med. 1981;305(11):603–6.
76. Brooks JL, Kozarek RM. Amebic colitis. Preventing morbidity and mortality from fulminant disease. Postgrad Med. 1985;78(1):267–74.
77. Soave R, Danner RL, Honig CL, Ma P, Hart CC, Nash T, et al. Cryptosporidiosis in homosexual men. Ann Intern Med. 1984;100(4):504–11.
78. Current WL, Reese NC, Ernst JV, Bailey WS, Heyman MB, Weinstein WM. Human cryptosporidiosis in immunocompetent and immunodeficient persons. Studies of an outbreak and experimental transmission. N Engl J Med. 1983;308(21):1252–7.
79. Soave R. Cryptosporidiosis and isosporiasis in patients with AIDS. Infect Dis Clin N Am. 1988;2(2):485–93.
80. DeHovitz JA, Pape JW, Boncy M, Johnson WD Jr. Clinical manifestations and therapy of Isospora belli infection in patients with the acquired immunodeficiency syndrome. N Engl J Med. 1986;315(2):87–90.

Anorectal Trauma and Injuries

28

Andrew H. Miller, Carlos V. R. Brown, and Matthew J. Martin

Introduction and Historical Perspective

"Ehud reached with his left hand, drew the sword from his right thigh and plunged it into the king's belly. Even the handle sank in after the blade, and his bowels discharged" [1]. This biblical account of Ehud slaying King Eglon on his palace roof is one of the earliest records of colorectal trauma in written history. Many principles of anorectal trauma management are rooted in the study of colorectal injuries; therefore a historical examination is prudent to understand how our past trials have shaped our current surgical landscape. As we examine the surgical history, it is through military literature that we find the best narrative highlighting the shifts in surgical management of anorectal injuries. During the pre-antibiotic era of the American Civil War and early First World War, soldiers with abdominal injuries were simply observed. The fortunate ones without an underlying bowel injury or hemorrhagic shock had reasonable odds of surviving; the alternative carried a 90% mortality rate with observation and surgical exploration was almost uniformly fatal [2, 3]. This would not change until later in World War I when surgeons began experimenting with proximal fecal diversion or externalization, as prior experience with primary repair had been abysmal.

In response to the substantial improvements in outcome seen with either proximal fecal diversion or externalization of colorectal injuries, Major General W. H. Ogilvie, who was the consultant surgeon of the Middle East Forces in the East African Command in 1943, ordered that mandatory colostomies be performed in all patients with colorectal trauma on the battlefield. This algorithmic shift, coupled with improved transport and resuscitation efforts, would result in a significant decrease in mortality rates in the range of 30% by the end of the Second World War [4]. The treatment for rectal trauma also saw major improvements during the world wars, although the volume of experience was significantly lower than that of colon injuries. The patients who survived the initial injury often died of severe retroperitoneal infections until diverting colostomy with presacral drainage became the operation of choice [2]. Surgeons during the Vietnam War often faced more destructive injuries to the rectum, which ushered in the addition of rectal repair with distal rectal washout. Regardless of colon or rectal injury, fecal diversion had become the mainstay in

A. H. Miller
Department of Surgery, The University of Texas at Austin Dell Medical School, Austin, TX, USA

C. V. R. Brown
University Medical Center Brackenridge, Austin, TX, USA

M. J. Martin (✉)
Scripps, San Diego, CA, USA

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_28

management. It wasn't until the late 1970s that civilian literature demonstrated that primary colonic repair without diversion in the right setting was an acceptable treatment option [5]. Multiple studies through the 1980s and 1990s validated this option [6, 7]. Strada and colleagues [6] used an aggressive primary repair approach and showed excellent results even in high-velocity colon injuries. As will be highlighted in the following sections of this chapter, the current treatment options for anorectal trauma contain both stalwarts of historical management and newer paradigms and algorithms. The optimal choice of operative repair and management will depend on multiple factors, most importantly the injury pattern and severity, patient physiology and comorbidities, the setting and available expertise/resources, the current evidence and literature, and individual surgeon comfort. What can be almost uniformly stated about anorectal trauma management is that there is no Level 1 evidence available, and thus it is particularly critical to understand the anatomy, pathophysiology, and prior published experience in order to tailor the best procedure or management strategy to each patient.

Injuries to the Rectum

While infrequent, a diagnosis of rectal injury is associated with risk for significant morbidity and mortality and warrants immediate evaluation and intervention. In the civilian setting, these injuries are typically seen in the setting of penetrating trauma; with gunshot wounds accounting for greater than 80% of all rectal injuries and stab wounds another 5% [8]. These injuries occur in blunt trauma less often with an incidence of 0.5–10% [9–12]. Rectal injuries occur at a higher rate in the military setting, and are typically more complex or destructive due to the predominance of high velocity penetrating or blast mechanisms not commonly seen in civilian practice [13]. Other causes of rectal trauma include impalement/straddle injuries, sex-related injuries, iatrogenic endoscopic and urologic injuries, and anorectal foreign bodies.

A high degree of suspicion is required to avoid the potentially devastating consequences in terms of morbidity, mortality, and anorectal function that can occur with a missed or delayed diagnosis. The evaluation to identify a traumatic rectal injury typically begins in the emergency department trauma bay. As with all trauma patients, the Advanced Trauma Life Support primary survey is paramount to ensuring patient stability. While anorectal injuries do take a high priority, they are not immediately life threatening and the initial evaluation should focus on the primary survey. Although the incidence of anorectal injury is a very low percentage of all trauma patients, there are several injury patterns or mechanisms that should raise suspicion and prompt particular attention to the anorectal evaluation. For penetrating trauma, any penetrating wound (stab or gunshot) to the buttocks, groin, proximal thighs, perineum, or sacral area should raise concern for an associated anorectal injury. In addition, any trans-pelvic gunshot wound should be assumed to have a rectal injury until proven otherwise. Finally, diagnosed injuries to any closely associated organ or structure such as the bladder, uterus/vagina, distal ureters, or iliac vessels should also prompt an evaluation for concomitant rectal injuries. With blunt traumatic mechanisms, an isolated anorectal injury is extremely rare, and is almost always associated with other major pelvic/perineal injuries. Obviously all impalement or straddle injuries should raise concern for direct anorectal trauma. Any pelvic fracture, and particularly the "open book" fracture or those with major posterior pelvic/sacral disruption, can cause rectal injury due to direct puncture from bone fragments or blunt shear/tearing forces.

During the secondary survey, significant history and symptoms should be obtained if possible. This includes eliciting any symptoms of abdominal, pelvic, or perineal pain or discomfort. One of the most common causes of a delay in diagnosis is the simple failure to do a careful exam, which starts by completely exposing and visualizing the lower abdomen, groin, perineum, and buttocks. This should include identification of any significant lacerations, bruising/hematomas, blood or active bleeding, and bullet or stab

wounds. A digital rectal exam (DRE) should be performed to check for the presence of blood, foreign objects, bony protrusion, and evaluate sphincter tone [10]. Some physicians have been moving away from including the DRE on every trauma patient, as its use alone has been suggested to provide little diagnostic information and has a low sensitivity and specificity for rectal injury [14–16].

This caveat is particularly true for the stool guaiac test for "occult blood", which has an extremely high false positive rate and low sensitivity. However, a good DRE is an essential part of the evaluation of a patient with a suspected anorectal injury to identify true rectal blood or bleeding, and to locate and characterize any defects, perforations, hematomas, or foreign bodies. One of the common errors in the anorectal exam is to not visualize and prepare the area by first cleaning the perineum of any old blood and controlling bleeding from nearby sources like a perineal laceration. Should only be performed after cleansing has been done to avoid confusion regarding the source and location of any identified blood and help decrease false positive rates with the finding of "gross blood". We have not found that FOBT adds any information of value in the trauma setting.

Rigid proctoscopy or flexible sigmoidoscopy should be performed in any patient with exam or imaging findings concerning for a rectal injury; with any high-risk penetrating injury as outlined above; and should be considered for all other patients with any question or concern for potential injury. The extent and degree of injury can be documented with this technique, though care must be taken not to worsen a potential defect during the exam by aggressive scope advancement or insufflation [17]. The presence of blood within the bowel lumen on proctoscopy can be considered diagnostic for rectal injury in traumatic settings other than foreign-body insertion. Care is taken to look for blood on the first pass of the scope, as repeat insertions may cause iatrogenic bleeding. Proctoscopy may also be utilized during abdominal exploration, should the surgeon encounter associated injuries that warrant further rectal evaluation.

Computed tomography (CT) has become the most common radiologic adjunct in the trauma setting. While the use of CT has been overcoming its historically poor stigma for identifying hollow viscus injury, its accuracy has not reached the point of using this technology as a standalone diagnostic tool. The use of triple-contrasted (IV, oral, and rectal) CT imaging has improved its diagnostic accuracy and can be performed should a rectal injury be suspected [18, 19]. Arguably the most important role for CT imaging in the setting of rectal trauma is the identification of high risk associated injuries such as complex pelvic fractures, or secondary signs including perirectal air, hematoma, wall thickening, or free fluid that should prompt endoscopy or surgical exploration. CT may also be helpful in depicting the trajectory of missile wounds to determine if it placed the rectum at risk of injury. Marking any external gunshot wounds with radiolucent markers and performing fine-cuts through the area of interest can often reliably re-create the missile tract and reveal whether it was in proximity to the rectum or safely distant.

The pelvis is a compact space where genitourinary, gastrointestinal, vascular, bony, and nervous anatomic structures lie in close approximation. It is not surprising that rectal injuries commonly coincide with injuries to any of the above listed groups. Associated injury patterns should trigger a surgeon's suspicion for a possible rectal injury. Any penetrating wounds that lie within, or have trajectory between, the anterior superior iliac spine (ASIS) and midthigh, including the buttocks and perineum, should prompt further evaluation. A study by Arthurs et al. from a forward combat hospital showed that 43% of patients with penetrating pelvic injuries sustained rectal trauma, half of which had associated vascular or urinary injuries [20]. Another study found that 41% of patients with penetrating bladder injuries had an associated rectal injury [21]. In one study of pediatric anorectal trauma [22], vaginal injuries were discovered in 60% of injured females. It is important to remember that blunt pelvic fractures are evidence of high energy transfer through the pelvis. In a patient with significant pelvic fractures, espe-

cially involving the sacroiliac joint or symphysis pubis, DRE and proctoscopy should be performed followed by a contrasted study if necessary [23].

Rectal Organ Injury Scale

The American Association for the Surgery of Trauma (AAST) has defined injuries to the rectum based on degree of injury thickness and extent of circumference involved (Table 28.1) [24]. Correctly defining a rectal injury is important, both for choosing the optimal management option and improving data collection and analysis. Grade I rectal injury is described as bowel wall contusion or partial thickness laceration. Any full thickness laceration of the rectal wall that involves less than 50% of the circumference is classified as a Grade II injury. Defects involving more than half the rectal circumference are classified as Grade III. If multiple injuries to the rectum are present, the grade is advanced by one level up to Grade III. Rectal lacerations communicating with open perineal wounds are graded level IV, and any devascularization of the rectum is considered the highest level of injury at Grade V.

A commonly utilized binary descriptive system categorizes all colon and rectal injuries as either "destructive" or "non-destructive". The definition of "destructive" is any injury involving greater than 50% of the circumference of the bowel wall or any mesenteric injury that compromises the perfusion of that segment of bowel. Additionally, most surgeons would include multiple smaller injuries that are in very close proximity in the destructive category. The clinical relevance of this categorization is that while many non-destructive injuries can be safely managed with primary repair, all destructive injuries should undergo segmental resection and either primary anastomosis, colostomy with no anastomosis, or primary anastomosis with a proximal diverting ostomy.

Table 28.1 AAST organ injury grading scale for injury to the rectum

Grade[a]	Type of injury	Description of injury
I	Hematoma	Contusion or hematoma without devascularization
	Laceration	Partial-thickness laceration
II	Laceration	Laceration <50% of circumference
III	Laceration	Laceration ≥50% of circumference
IV	Laceration	Full-thickness laceration with extension into the perineum
V	Vascular	Devascularized segment

Source: Adapted from Moore et al. [24]
[a]Advance one grade for multiple injuries up to grade III

Anatomic Considerations

The rectum is a unique segment of the gastrointestinal tract with multiple encasing layers of tissue that differ along its length. Anteriorly and laterally, the proximal two-thirds of the rectum are covered with peritoneum, while the posterior surface is extraperitoneal. The distal third of the rectum lies completely extraperitoneal. The mesorectum is a thick connective tissue and fat layer surrounding the extraperitoneal rectum and contains the neurovascular supply. Its location within the bony pelvis provides some protection, however this anatomy can make injury exposure difficult, perhaps more so in males [25]. This will also vary by gender. Males typically have a longer and more narrow pelvis that makes mobilization/exposure of the mid- to distal rectum much more difficult than in females with naturally wider pelvises. The anatomical location of injuries has come to play a major role in determining the optimal operative pathway. The significant amount of dissection required to expose the extraperitoneal rectum leads to vast management differences as compared to the proximal intraperitoneal rectum. The other key factor in the management of rectal injuries, and particularly in the operative exposure and repair, is a clear understanding of the anatomic locations and relationships of the key pelvic structures/organs that are in close proximity to the rectum. These structures include the bladder anteriorly, the sacrum and sacral venous plexus posteriorly, the iliac vessels and

ureters posterolaterally, the prostate and seminal vesicles anteriorly (in males), and the uterus/vaginal wall anteriorly in females.

Management of Intraperitoneal Rectal Injuries

A review of the literature on management specific to intraperitoneal rectal injuries reveals a paucity of reliable data on which to base definitive conclusions. As a result, this injury has historically been managed like that of a left colon injury. In instances of non-destructive injuries, commonly defined as lesions involving less than 50% of the bowel wall circumference and without major mesenteric injury or devascularization, the use of primary repair without diversion is a safe option. Multiple studies during the 1990s consisting of level I and II data demonstrated lower rates of intra-abdominal sepsis and overall complications with primary repair of colonic injuries as compared to diversion [26–28]. While these data do not apply directly to the rectum, multiple small studies [11, 29, 30] have subsequently replicated similar results in patients with intraperitoneal rectal injuries. Primary repair also avoids the added risk of forming and closure of a diverting stoma [31–33], not to mention the physical and emotional stresses that accompany a colostomy.

Any rectal perforation adjacent to, or involving, another abdominal structure should be repaired in a way to separate the two injured structures; thus decreasing the likelihood of fistula formation [34]. The key is placement of ample, viable tissue such as omentum between the injured rectum and adjacent organ [35]. If omentum is not available, then a flap of peritoneum can usually be fashioned. If primary repair is not feasible due to a destructive lesion or to multiple adjacent smaller lesions, resection with primary anastomosis is a viable option in the majority of patients. Hemodynamically unstable or tenuously stable patients receiving large volume blood transfusion, or who have severe concomitant injuries or comorbidities, many have advocated forgoing any attempt at primary repair or anastomosis and instead performing a proximal diverting colostomy (Hartmann's procedure). Although this method has been touted as the "safe" option, it has not been found to reduce the overall morbidity or mortality. Furthernore, it also carries the risks of the subsequent operation to reverse the colostomy, as well as the risk of the patient never having the colostomy reversed. Several other viable alternatives now exist that are superior to the standard fallback of the Hartmann's procedure.

The first is to perform a "damage control laparotomy" where the rectal injury is temporized with either a rapid primary repair or resection, and the abdomen is then left open to facilitate a planned second-look laparotomy. This option is ideal for the unstable patient where rapid surgery is of the essence, and the decision for reconstruction versus diversion is deferred to a time when the patient has been resuscitated and stabilized (Fig. 28.1).

The second alternative is to perform a primary anastomosis and then protect it with a proximal loop ileostomy. This intervention provides fecal diversion and theoretical "protection" of the anastomosis while it heals, mitigates the consequences of an anastomotic leak, and facilitates a much

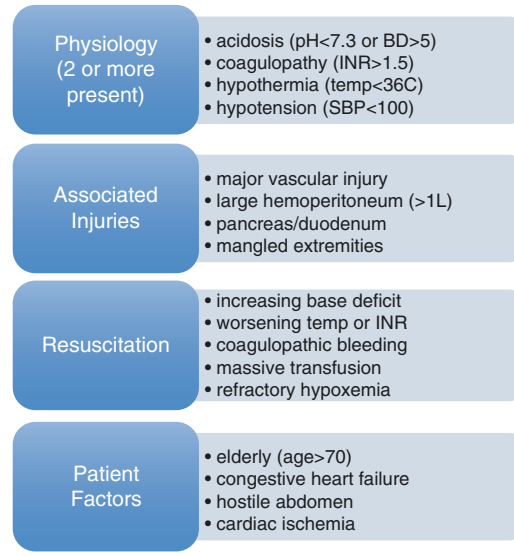


Fig. 28.1 Triggers for damage control laparotomy. With permission from [50] © 2014 Springer

easier subsequent surgery to reverse the ostomy. We believe that this option is superior to a Hartmann's procedure for the patient who is stable but is felt to be at higher risk for anastomotic breakdown (i.e. elderly, malnourished, chronic steroid use, etc.). Numerous patient, surgeon, and situational factors such as age, nutritional status, use of immunosuppressive or chemotherapeutic agents and hemodynamic status must be considered in the therapeutic algorithm. Table 28.2 outlines multiple decision points and operative points in the setting of colorectal trauma.

Table 28.2 Key intraoperative management issues and decisions in colon and intraperitoneal rectal trauma

Key decision	Factors to consider	Technical pearls
Primary repair or resection?	– Size of injury – Shape of injury (linear, round/stellate) – Single or multiple – Tissue quality – Mesentery status (rents, hematomas, devascularized segment)	– Debride injured or burned tissue – Connect close injuries rather than leaving "bridges" – Evacuate large mesenteric hematomas – Close mesenteric tears – Resect segment with "bucket-handle" mesenteric defect
Damage control?	– Patient stability – Transfusion requirement – Acid/base getting better or worse? – Multiple injuries? – Another reason for a "second-look" (i.e. borderline bowel viability)	– Make decision early in the case – Proceed if patient improving, terminate if getting worse – Vacuum-assisted temporary closure works best – Usually no need for other drains
Anastomosis or ostomy?	– Patient baseline status (age, comorbidities, meds) – Physiologic status – Quality of the tissues – Other injuries and proximity to anastomosis – Body habitus, ability to properly site an ostomy	– Consider difficulty and risk of ostomy takedown – Be wary of anastomosis with an associated pancreatic injury! – Obesity increases difficulty and complications with ostomy
Anastomosis: hand-sewn or stapled?	– Operative time – Other injuries to address – Personal experience and comfort – Tissue quality, edema – Anatomic area and bowel alignment – Available equipment	– No difference in leak or complication rates in most series – Hand-sewn potentially more secure with suboptimal tissue quality, bowel wall edema – Laparoscopic staplers great for pelvis, hard-to-reach areas or sharp angles
Ostomy: loop, end, other?	– High risk anastomosis that needs protection? – Need access to distal bowel segment? – Body habitus – Mesentery—shortened, edematous	– Loop or end-loop may reach the skin easier with obesity or shortened mesentery. – May not get complete fecal diversion with a loop – Use an ostomy bar if any tension or obese patient – Wrap ostomy in Seprafilm© (Sanofi-Aventis, Cambridge, MA) for easier takedown
Leave a drain?	– No indication for routine drainage of bowel anastomoses – Widely drain any other adjacent injuries (pancreas, bladder, etc.) – Other reasons: associated abscess cavity, control ascites in cirrhotic patient	– Avoid direct contact of drain with anastomosis – Larger sump drains usually not beneficial – Make exit site remote from incision and any ostomy
Place a feeding tube?	– Degree of bowel injuries and surgery – Estimated need for prolonged NPO status – Estimated inability to take oral nutrition – Need for feeding access as well as gastric decompression? – Pancreatic or duodenal injury?	– Generally avoid making additional holes in bowel in the trauma setting – Stamm gastrostomy relatively safe and secure – Higher complications with jejunostomy tubes with little benefit – Consider intraoperative placement of nasojejunal tube

With permission from [50] © 2014 Springer

Management of Extraperitoneal Rectal Injuries

As mentioned above, experiences during the Vietnam War resulted in a shift in operative management that has since dictated treatment algorithms [36]. This experience led to the wide promulgation of the "4 D's" of rectal injury management: Divert, Drain, Direct repair, and Distal washout. The use of this paradigm of performing a proximal diverting colostomy, placing a presacral drain, exploring and directly repairing the injury, and performing a distal rectal washout as the standard treatment for all extraperitoneal rectal injuries has been repeatedly questioned during the last two decades. Performing all four of these components is almost never truly required or indicated. Arguably the most important of these for treating the true full-thickness rectal injury is proximal diversion, and often this maneuver alone will suffice. The remaining three procedures each have specific scenarios in which they may provide added benefit, and thus should continue to be utilized, albeit on a highly selective basis.

The use of fecal diversion with a proximal colostomy remains the mainstay treatment for an extraperitoneal rectal injury. Whether an end colostomy or a loop colostomy is performed depends on injury extent, the associated injuries, the operative approach, the patient's body habitus, colon mobility, and surgeon preference. For destructive rectal injuries, a Hartmann's resection with end colostomy has been the time-honored procedure of choice. However, as with intraperitoneal rectal injuries, there is no convincing evidence that this is the superior alternative or provides better protection than a proximal loop colostomy. In addition, the reversal of an end descending or sigmoid colostomy, particularly following a major traumatic rectal injury, can be a major undertaking with higher risks than even the original operation. The majority of extraperitoneal rectal injuries can safely be treated with diverting loop colostomy alone, which has been shown to provide complete fecal diversion and avoids the added risks of complicated takedown procedures for an end colostomy [35, 37]. Although these stomas were performed via laparotomy, there is now an increasing body of experience with performing a simple laparoscopic colostomy (end or loop). Laparoscopic stoma creation is an ideal option for scenarios where there is no other indication for a laparotomy, or where there are associated abdominal injuries that are also amenable to laparoscopic exploration and repair. Laparoscopy can also be a highly useful diagnostic adjunct in cases where there are equivocal imaging or endoscopy findings, and can evaluate the intraperitoneal rectum and the extraperitoneal mesorectum for any signs of full thickness injury (i.e. hematoma, bleeding, fecal soilage).

The direct repair of extraperitoneal injuries, in general, is best performed only when easily accessible without significant tissue dissection, or when the injury is encountered during the exposure of an associated injury [25]. The typical injuries amenable to direct repair include injuries to the proximal extraperitoneal rectum that can be easily exposed and repaired via abdominal mobilization, and injuries to the distal rectum that can per repaired via a transanal exposure. As with intraperitoneal injuries, if a perforation is encountered near or involves an adjacent structure, repair of the perforations and placement of viable omentum or other vascularized tissue between the injuries should be performed to prevent fistulae formation. This precaution is particularly important in females to help avoid rectovaginal fistulae. Success has been demonstrated with primary repair of extraperitoneal injuries alone without diversion in selected patients, especially if dissection is not extensive [11, 12, 29]. A transanal approach can offer access to the injury and has been shown to provide adequate repair without the need for diverting colostomy in selected patients [11]. In general, proximal diversion should still be performed even if direct repair was accomplished in patients with large or complex injuries, with significant surrounding soft tissue defects or cavities, or for combined injuries to surrounding structures.

Once lauded for its improvement in mortality rates, presacral drainage has lost significant sup-

port after the publication of a 1998 American Association for the Surgery of Trauma prospective, randomized trial [38] that demonstrated no difference in pelvic sepsis between those who received the extra procedure and those who did not. Albeit a small study of only 48 patients, it represented the first Level 1 data on rectal injuries and has led to a further decline in its use. It should be noted that all of the patients in the study were treated with diversion regardless of the use of closed-suction presacral drains. Still, some advocate for the use of a presacral drainage for those inaccessible injuries that cannot be repaired, in addition to diversion [29, 35, 39]. Such a drain is placed by making a curved, transverse incision posterior to the anus and bluntly dissecting the presacral space to the level of the rectal injury (Fig. 28.2). It is imperative to place the drains anterior to the presacral fascia (Waldeyer's fascia); a characteristically tough membrane that commonly requires incision with a sharp instrument in order to traverse. A misplaced drain, which is not uncommon due to the difficulty of this dissection, is rendered ineffective. The use of coccygectomy to widen the area of drainage is not supported due to the potential for osteomyelitis.

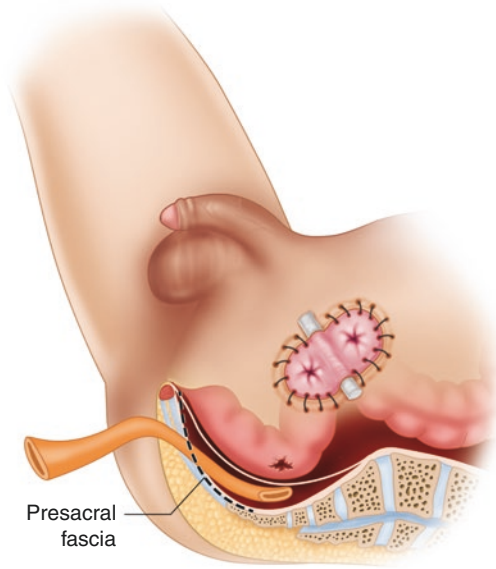


Fig. 28.2 Placement of drains in the presacral space, anterior to Waldeyer's fascia, up to the level of the rectal injury. © Baylor College of Medicine 1988 [40]

Drains should be placed near the rectal injury, avoiding direct contact with any suture or staple lines. Both Penrose and closed-suction drains have been used successfully and are removed once drainage becomes serous and low in volume [40]. Presacral drain placement should also be considered for any large posterior rectal defects, for significant fecal soilage of the presacral space, or for injuries that have created a significant cavity in the presacral space due to hematoma or soft tissue loss. For all others there appears to be little to no benefit of placing a presacral drain, and there are concerns for iatrogenic injuries during drain placement or contaminating the presacral space if it had not already been violated.

The use of distal rectal washout was also introduced after the Vietnam War and has since seen fluctuations in support and utilization. Supporters claim the removal of remaining stool in the defunctioned rectal vault will decrease the risk for sepsis, especially with a potentially open rectal wound. Those opposed to this view hypothesize that the forceful irrigation of liquid into the rectal vault will push bacteria and fecal material into otherwise unaffected or minimally contaminated tissues. Many of the studies reporting on the value of rectal washout, positive or negative, are clouded by the varied coexistent use of fecal diversion and presacral drainage. Therefore, the ability to draw conclusions on this practice is limited and the authors of this chapter do not routinely employ it in the setting of rectal trauma. In select situations where there is a large volume of retained stool in the rectal vault, and the injury has been controlled or excluded from the area of the washout, then a distal washout can be performed. Another less common scenario would be in the setting of a rectal resection and primary anastomosis in the face of a significant volume of retained stool in the rectum. This method can help facilitate the anastomosis and also theoretically decrease the chance of an anastomotic complication due to distal fecal impaction/obstruction. Distal washout can be performed antegrade from the abdominal cavity or through the distal limb of a loop colostomy, or retrograde via a catheter inserted from the perineum.

The Eastern Association for the Surgery of Trauma (EAST) recently released a set of practice

guidelines for the management of nondestructive, penetrating injuries to the extraperitoneal rectum (Table 28.3). It should be mentioned that the conditional recommendations *for* proximal diversion and *against* presacral drainage and rectal washout are based on evidence graded as "very low" by the authoring committee [41]. Any of these interventions may be indicated in specific scenarios and tailored to the extent of injury at the discretion of the operating surgeon.

The authors of this chapter use the following algorithm (Fig. 28.1) for extraperitoneal rectal injuries based on the above reviewed literature. If the injury is limited and easily accessible, either through transanal or abdominal exposures with minimal dissection, then primary repair with or without loop colostomy diversion should be performed. Destructive or inaccessible injuries should be diverted with loop colostomy. In rare cases when a formal rectal resection is deemed necessary, then either a primary anastomosis with a proximal diverting loop ileostomy, or resection with an end colostomy (Hartmann's procedure) is performed based on patient and injury factors. Distal rectal washout and presacral drainage are not routinely performed, but should be reserved for those select indications described above where they may confer some additional benefit.

Retained Rectal Foreign Bodies

The insertion of a foreign body into the rectum typically presents to the hospital as a retained object. Less commonly, an actual rectal injury has occurred. Often, these patients attempt removal or passage of the foreign body at home, causing them to present hours to days after the inciting event. As a result of their delay, these patients can present quite sick. Supine and upright abdominal radiographs should be obtained to define the characteristics and location of the object, as well to look for pneumoperitoneum. Small objects will likely naturally pass and passage can be facilitated with an enema or cathartics. The vast majority of foreign bodies can be removed at bedside in the emergency department [42]. A retractor or speculum device should be inserted into the anus and the foreign body grasped if easily visualized. Blindly grasping for the object is not suggested, as this maneuver can cause further mucosal damage. Once the object is firmly grasped, a suction effect may be encountered that prevents easy withdrawal. Suction can be diminished with the use of a Foley catheter placed beyond the object and air instilled through the catheter lumen to break the suction. The inflated Foley balloon may also assist in the extraction. If the patient presents with peritonitis, laparotomy is indicated. A stable patient without peritonitis, from whom the object cannot be retrieved at bedside should be taken to the operating room for transanal extraction under conscious sedation. A foreign body located in the sigmoid colon is predictive for operative intervention [42]. If this technique is unsuccessful, then laparotomy should be performed to milk the object distally so that it can be transanally retrieved. In some instances, a colotomy may be required to remove the object. Foreign bodies that are in danger of causing mucosal injury during extraction, such as fragile glass items that may break while

Table 28.3 Summary of recommendations from the 2016 EAST Practice Management Guideline on Penetrating Extraperitoneal Rectal Injuries [41]

PICO question	Recommendation	Number of studies	Quality of evidence
1. Should proximal diversion be performed versus primary repair without diversion?[a]	Conditional recommendation FOR proximal diversion	14	Very low
2. Should presacral drainage be performed?[a]	Conditional recommendation AGAINST presacral drainage	17	Very low
3. Should distal rectal washout be performed?[a]	Conditional recommendation AGAINST distal rectal washout	13	Very low

[a]All recommendations are based on the scenario of a non-destructive penetrating extraperitoneal rectal injury; PICO = methodology considering the population, intervention, comparator, and outcome

inside the rectum, may warrant laparotomy with colotomy earlier in the algorithm for safe removal. The use of a flexible sigmoidoscope with a snare or basket may be beneficial to retrieve smaller objects that are out of reach from manual extraction. Once the object is successfully removed, proctoscopy or flexible sigmoidoscopy should be performed to evaluate the mucosa. Often mucosal examination will show excoriations or small mucosal tears that will heal without intervention. Should a full thickness injury be found, carry on with one of the algorithms described above.

Anal Trauma

Non-obstetric trauma to the anus or sphincter complex is a decidedly rare diagnosis [22, 43]. Injury may occur via penetrating or blunt trauma and result in separation of the anus from surrounding tissues or extension of injury from the perineum into the anus and involve the sphincter musculature [44]. In contrast to the colon and rectum, examination of the literature yields a relative void of information on the treatment of non-obstetric trauma to the anus and sphincter complex. Much of the data focus on the results of late sphincter repair in patients with resultant fecal incontinence [45, 46]. With the onset of the recent wars in Iraq and Afghanistan, an increase has been seen in wartime perineal and pelvic wounds due to improvised explosive devices (IEDs) [47]. Using the Department of Defense Trauma Registry, Glascow et al. [43] identified a 0.1% prevalence of wartime anal trauma, with the vast majority occurring due to blast injuries (76%) and gunshot wounds (24%). However, these injuries were typically seen in conjunction with massive destructive injuries to the perineum, mangled or amputated extremities, and concomitant truncal trauma that is uncommonly seen in the civilian setting. In the majority of civilian trauma settings, trauma to the anus and anal sphincter complex is typically seen with penetrating injuries to the perineum, blunt straddle or impalement injuries, or in association with complex open pelvic fractures. Additionally, anal trauma can come in the form of sexual assault, autoeroticism ("fist fornication", insertion of myriad objects that fit in the rectum), and iatrogenic injuries (enema use, thermometer insertion). Unlike rectal injuries, which can have subtle external signs and be easily missed, the majority of significant anal injuries are readily apparent both by symptoms and on physical exam. In addition, they rarely require any evaluation beyond a careful history and physical exam to guide the initial diagnosis and plan of care.

A careful understanding of the anal canal anatomy and its surrounding muscles is necessary to identify and potentially treat injuries to this complex region (Fig. 28.3). The anal canal begins proximally at the levator ani muscles and extends to the anal verge for a total length of about 4 cm. The canal is surrounded by two circular layers of strong musculature that can be envisioned as two concentric muscular tubes. The inner tube is a continuation of the circular, smooth muscle layer of the rectum and becomes the internal anal sphincter, which is under tonic contraction via autonomic innervation to act as a constant barrier to involuntary loss of stool and gas [48]. The outer tube is made of striated, skeletal muscle under voluntary control. This funnel-shaped external muscle consists of the levator ani and puborectalis muscles proximal and the external anal sphincter distally, ending slightly distal to the internal sphincter. The external anal sphincter has been described as having three portions (deep, superficial, and subcutaneous), though this distinction has been questioned and it is probably best to think of it as a single sheet of muscle. The external sphincter bolsters the resting tone of the internal sphincter through both voluntary and reflex mechanisms, while also having a component of resting tone through spinal reflex arcs. While physiologically strong, these muscle layers are quite thin at 2–3 mm and 6 mm for the internal and external sphincters, respectively [48]. This demonstrates how anal and perineal trauma can have a significant effect on fecal continence; and how difficult it can be to make sense of the anatomy after an injury.

Literature on the acute management for anal trauma is relatively sparse, though basic princi-

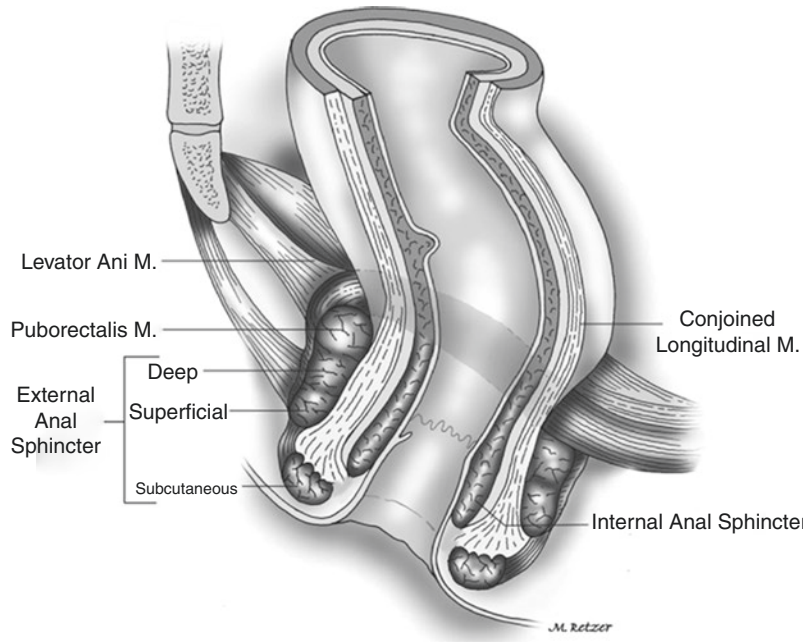


Fig. 28.3 Anal canal anatomy and its surrounding muscles. With permission from [48] © 2011 Springer

ples exist. The perineum and anus should be thoroughly evaluated as soon after presentation as possible. After the primary trauma survey is completed, bedside evaluation can be performed by inspecting and palpating the perineum and grossly assessing sphincter function with DRE and asking the patient to squeeze down on your finger. Females should undergo vaginal exam as well. As mentioned earlier, anal trauma is typically identified quickly on secondary survey and prompts an evaluation in the operating room. Careful examination of the wound should determine which sphincter muscles are involved, whether the injury is a laceration through the muscle or represents actual tissue loss, and gentle proctoscopy performed to evaluate both the anal canal and look for associated rectal injury. Minor injuries to the anal canal can be treated with transanal debridement back to healthy tissue and primary suture repair with absorbable suture. Early debridement of non-viable soft tissues is paramount to prevent infection and pelvic sepsis, though care must be taken to minimize muscular debridement to preserve the anal sphincter mechanism. Primary repair/approximation of the internal and external sphincters with absorbable suture can be performed acutely for simple

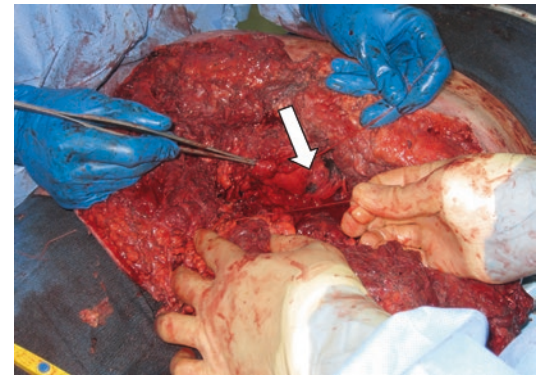


Fig. 28.4 Massive perineal blast wound with destruction of the sphincter complex and exposed distal rectum (arrow). These patients warrant immediate operative intervention to prevent exsanguination, perform debridement, and in this case perform diverting colostomy. With permission from [50] © 2014 Springer

lacerations in otherwise uninjured and hemodynamically stable patients [49], and fecal diversion may not be necessary in such patients [22].

Significant perineal injuries often present from motor vehicle and motorcycle collisions or auto-pedestrian incidents and can result in the significant loss of tissue and complex wounds (Fig. 28.4). For large or complex perineal wounds, immediate operative debridement and

prevention of exsanguination is mandatory. In the trauma bay, the wound should be rapidly packed and wrapped with elastic gauze for compression to stem blood loss on the way to the operating room [50]. The sphincter complex and anal canal are examined as before, but in this circumstance management of the anal trauma is clearly secondary to resuscitation and repair of life-threatening injuries. The cut ends of sphincter muscle should be tagged with suture and any non-viable tissue removed, with the plan for repeat visits to the operating room for serial debridement of surrounding soft tissue as it declares viability. A colostomy should be performed early in the surgical management of the patient if the perineal injury is devastating or there is concomitant involvement of the rectum [17, 22, 43]. Once the patient has been resuscitated and viable tissue remains, the sphincter injury should be readdressed. If the musculature can be approximated, repair should be performed as best possible with absorbable suture. If the anal sphincter complex has been destroyed or is unable to be approximated, diversion allows maintenance of a clean wound for healing. Surrounding perineal soft tissue wounds may require negative pressure vacuum-assisted closure or grafting.

Subsequent evaluation of the sphincter muscles in the outpatient setting will dictate further therapy, if necessary. An easy and early test of continence is the use of an enema challenge. If the patient can retain a 100 mL saline enema, further surgical or physical therapy treatment is unlikely to provide added benefit [51]. To determine whether a patient has a resultant sphincter defect contributing to their incontinence, anal endosonography can be performed and has been found to have the highest sensitivity over other modalities. Endoanal-coil magnetic resonance imaging (MRI) allows a comparable detection of defects to endoanal ultrasound, but is superior in distinction of between muscle fibers and fibrous tissue. Anorectal manometry is used to determine the patient's basal and squeeze pressures, though its prediction of incontinence or improvement has been debated and is beyond the scope of this chapter. The use of pelvic floor physical therapy with sphincter exercises and biofeedback can improve tone and squeeze mechanics with resultant improvement of continence of feces and flatus in the setting of minor traumatic sphincter injuries [43, 49, 52]. The presence of a small sphincter defect and continued fecal incontinence despite sphincter exercises may warrant overlapping sphincteroplasty or sacral neurmodulation [53]. Muscle transpositions or interpositions may be subsequently indicated for patients with significant sphincter complex loss. Some of these patients, especially those individuals with poorly or non-functioning sphincter complexes, may be best served with a permanent colostomy.

References

1. The holy bible. New international version. Grand Rapids: Zondervan Publishing House; 1993.
2. Perry BW, Brooks JP, Muskat PC. The history of military colorectal trauma management. Sem Colon Rectal Surg. 2004;15(2):70–9.
3. Welling DR, Duncan JE. Stomas and Trauma. Clin Colon Rectal Surg. 2008;21(1):45–52.
4. Imes PR. War surgery of the abdomen. Surg Gynecol Obstet. 1945;81:608–16.
5. Stone HH, Fabian TC. Management of perforating colon trauma: randomization between primary closure and exteriorization. Ann Surg. 1979;190:430–6.
6. Strada G, Raad L, Belloni G, Carraro P. Large bowel perforations in war surgery: one-stage treatment in a field hospital. Int J Color Dis. 1993;8:213–6.
7. George SM Jr, Fabian TC, Voeller GR, Kudsk KA, Mangiante EC, Britt LG. Primary repair of colon wounds: a prospective trial in nonselected patients. Ann Surg. 1989;209:728–34.
8. Velmahos GC, Gomez H, Falabella A, Demetriades D. Operative management of civilian rectal gunshot wounds: simpler is better. World J Surg. 2000;24(1):114–8.
9. Williams MD, Watts D, Fakhry S. Colon injury after blunt abdominal trauma: results of the EAST Multi-Institutional Hollow Viscous Injury Study. J Trauma. 2003;55:906–12.
10. Steele SR, Maykel JA, Johnson EK. Traumatic injury of the colon and rectum: the evidence vs dogma. Dis Colon Rectum. 2011;54(9):1184–201.
11. Levine JH, Longo WE, Pruitt C, Mazuski JE, Shapiro MJ, Durham RM. Management of selected rectal injuries by primary repair. Am J Surg. 1996;172(5):575–9.
12. Thomas DD, Levison MA, Dykstra BJ, Bender JS. Management of rectal injuries. Dogma versus practice. Am Surg. 1990;56(8):507–10.
13. Cho SD, Kiraly LN, Flaherty SF, Herzig DO, Lu KC, Schreiber MA. Management of colonic injuries in the combat theater. Dis Colon Rectum. 2010;53:728–34.

14. Shlamovitz GZ, Mower WR, Bergman J, et al. Poor test characteristics for the digital rectal examination in trauma patients. Ann Emerg Med. 2007;50:25–33.
15. Porter JM, Ursic CM. Digital rectal examination for trauma: does every patient need one? Am Surg. 2001;67:438–41.
16. Esposito TJ, Ingraham A, Luchette FA. Reasons to omit digital rectal exam in trauma patients: no fingers, no rectum, no useful additional information. J Trauma. 2005;59:1314–9.
17. Herzig DO. Care of the Patient with Anorectal Trauma. Clin Colon Rectal Surg. 2012;25:210–3.
18. Anderson SW, Soto JA. Anorectal trauma: the use of computed tomography scan in diagnosis. Semin Ultrasound CT MR. 2008;29(6):472–82.
19. Shanmuganathan K, Mirvis SE, Chiu WC, Killeen KL, Hogan GJ, Scalea TM. Penetrating torso trauma: triple-contrast helical CT in peritoneal violation and organ injury—a prospective study in 200 patients. Radiology. 2004;231:775–84.
20. Arthurs Z, Kjorstad R, Mullenix P, Rush RM Jr, Sebesta J, Beekley A. The use of damage-control principles for penetrating pelvic battlefield trauma. Am J Surg. 2006;191:604–9.
21. Pereira BM, Reis LO, Calderan TR, de Campos CC, Fraga GP. Penetrating bladder trauma: a high risk factor for associated rectal injury. Adv Urol. 2014;2014:386280.
22. Russell KW, Soukup ES, Metzger RR, Zobell S, Scaife ER, Barnhart DC, Rollins MD. Fecal continence following complex anorectal trauma in children. J Pediatr Surg. 2014;49:349.
23. Aihara R, Blansfield JS, Millham FH, LaMorte WW, Hirsch EF. Fracture locations influence the likelihood of rectal and lower urinary tract injuries in patients sustaining pelvic fractures. J Trauma. 2002;52(2):205–8. discussion 208-9
24. Moore EE, Cogbill TH, Malangoni M, Jurkovich GJ. Scaling system for organ specific injuries. Available at: http://www.aast.org/library/traumatools/injuryscoringscales.aspx. Accessed 22 Feb 2016.
25. Hoyt DB, Lekawa ME. Trauma of the colon and rectum. In: Beck DE, Roberts PL, Saclarides TJ, Senagore AJ, Stamos MJ, Wexner SD, editors. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2007.
26. Chappuis CW, Frey DJ, Dietzen CD, Panetta TP, Buechter KJ, Cohn I Jr. Management of penetrating colon injuries. A prospective randomized trial. Ann Surg. 1991;213:492–8.
27. Gonzalez RP, Merlotti GJ, Holevar MR. Colostomy in penetrating colon injury: is it necessary? J Trauma. 1996;41:271.
28. Sasaki LS, Allaben RD, Golwala R, Mittal VK. Primary repair of colon injuries: a prospective randomized study. J Trauma. 1995;39:895.
29. McGrath V, Fabian TC, Croce MA, Minard G, Pritchard FE. Rectal trauma: management based on anatomic distinctions. Am Surg. 1998;64:1136.
30. Maxwell RA, Fabian TC. Current management of colon trauma. World J Surg. 2003;27:632–9.
31. Berne JD, Velmahos GC, Chan LS, Asensio JA, Demetriades D. The high morbidity of colostomy closure after trauma: further support for the primary repair of colon injuries. Surgery. 1998;123:157–64.
32. Demetriades D, Pezikis A, Mellssas J, Parekh D, Pickles G. Factors influencing the morbidity of colostomy closure. Am J Surg. 1988;155:594–6.
33. Park JJ, Pino AD, Orsay CP, Nelson RL, Pearl RK, Cintron JR, Abcarian H. Stoma complications: the Cook County Hospital experience. Dis Colon Rectum. 1999;42:1575–80.
34. Franko ER, Ivatury RR, Schwalb DM. Combined penetrating rectal and genitourinary injuries: a challenge in management. J Trauma. 1993;34:347.
35. Burch JM, Feliciano DV, Mattox KL. Colostomy and drainage for civilian rectal injuries: is that all? Ann Surg. 1989;209:600–11.
36. Lavenson GS, Cohen A. Management of rectal injuries. Am J Surg. 1971;122:226–30.
37. Rombeau JL, Wilk PJ, Turnbull J, R B, Fazio VW. Total fecal diversion by the temporary skin-level loop transverse colostomy. Dis Colon Rectum. 1978;21:223–6.
38. Gonzalez RP, Falimirski ME, Holevar MR. The role of presacral drainage in the management of penetrating rectal injuries. J Trauma. 1998;45:656.
39. Weinberg JA, Fabian TC, Magnotti LJ, et al. Penetrating rectal trauma: management by anatomic distinction improves outcome. J Trauma. 2006;60:508–14.
40. Burch JM. Injury to the colon and rectum. In: Feliciano DV, Moore EE, Mattox KL, editors. Trauma. 3rd ed. Stamford: Appleton and Lange; 1996.
41. Bosarge PL, Como JJ, Fox N, Falck-Ytter Y, Haut ER, Dorion HA, Patel NJ, Rushing A, Raff LA, McDonald AA, Robinson BRH, McGwin GJ, Gonzalez RP. Management of penetrating extraperitoneal rectal injuries: An Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg. 2016;80(3):546–51.
42. Lake JP, Essani R, Petrone P, Kaiser AM, Asensio J, Beart RW Jr. Management of retained colorectal foreign bodies: predictors of operative intervention. Dis Colon Rectum. 2004;47:1694–8.
43. Glasgow SC, Heafner TA, Watson JDB, Aden JK, Perry WB. Initial management and outcome of modern battlefield anal trauma. Dis Colon Rectum. 2014;57:1012–8.
44. Haas PA, Fox TA Jr. Civilian injuries of the rectum and anus. Dis Colon Rectum. 1979;22:17–23.
45. Engel AF, Kamm MA, Hawley PR. Civilian and war injuries of the perineum and anal sphincters. Br J Surg. 1994;81:1069–73.
46. Madiba TE, Moodley MM. Anal sphincter reconstruction for incontinence due to non-obstetric sphincter damage. East Afr Med J. 2003;80:585–8.
47. Mossadegh S, Tai N, Midwinter M, Parker P. Improvised explosive device related pelvi-perineal

trauma: anatomic injuries and surgical management. J Trauma Acute Care Surg. 2012;73(2 suppl 1):S24–31.
48. Jorge JMN, Habr-Gama A. Anatomy and embryology. In: Beck DE, Roberts PL, Saclarides TJ, Senagore AJ, Stamos MJ, Wexner SD, editors. The ASCRS textbook of colon and rectal surgery. 2nd ed. New York: Springer; 2011.
49. Critchlow JF, Houlihan MJ, Landolt CC, Weinstein ME. Primary sphincter repair in anorectal trauma. Dis Colon Rectum. 1985;28(12):945–7.
50. Martin MJ, Brown CVR. Colon and rectal trauma. In: Steele SR, Champagne BJ, Maykel JA, Orangio GR, editors. Complexities in colorectal surgery. New York: Springer; 2014.
51. Gordon PH, Schouten WR. Fecal incontinence. In: Gordon PH, Nivatvongs S, editors. Principles and practice of surgery for the colon rectum and anus. 3rd ed. New York: Informa Healthcare; 2007.
52. McCune WS. War wounds of the rectum and anal sphincter. Surgery. 1948;23:653–64.
53. Barisic G, Krivokapic Z, Markovic V, Popovic M, Saranovic D, Marsavelska A. The role of overlapping sphincteroplasty in traumatic fecal incontinence. Acta Chir Iugosl. 2000;47(4 suppl 1):37–41.

29 Ulcerative Proctitis and Anorectal Crohn's Disease

Colin B. Peirce and Matthew F. Kalady

Abbreviations

UP	Ulcerative proctitis
UC	Ulcerative colitis
IBD	Inflammatory bowel disease
TNF	Tumor necrosis factor
5-ASA	5-Aminosalicylate
BDP	Beclomethasone dipropionate
EGF	Epithelial growth factor
SNS	Sacral nerve stimulation
CD	Crohn's disease
HS	Hidradenitis suppuritiva
EUA	Examination under anesthesia
MRI	Magnetic resonance imaging
AZA	Azathioprine
6-MP	6-Mercaptopurine

Ulcerative Proctitis

Definition

Proctitis is defined as macroscopic or microscopic inflammation of the rectal mucosa, and is characterized as a persistent or relapsing rectal inflammatory process. The anatomic extent of what is termed proctitis varies in the literature: some authors describe it as inflammation within 12 cm of the anal verge [1] while others classify it as extending anywhere between 5 and 25 cm from the anal verge [2, 3]. Ulcerative proctitis (UP) is a subset of ulcerative colitis (UC). UP is classified based on location of disease as per the Montreal classification with UP defined as distal to the rectosigmoid junction [4].

Etiology

The precise cause of UP remains unknown, as is the case with all subtypes of UC. The most popular current understanding is that affected patients are genetically susceptible. This genetic predisposition appears to result in dysregulation of the rectal mucosal response to an alteration in commensal gut flora, or dysbiosis, with subsequent development of chronic inflammation [5, 6]. There are a number of documented genetic factors implicated in the etiology of UC; e.g. genes implicated in mucosal barrier function [ECM1, CDH1, HNF4α and laminin B1), and E-cadherin was the first documented genetic correlation between UC and colorectal cancer [7]. Family history seems to be a predisposing risk factor for UP, as it does in patients with proximally located UC. Environmental factors may be causative or

C. B. Peirce
Department of Surgery, University of Limerick Hospitals Group, Limerick, Ireland
e-mail: colinpeirce@rcsi.ie

M. F. Kalady (✉)
Department of Colorectal Surgery, Digestive Disease and Surgery Institute, Cleveland Clinic, Cleveland, OH, USA
e-mail: kaladym@ccf.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_29

protective. Diet, hydrogen sulfate, estrogen, gastrointestinal infection [8, 9], and non-steroidal anti-inflammatory drugs [10] are implicated as causative agents. A Japanese study reported that combined consumption of Western foods (e.g. bread, butter, margarine, cheese, pork) was significantly associated with development of UC compared with consumption of a traditional Japanese diet [11]. A recent review has also highlighted red meat as a possible etiological factor [12]. Tobacco smoking [13] and prior appendectomy are thought to be protective [14]. Vascular factors such as angiogenesis and lymphogenesis are also thought to play a significant role.

Recent evidence strongly suggests that changes in both innate and adaptive immune responses influence UP pathogenesis. Hart and colleagues have demonstrated a heightened innate immune response in inflammatory bowel disease (IBD) patients characterized by an increased number of both activated and mature dendritic cells [15]. These cells lead to increased production of proinflammatory cytokines such as tumor necrosis factor-α (TNF-α), interleukin-1β, and interleukin-6. UC patients have also been shown to have an increase in immunoglobulin levels (IgM, IgA and IgG) [16] as well as an atypical T-helper 2 cell response identified by the presence of IL-13 secreting natural killer T-cells in the lamina propria of affected specimens [17].

Epidemiology

In recent years, there has been a global increase in the number of documented cases of UC. This increased incidence reflects increases in Latin America [18] and Asia [19] as the incidence in Western Europe [20] and North America [21] has remained static or even decreased. The prevalence remains higher in developed compared to developing countries. Affected individuals have a mortality rate similar to or just slightly increased compared to the general population 2 years following diagnosis, but some authors have reported a mortality hazard ratio of 2.43 within the first year following diagnosis [22].

Traditionally, 2 incidence peaks have been reported—between 30 and 40 years of age and between 60 and 70 years of age. The majority of patients fall within the 30–40 age group at diagnosis [23, 24]. A recent study from the United States has demonstrated a dramatic increase in the number of hospitalizations in pediatric patients with UC between the years 2000 and 2009 [25]. Most studies report an equal sex distribution of disease [23, 26], often with a slight male predominance. Betteridge and colleagues recently reported on 35,404 cases of IBD with a female predominance in UC patients and a relative risk of 1.35 [27]. It is difficult to know the percentage of patients with UC who present with UP alone, but a Dutch prospective epidemiological study reported an incidence of 10 cases per 100,000 inhabitants for UC, 23% of whom presented with UP [28].

Presenting Symptoms

The predominant and most commonly reported symptom of UP is bright red bleeding per anus, which can be of high volume and frequency. The passing of mucus per rectum, rectal urgency, diarrhea, abdominal pain, and tenesmus may also occur. Some patients may surprisingly report constipation. Historically, disease severity has been classified as mild, moderate, severe, or fulminant [29, 30]. Akin to all forms of IBD, extraintestinal manifestations may occur (ocular, rheumatologic, dermatologic, and calculus disease of renal tract and gallbladder) but are less common than when a formal diagnosis of more extensive UC or Crohn's proctocolitis is made. The clinical course of UP is hallmarked by periods of remission intertwined with acute exacerbations; i.e. remission-relapse cycles. Remissions occur either spontaneously or in response to changes in treatment or concurrent illness [31].

Differential Diagnosis

Many conditions that cause persistent inflammation of the rectum can present as chronic proctitis and produce symptoms of bloody diarrhea, urgency, and tenesmus and thus can readily mimic UP. Although many forms of proctitis

share similar clinical presentations and adversely affect patient quality of life and health, it is important to differentiate these diseases from UP as the etiology, natural history, and treatment often differ.

The most common forms of chronic proctitis (other than UP) encountered in the clinical setting are radiation proctitis, diversion proctitis, and infectious proctitis [32–35]. Usually, these can be distinguished based on clinical history. Chronic radiation proctitis, or radiation injury to the rectum, occurs after radiation exposure to the rectum causes cellular toxicity and rectal mucosal injury [36, 37]. Injury in the acute phase is limited, often resolves soon after cessation of radiotherapy, and is a result of acute inflammatory injury to mucosal cells. The natural history of chronic radiation injury, however, follows a mechanism characterized by obliterative endarteritis with resultant ischemia and fibrosis, the severity of which likely relates to dosage and route of delivery. Months to years may pass after completion of radiotherapy before symptoms occur [38, 39].

Diversion proctitis arises in out-of-circuit rectal mucosa that has been excluded from the fecal stream. Although the incidence and endoscopic findings of rectal inflammation are thought to be universal [40–42], fewer than 50% of patients note clinical symptoms of proctitis [43, 44]. The etiology of diversion proctitis is not clear, but thought to be related to deficiency of nutritional factors normally absorbed on the luminal surface of the intestine [43]. As such, symptoms, as well as endoscopic findings of diffuse edema, granularity, and friability, usually resolve after restoration of intestinal continuity. Notably, air insufflation may stimulate or worsen rectal bleeding. Pathologic evaluation with biopsy is warranted, and severity is more dependent on the condition of the rectum prior to fecal diversion rather than length of rectal exclusion.

Infectious proctitis presents as anal pain and discharge in a patient exhibiting symptoms of an associated sexually transmitted infection. The most commonly involved organisms include *Neisseria gonorrhoea*, *Chlamydia trachomatis*, *Treponema pallidum*, and *Herpes simplex*. An astute clinician must be prepared to study the patient for other sexually transmitted diseases. Herpetic proctitis can produce significantly painful rectal burning and tenesmus, sometimes coupled with constipation and urinary retention. Anoscopy reveals confluent rectal ulceration. Patients with gonococcal and chlamydial proctitis may exhibit anoscopic findings similar to UP, with friable and ulcerated rectal mucosa with purulent exudate. Serologic testing for *Lymphogranuloma venereum* and cultures sensitive for chlamydia are diagnostic. Similarly, syphilis may manifest as proctitis with associated rectal ulcers and friable mucosa, and serologic testing for syphilis is recommended in cases of diagnostic doubt.

There have been reports of other conditions mimicking ulcerative proctitis: psoriatic colitis [45], hydrogen peroxide exposure [46] and symptoms caused by larvae of the drone fly Eristalis tenax [47].

Diagnostic Evaluation

The cornerstones of diagnosis include a detailed history, endoscopy (proctoscopy), and pathological analysis of biopsy specimens taken at endoscopy. The history should include the presenting symptoms, prior radiation exposure, prior colorectal surgery and a diverted rectum. At endoscopy, UP appears as diffuse inflammation with edema, erythema, exudate, granularity, friability and ulceration. An example is shown in Fig. 29.1. These findings usually commence at the anal verge and extend proximally where there is a clear demarcation at the level of the rectosigmoid junction [48], but it must be noted these are also present in both radiation and diversion proctitis. Inflammatory polyps may be seen and although not pathognomic, these are not usually a feature of the other 2 main proctitides. Histological analysis may show acute and chronic inflammatory changes, mucin depletion, erosion, cryptitis, ulceration, crypt distortion, and Paneth cell metaplasia (Fig. 29.2). Again, these findings are not exclusive to UP. A more specific, but not unique, histologic feature is the presence of prominent basal lymphoplasmacytosis.

Radiological investigations are of limited value and the role of barium enema is now all but negligible. Similarly, serological markers (e.g. p-ANCA and ASCA) are not particularly useful due to low sensitivity and specificity for the disease [49].

Natural History of the Disease

As described above, UP is one of the 3 subtypes of UC based on the limit of disease extension. There have been several studies from Western populations [50, 51] and more recently from Eastern populations [52, 53], which focus on the natural history and progression of the disease. Uniformly, these studies clearly demonstrate that a significant percentage of patients with proctitis will develop disease extension in the years following initial diagnosis.

Farmer and colleagues from the Cleveland Clinic studied 516 patients with a diagnosis of proctitis between 1960 and 1983 [50]. Of these patients, 72 (13.9%) underwent surgery with over half of the operations performed due to disease intractability or chronicity. The mean follow up was 12.7 years with data available for 318 patients, of whom 45.9% demonstrated disease progression. Risk factors identified for disease progression included both early age at diagnosis and joint symptoms. A United Kingdom based study reviewed 145 patients with a median follow-up of 10.9 years and reported disease extension in 53 (36.5%) patients [51]. They also reported that of the patients who experience disease progression, 68% had a preceding clinical exacerbation of their disease. Only patients who experienced disease progression subsequently required surgery—17 of 53 patients (32%)—at a median interval of 0.4 years following diagnosis of disease progression.

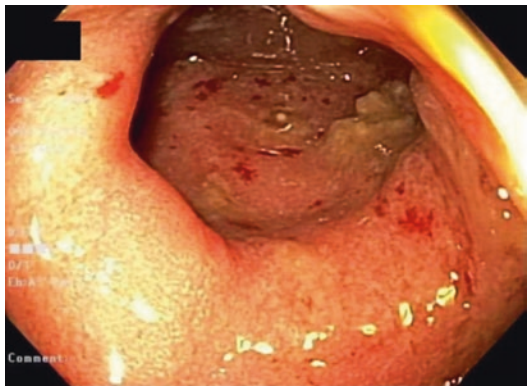


Fig. 29.1 Endoscopic appearance of ulcerative proctitis. Note the friable, erythematous and edematous mucosa

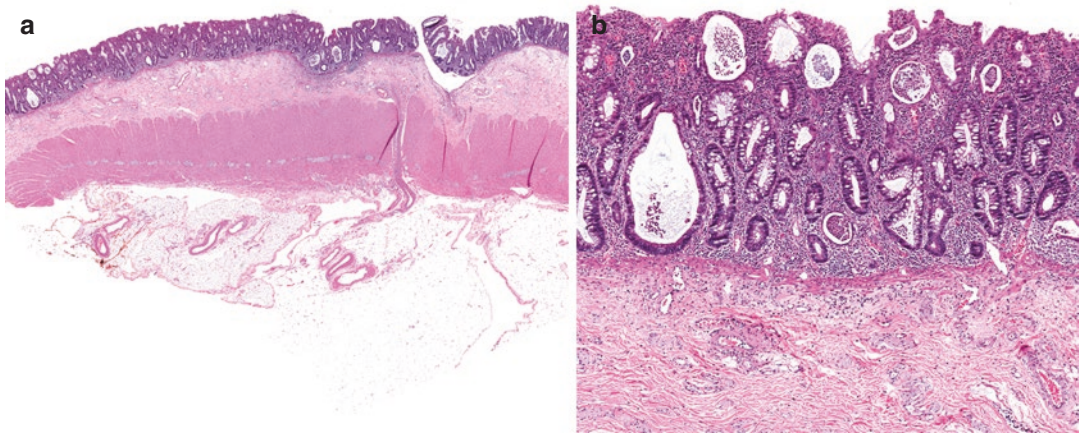


Fig. 29.2 (**a**, **b**) Photomicrograph of ulcerative colitis resection specimen. Low-power (**a**, original magnification ×9) image confirms that the colitis is restricted to the mucosa without any features of Crohn's disease such as transmural lymphoid aggregates. Medium-power (**b**, original magnification ×54) demonstrates chronic active colitis, characterized by branched and abnormally-shaped crypts, many of which are damaged by neutrophilic infiltrates in the form of cryptitis and crypt abscesses. Courtesy of Tom Plessec, MD

A prospective study of Norwegian UC patients between 1990 and 1994 demonstrated that 28% of patients with an initial diagnosis of proctitis had disease progression at 5-year follow up, 10% to pancolitis, but it is unclear if any of these patients underwent a colectomy due to disease progression [54]. A recently published retrospective analysis from Korea of 98 patients reported a 27.6% disease extension rate at a mean duration of follow-up of almost 9 years [52]. Only one patient required a colectomy and this patient experienced disease extension. Factors associated with disease extension were a higher Mayo or partial Mayo score, a higher endoscopic score, corticosteroid use at diagnosis along with initial chronic disease activation (persistent active disease for 6 months or more despite treatment as per standardized protocol), disease relapse, and need for hospitalization. In a single institution Japanese study spanning a 35-year period, 66 patients with proctitis were shown to have cumulative rates of disease extension of 17.9%, 33.8%, 41.9% and 52.2% at 5, 10, 15 and 20-year follow-up, respectively [53]. The median time interval from disease onset to disease extension was 11.5 years. Disease extension was significantly more likely in patients with disease onset prior to 25 years of age and in those treated with corticosteroids. No correlation was demonstrated between disease extension and either extraintestinal manifestations or smoking. Interestingly, the authors also report that 3 of the patients developed dysplasia during colonoscopic surveillance and that this only occurred following documented disease extension and over 20 years following the initial diagnosis of proctitis. One of these patients had high grade dysplasia and underwent a total colectomy with no invasive malignancy in the surgical specimen.

Historically, proctitis has been regarded to have low risk for the development of colorectal cancer compared to pancolitis [55]. However, findings from the Japanese study reported above led the authors to recommend proctitis patients be monitored closely for disease extension, especially in the younger disease onset population, and that patients who suffer disease progression should be included in formal surveillance programs when this occurs. Disease extension is also associated with increased risk of relapse and hospitalization, both of which are indicators of a poor prognosis.

Treatment

The goal of treatment is to both induce and maintain disease remission, which should minimize the need for steroid use, improve quality of life, and minimize the risk of rectal cancer from long-standing proctitis. Although not as well documented as for more extensive disease, recent guidelines from the American College of Gastroenterology [56] and a recent European review [57] recommend a treatment algorithm for UP. Following a definitive endoscopic and histological diagnosis, first line treatments are topical 5-aminosalicylate compounds (5-ASA), oral 5-ASA, or topical steroids. Evidence favors topical 5-ASA as superior to the latter two options. A combination of both topical and oral 5-ASA is more effective than either alone. Patients with disease refractory to 5-ASA and topical steroids may require oral steroids and/or biologic agents although the evidence in this setting remains weak. The evidence supporting these recommendations is discussed below.

There have been numerous trials, many randomized and placebo controlled, on treatment options for UP. However, these can be difficult to compare and contrast due to different agents being used at different dosages and frequencies, different routes of administration, and different distribution (i.e. suppository versus foam versus enema), different length of treatment, different endpoints measured, and variable follow up. Two recent systematic reviews focused on drug therapies [57] and rectal therapies [58] provide a robust critical appraisal of the literature and solid conclusions.

5-ASA: Topical

Topical therapies are divided into the 3 categories as listed above, the difference being the extent of the distribution of the medication: suppositories are limited to the rectum, foam will

reach to the sigmoid and possibly the descending colon, and an enema may reach as proximal as the splenic flexure [59].

There have been 6 trials designed to compare topical 5-ASA agents (in either enema or suppository form) versus placebo for clinical remission induction [60–65]. Four of these studies treated patients for 4 weeks with the remaining 2 studies treating patients for 6 weeks. The pooled results demonstrate that 40% more patients in the 5-ASA group achieved clinical remission (65% versus 25%) with a pooled relative risk of 2.39 compared with placebo ($p < 0.0001$). Two studies have analyzed different doses of 5-ASA suppositories and compared 500 mg two or three times daily (i.e. 1 g versus 1.5 g total daily dose) and found no significant difference in the induced remission rates of 81.9% and 83.8%, respectively [60, 66]. A further study compared 500 mg twice daily versus 1 g daily (i.e. same daily dose). No significant difference was reported although the remission rates were lower than other studies at 43.8% and 59%, respectively [67]. Further studies have compared suppositories with enemas [68], and liquid enemas with foam enemas [69], neither demonstrating any difference between the treatment arms with remission rates between 75.2% and 80%. There is also evidence that 5-ASA induces not only clinical but also endoscopic remission [60, 61, 63, 64] with a trend toward histological remission, 17.9% vs. 4.93%, $p = 0.08$ [60, 61]. A recent Cochrane Database review has confirmed that rectal 5-ASA should be considered as first line therapy for induction of remission in mild to moderately active distal UC [70].

There have been 3 randomized double-blind trials investigating the maintenance of remission with topical 5-ASA formulations [71–73]. Patients were treated for 1–2 years and clinical remission was maintained in 65.5% of patients treated with topical 5-ASA versus 26% placebo with a pooled relative risk of 2.80 ($p = 0.02$). One of these trials also compared once with twice daily 500 mg suppositories [71] with a significantly increased remission rate of 91.7% versus 72.5% for the higher dose (1 g daily) group. Similar to the review for induction of remission, there is also a Cochrane review for maintenance of remission which report that although the data is limited it does suggest that rectal 5-ASA is both safe and effective for maintenance of remission [74].

5-ASA: Oral

In 1998, Gionchetti and colleagues reported a trial comparing a daily dose of 1200 mg 5-ASA suppositories with 2400 mg oral 5-ASA and found that the clinical remission rate in the suppository (i.e. topical therapy) group was over twice that of the oral group: 89.6% versus 41.4% [75]. The ASCEND II trial published in 2005 did not demonstrate a difference in clinical remission between a 2400 mg daily oral 5-ASA group and a 4800 mg daily oral 5-ASA group, but did report low clinical remission rates (20% and 30%) when compared to those reported for topical therapies [76].

In terms of remission maintenance, a multicenter study compared oral sulphasalazine with oral olsalazine treatment for a 6–18 month period with no demonstrable differences between the groups (69% and 58.1%) [77]. A further study focused solely on the optimal dose of oral olsalazine (500, 1000 and 2000 mg) for maintaining remission with a trend toward maintenance of remission in the higher dose groups—50% (500 mg) versus 62.8% (1000 mg) versus 90% (2000 mg) [78].

The Cochrane group report that a combination of oral and rectal 5-ASA appears to be more effective than either formulation alone for induction of remission [74], but there is insufficient data regarding combination therapy for maintenance of remission. A recent study from Massachusetts reported on treatment escalation and associated cost for UP patients [79]. The authors compared 3 treatment options for newly diagnosed patients with UP derived from a United States health insurance database: oral 5-ASA, mesalamine suppository, or mesalamine enema. The endpoint studied was treatment escalation, as opposed to response to treatment, which is a surrogate marker of treatment success. They reported that treatment escalation occurred in 34% of those patients who were initially treated with oral 5-ASA compared to 21% for both the mesalamine suppository and enema group. Furthermore,

the patients treated initially on oral 5-ASA had a 12-month cumulative treatment cost of $1,552 compared with $996 and $986, respectively.

Summarizing the above data, rectal 5-ASA therapies are superior to oral counterparts. Despite this, studies report that oral therapy is slightly more commonly used than rectal therapy in patients with UP (29.5% versus 25.6%) [80]. Furthermore, the number of 5-ASA prescriptions increased by sixfold between 1992 and 2009, but the percentage for rectal administration decreased from 11 to 9%. Reasons cited for under-utilization of rectal therapies include difficulties with administration, patient inconvenience, and patient and physician reluctance to use rectal therapies [81].

Corticosteroid: Topical

Topical steroids are favorable over oral counterparts as lower systemic bioavailability produces minimal side effects. For example, budesonide has near 90% first-pass hepatic metabolism. The formulations utilized are either foams or enemas, with foams thought to have superior retention rates and less often cited as inconvenient to administer. There have been a number of studies reporting on the efficacy of inducing remission for distal UC as well as examining the safety profile of the individual formulations [82–91].

Corticosteroid: Foam

There are 2 randomized controlled studies documenting remission of symptoms following corticosteroid foam treatment [82, 83]. The first study, with an enrolment of 533 patients, demonstrated no difference after 4 weeks of treatment between patients receiving either budesonide foam 2 mg/25 ml or budesonide enema 2 mg/100 ml, with clinical remission rates of 60% and 66%, respectively. One-third of patients experienced side effects (headache, nausea, abdominal pain) and approximately 1% of patients were shown to have decreased morning cortisol levels. The second smaller study (38 patients total) compared betamethasone enema 5 mg/100 ml with budesonide foam 2 mg/50 ml, and although the enema preparation showed significant improvement in clinical remission at 4 weeks (77.2% vs. 63.5%, $p < 0.05$), this came at the cost of increased corticosteroid side effects (43.8 vs. 17.4%) and decreased plasma cortisol levels (87 vs. 22%).

Enemas

The efficacy and safety profiles of corticosteroid enemas alone have been reported in 8 studies [84–91]. Two of the studies were randomized, placebo-controlled and double-blinded and demonstrated significantly improved endoscopic disease status at 4 and 6 weeks following budesonide 2 mg/100 ml enema therapy [88, 89]. Similarly, histology scores were significantly improved 2, 4 and 6 weeks following initiation of treatment. Increasing the enema dosing regimen from once to twice daily has not been shown to improve induction or maintenance of remission, but does lead to a significantly increased incidence of adrenal impairment [87].

Several studies report on the relative efficacy of corticosteroids enemas and 5-ASA preparations. Hartmann and colleagues demonstrated that high dose 5-ASA enema (4 g/60 ml) was significantly better than budesonide enema (2 mg/100 ml) at inducing clinical remission at 4 and 8 weeks (approximately 77 vs. 65%) with nearly 120 patients in each treatment arm [84]. The side effect profile was also less in the 5-ASA arm with fewer patients, only 2.4%, discontinuing treatment as a result of these. Equivalent rates of remission were reported between beclomethasone dipropionate (BDP) and 5-ASA 2 g enemas [85], albeit both groups had markedly lower remission rates at 8 weeks of 24% and 28% compared with the preceding study. Similarly, Gionchetti and colleagues reported decreases in disease activity index (DAI) scores and equivalent remission after 6 weeks of treatment when they studied 217 patients receiving either BDP 3 mg/60 ml or 5-ASA 1 g/100 ml enemas therapy [86]. However, the remission rates of 36.7% (BDP) and 29.2% (5-ASA) were again lower than those previously reported.

A Dutch study published in 1996 compared BDP 3 mg enema to 5-ASA 2 g enema and also included a third group who received a BDP 5-ASA 3 mg/2 g combination enema [92]. After 4 weeks of treatment the authors reported a 100% clinical,

endoscopic, and histological improvement for the combination enema patients. This group was superior to either single-agent therapy in overall improvement ($p < 0.01$). Further trials combining steroid and 5-ASA in enema preparation appear to be lacking, although there have been retrospective reports supporting the efficacy of combination enemas in patients refractory to corticosteroid enemas alone [93].

Corticosteroid: Oral and Intravenous

There is a paucity of data on the role and use of both oral and intravenous steroids specifically for UP. Interestingly, oral steroids were the treatment of choice when the condition was initially described. Over the ensuing decades, oral and intravenous steroids have been avoided if possible due to their potential extensive side effect profiles. However, the general consensus appears to be that refractory or escalating UP symptoms should be managed using the same treatment algorithm as those for more extensive UC [94]. Bitton has previously described a regimen of oral prednisone, commencing with an initial 40–60 mg dose for 7–10 days and tapering in 10 mg and 5 mg doses over the ensuing weeks [95].

Thiopurines

A study on 27 patients with intractable proctosigmoiditis treated with 6-mercaptopurine, with doses ranging from 25 to 150 mg/day, reported a complete or moderate improvement in 63% of patients with discontinuation of concurrent steroid therapy in 68% of the cohort [96].

Cyclosporine

A randomized trial utilizing cyclosporine enemas for the treatment of left-sided UC was published over 20 years ago [97]. At a dosing regimen of 350 mg/day, no difference in disease activity was demonstrable when compared to placebo after 1 month of treatment.

Sucralfate

In a randomized trial setting, sucralfate enemas were shown to be less effective at inducing clinical, endoscopic or histological remission when compared with hydrocortisone enemas [98].

Anti-Tumor Necrosis Factor (TNF) Agents

To date, many prospective randomized controlled trials using anti-TNF agents have excluded patients with UP. However, in the ACT 1 and 2 trials which were centered on infliximab use in UC, 55% of patients were documented as having left-sided or distal colitis with approximately two-thirds of all patients showing a good clinical response, although there was no specific subgroup analysis performed [99]. Bouguen and colleagues identified 13 patients with refractory UP out of a total of 420 UC patients treated with intravenous infliximab between 2005 and 2009 across 6 referral centers [100]. Of these 13 patients, 9 had a complete clinical response, 2 a partial response, and 2 were non-responders. Nine of the 11 responders remained in remission at a median follow up of 17 months, demonstrating the potential role of infliximab in both induction and maintenance of remission in refractory disease. Topically administered infliximab has also been shown to be effective in a refractory case of UP unresponsive to initial intravenous induction treatment [101].

Tacrolimus

Two studies have investigated the effects of topical tacrolimus ointment [102, 103]. Two-thirds of the enrolled patients demonstrated clinical improvement following a 4–8 week period of tacrolimus treatment. Importantly, trough drug levels remained low after topical administration and none of the patients reported side effects [103]. Oral tacrolimus has also been shown to be of benefit in patients with steroid-refractory disease [104].

Rebamipide

Rebamipide is a cytoprotective, anti-neutrophil agent, which increases the expression of epithelial growth factor (EGF) and the EGF receptor. In two small studies from approximately a decade ago totaling 36 patients, rebamipide enemas improved clinical, endoscopic, and histological findings after 4 weeks of treatment in the first study [105] and a clinical remission rate of 55% after 3 weeks in the second study [106].

Other Topical Agents

There have been encouraging initial reports on the use of epidermal growth factor enemas [107], escabet sodium enemas [108] and ropivicaine gel [109] in patients with active proctosigmoiditis. However, these 3 studies included only 31 patients in total and thus do not provide strong evidence and are lacking in terms of follow-up and further investigation.

Complementary and Alternative Medicines

A recent systematic review has reported on the efficacy of a number of herbal therapies in the treatment of inflammatory bowel disease patients [110]. A placebo controlled trial of Xilei-san demonstrated significant clinical and endoscopic efficacy in refractory UP when compared to placebo [111]. A subsequent double-blind randomized clinical trial reported that Xilei-san enemas were comparable to dexamethasone enemas (88.2 vs. 87.5% clinical response after 4 weeks) and were safe and well accepted in the target Chinese population [112].

Surgery

Surgery is rarely indicated for UP alone, but is indicated with for severe disease that cannot be successfully managed medically, and the patient often has associated proximal disease extension. The surgical options are restorative proctocolectomy (usually a 3-stage approach in the disease-refractory patient), proctocolectomy with end ileostomy, proctocolectomy with continent ileostomy, or in select cases (elderly, significant comorbidity for example) a diverting ostomy. Although rare in isolated UP, dysplasia and/or malignancy may develop and require resection if staging demonstrates no distant metastatic spread.

The role of appendectomy in UP patients has come under increasing interest in recent years. Individual case reports [113] of resolution of symptoms following appendectomy further support the initial data from Bolin and colleagues [114]. They prospectively followed 30 patients with UP who underwent appendectomy without any signs or symptoms of appendicitis. The clinical activity index of disease improved in 90% of the cohort and 40% had complete resolution of symptoms within 1 year following surgery.

Cuffitis

Cuffitis is defined as inflammation of the rectal cuff in the area between the ileal pouch-anal anastomosis and dentate line. Inflammation of this retained cuff can be seen endoscopically and/or on histologically, and can occur with or without minimal inflammation of the pouch body itself [115, 116]. It is hypothesized that cuffitis represents residual proctitis and causes similar symptomatology and endoscopic findings [117]. The Cleveland Clinic reported 120 of 931 IPAA patients developed cuffitis in their experience from a dedicated Pouchitis Clinic database [118]. Recommended first line treatment is topical mesalamine and/or topical corticosteroid enemas, which are effective for symptom control in 70% of patients [117]. Based on the response to treatment, patients are sub-classified as 5-ASA/steroid-responsive, 5-ASA/steroid-dependent or 5-ASA/steroid-refractory. Nearly half of the reported patients from the Pouchitis Clinic database (n = 58) were in the 5-ASA/steroid-refractory subgroup. This subgroup of patients underwent examination under anesthesia (EUA) and/or pelvic MRI/CT and 32.8% were diagnosed with Crohn's disease (CD), and 24.1% with previously undiagnosed surgical complications (24.1%). Sixteen patients from the entire cohort (13.3%) ultimately had a failed pouch but the authors stressed that cuffitis encompasses a disease spectrum and that the physician must thoroughly investigate the patient with refractory cuffitis.

Summary Of Ulcerative Proctitis

UP is inflammation of the rectal mucosa, which often causes significant symptoms. The diagnosis is based on the characteristic clinical history, endoscopic, and histological findings, while excluding other known causes of proctitis. The disease has a classical relapse-remission course and varies in severity between patients. The goals of treatment

are twofold: to induce and maintain remission, and prevent disease progression. The first line treatment for mild disease is topical 5-ASA as it is superior to oral 5-ASA and topical corticosteroid. The recommended regimen is 1 g once daily as this has equivalent efficacy to an increased daily dosage or an increased frequency of administration. If topical 5-ASA doesn't achieve an adequate clinical response, it should be supplemented with oral 5-ASA and/or topical steroid. Patients with moderate to severe disease are usually started on dual 5-ASA therapy as first line treatment. Patients with severe disease at presentation may require oral or intravenous corticosteroids.

Maintenance therapy usually includes 5-ASA treatment. Refractory UP is a difficult management problem for patients and physicians alike. First and foremost, the clinical diagnosis should be re-confirmed and other potential diagnoses definitively out-ruled. The treatment algorithm following failure of topical 5-ASA and corticosteroid therapies may include a thiopurine or anti-TNF agent. Topical tacrolimus and cyclosporine may also be utilized. Surgery is an effective option after failed medical management.

Anorectal Crohn's Disease

Definition

Crohn's disease (CD) is a chronic, unremitting inflammatory disorder that can affect any segment of the gastrointestinal tract and extraintestinal sites. Management is centered on relieving symptoms using a combined medical therapy and surgical armamentarium. The potential anorectal manifestations are many and include abscesses, fistulae, fissures, ulcers, strictures, hemorrhoids, skin tags, proctitis, dysplasia, and malignant change.

Epidemiology

Globally, the prevalence of CD has increased in recent times [119]. The disease has a recognized bimodal age distribution with the peaks being between 15 and 30 and 60 and 80 years of age, respectively. However, the majority of patients develop disease prior to age 30. In 1998, Loftus and colleagues estimated that the prevalence of CD in Olmstead County, Minnesota, in the United States was 8 cases per 100,000 population [120]. A subsequent analysis from the period 2003-2004, with data extracted from a health insurance claims database, estimated the prevalence of CD among US adults and children was closer to 201 cases per 100,000 amongst adults and 43 per 100,000 amongst children [121]. The disorder is more common in whites than blacks and an increased prevalence has also been demonstrated amongst Jewish populations [122]. The incidence of perianal manifestations increase the more distal the disease. Hellers and colleagues reported that perianal fistulae occurred in 12% of patients with ileal disease, 15% with ileocolonic disease, 41% with colonic disease that spared the rectum, and 92% of patients with rectal and colonic CD [123].

Etiology

The exact etiology of CD remains unknown. It is likely that the end result is due to a complex interplay between certain conditioning factors, such as genetics and triggering events, and effector mechanisms. The combination of these is thought to result in dysregulation of both intestinal immune and non-immune functions as per reports in recent years [124–126]. Reported environmental triggers include smoking, antibiotics, oral contraceptives and selected microbes [127–129]. A number of loci which influence an individual's susceptibility for the disease have been identified [130, 131]. In essence, CD is thought to develop in genetically susceptible individuals exposed to triggers, which are usually harmless leading to a dysregulated inflammatory response and subsequent persistent inflammatory state.

Presenting Symptoms

Due to the great number of potential anorectal manifestations, the physician must be cognizant of varying symptoms**.** An abscess presents as

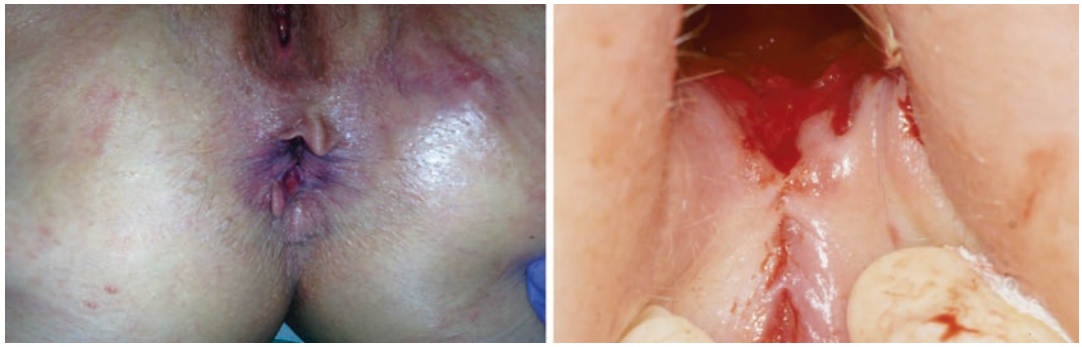


Fig. 29.3 Manifestations of perianal Crohn's disease. Common findings include enlarged skin tags, waxy and edematous perianal skin, and ulcerated fissures. Courtesy of Dr. James Church

painful swelling and may have associated diarrhea or urinary symptoms. Fecal incontinence is commonly reported and can be caused by sphincter damage, fibrosis and stricture, fistulous disease, prior surgery and proctitis. Soiling and low volume drainage are often present when there is a fistula and fissures are more commonly painless as opposed to painful. Skin tags may cause local irritation and discomfort and hemorrhoids often present in the usual fashion. The perianal skin will often have a waxy appearance. In a series of 102 patients with anorectal stricture in the setting of CD, 51% complained of perianal pain, 29% of bloody diarrhea and/or mucus, 14% were asymptomatic, and 6% reported constipation and/or incontinence [132]. Examples of perianal Crohn's disease are shown in Fig. 29.3.

Differential Diagnosis and Diagnostic Evaluation

It is important to remember that CD may exist along with other conditions. Church and colleagues reported on a cohort of 61 patients with a diagnosis of hidradenitis suppurativa (HS), 24 of whom also had a diagnosis of CD; almost all involving the large bowel [133]. Twenty-four patients had HS of the perineum and 25% of these were found to have granulomas in the pathological specimen—an important finding as the management strategy for perineal CD and HS differ, albeit granulomas are not exclusive to CD and can occur in HS.

Abscesses and fistulae related to CD need to be differentiated from those of cryptoglandular origin. The tenets of evaluation are a thorough clinical history, a complete physical examination concluding with a detailed perineal, perianal, and digital rectal examination coupled with anoscopy and flexible sigmoidoscopy in the office. If not tolerated in the office, a formal examination under anesthetic (EUA) is the diagnostic modality of choice. During EUA, tissue should be sampled from affected areas (abscess cavity, fistula tract, perianal or perineal skin, anal canal, rectal mucosa, stricture) for pathological analysis. Imaging with ultrasound or magnetic resonance imaging (MRI) can be used as an adjunct and has been shown to increase diagnostic accuracy by 10% [134]. Pelvic MRI may assist in diagnosis and also may delineate further disease and thus alter the proposed surgical strategy [135, 136]. All patients should have a complete colonoscopy once the acute presentation has been adequately managed. Based on symptoms, some patients may also require investigation of the proximal gastrointestinal tract.

Natural History of Disease

In their original description of the disease, Burrill Crohn and colleagues did not describe any perianal manifestations in affected patients [137]. However, Colles had previously reported on fistulizing perianal and rectal disease among Irish children in 1830 [138]. Six years following the

initial publication, Crohn and colleagues published a series of 3 patients with perianal disease and estimated that 14% of patients would present with fistula-in-ano [139]. The incidence of anorectal involvement in patients with CD varies greatly in the literature, with reports anywhere between 8 and 90% [140–142]. This variation is likely due to differences in definitions and reporting of what actually constitutes perianal disease; e.g. abscesses and fistulae requiring intervention are more likely to be reported than hemorrhoids and skin tags not requiring intervention.

Disease site plays an important role with 15% of patients with ileocolonic disease developing fistulae compared with 92% of patients with Crohn's colitis and proctitis [142]. A longer duration of Crohn's is associated with increased likelihood to develop perianal manifestations. Studies have reported on the evolution of disease in CD patients with less than 10% of patients with proximal disease developing perianal fistulous disease in the initial 5-year period post CD diagnosis, but over 25% developing perianal disease over the course of 20 years [143, 144]. The most common perianal manifestations of CD are anoperineal and anovaginal fistulae [145]. A population-based study from Olmstead County reported the cumulative risk for CD patients for developing any fistula was 33% after 10 years and 50% after 20 years. Of note, 34% of patients also developed at least one recurrent fistula [142].

Patients with CD who present with or develop perianal manifestations have a worse outlook than those who do not. Perianal disease is associated with a more disabling natural history [146] and an increased incidence of both extraintestinal manifestations [147] and steroid resistance [148]. The majority of patients will require some form of surgical intervention.

Treatment

Medical Management of Perianal Crohn's Disease

A wide variety of presenting pathologies exist for patients with perianal CD and, as such, there is a wide range of medical therapies that are offered to these patients with varying success. For many of the anoperineal conditions, local measures may provide symptomatic relief (e.g. warm Sitz baths) and regulation of Crohn's related bowel dysfunction via fiber supplementation or use of anti-diarrheal medication. Many standard medications used to treat intestinal manifestations of CD, such as ASA derivatives and steroids, are poorly effective in terms of resolution of anoperineal symptoms [149–151]. Antibiotics, immunomodulators and anti-TNF agents (biologic agents) are established therapeutic options and will be discussed here.

Antibiotics

Antibiotics have classically been the first-line therapy for the treatment of perianal CD and its common infectious sequelae, with metronidazole and ciprofloxacin being the most studied agents. The typical doses are metronidazole at 750–1000 mg/day and ciprofloxacin 1000–1500 mg/day. Uncontrolled studies have shown an association between metronidazole use and reduction in fistula drainage and pain, with healing in up to 50% of patients [152]. Clinical improvement is seen in 6–8 weeks, although symptoms often recur if therapy is discontinued, with some authors reporting as high as an 80% recurrence rate within 4 months of cessation of antibiotic therapy [153].

Two small case series have evaluated ciprofloxacin as a possible therapy for perianal CD and demonstrated fistula healing in 80–100% of patients [154, 155], but these results have not been widely reproduced. The combination of ciprofloxacin and metronidazole is commonly utilized for Crohn's-related perianal fistulae, with studies showing a clinical improvement in fistulizing disease after 12 weeks in 60% of patients and complete closure in 20% [156]. As is often the case with single-agent therapy, no significant sustained response to combination therapy has been demonstrated, with symptoms commonly recurring after treatment cessation. Direct comparison of the two agents in a study of 25 patients revealed a superiority of ciprofloxacin over metronidazole [157]. After a 10-week treatment course, response (defined as ≥50% reduction in

number of draining fistulas) was seen in 40% of patients treated with ciprofloxacin, 14.3% treated with metronidazole and 12.5% in the placebo group. Interestingly, therapy was terminated prior to scheduled completion of the antibiotic course in 71.4% of the metronidazole group compared with 10% in the ciprofloxacin group, suggesting a differing tolerance profile.

Despite some promise in the treatment of perianal CD, the long-term use of antibiotics is not ideal given the risk for the potential development of antibiotic resistance and the possibility of suffering from severe medication side effects. Long-term metronidazole use is often complicated by a metallic taste, nausea and peripheral neuropathy. Chronic headache, nausea, tendon weakness, and chronic diarrhea may limit consistent, long-term use of ciprofloxacin [158].

Immunomodulators

The immunomodulator azathioprine (AZA) and its active metabolite 6-mercaptopurine (6-MP) are mainstays in the induction and maintenance treatment of luminal CD, but few studies have highlighted this group of medications as a primary management of perianal disease [159]. Treatment effect may not be noted for several weeks after initiation of therapy, and thus, immunomodulators are typically used in conjunction with other agents that are more effective for acute symptoms. Support for the beneficial use of these agents in the treatment of perianal CD has been varied.

In a study of 92 perianal CD patients treated with AZA/6-MP, Lecomte and colleagues reported an overall response of 29% (27/92), with over half of participants (50/92) developing perianal complications during the first 3 months of therapy [160]. Despite these discouraging results, there is data which supports their use in combination therapy. Five randomized trials were highlighted in a meta-analysis evaluating AZA and 6-MP with fistula healing as a secondary endpoint, and showed a response rate of 54% in the treatment arm which compared favorably with 21% in the placebo arm [161]. Similarly, complete fistula healing has been reported in patients undergoing therapy with 6-MP (31% in treatment arm, 6% placebo) [162].

A 2003 study by Dejaco et al. reported a benefit of AZA use in combination with antibiotic therapy [163]. In this study, AZA seemed necessary to maintain response to ciprofloxacin and/or metronidazole use. Similar results of an improvement in degree and duration of response have also been shown with the addition of AZA/6-MP to anti-TNF therapy [164].

Biologic Agents

The introduction of anti-tumor necrosis factor (anti-TNF) therapies has proved a major advance in the treatment of inflammatory bowel disease, with specific success seen in patients with perianal CD. Present and colleagues evaluated the efficacy of infliximab, with the primary endpoint of reduction of ≥50% in the number of draining fistulas) [165]. This endpoint was achieved in 62% of patients in the treatment arm compared with 26% in the placebo group. Additionally, up to one-half of patients showed complete healing of all fistulas (55% of patients receiving 5mg/kg dose, 38% of patients receiving 10 mg/kg dose). A follow-up study evaluated infliximab in the maintenance of fistula closure in 195 patients who were considered 'responders' after 14 weeks of initial treatment and continuing maintenance therapy until week 54. At completion of therapy, 36% of patients on maintenance infliximab therapy had complete resolution of drainage and this compared very favrably with 9% in the placebo group [166].

More recently, next generation anti-TNF agents have become commercially available in the form of adalimumab and certolizumab. No randomized placebo-controlled trials have evaluated the efficacy of either of these medications for fistulizing CD, but the effect of each on fistulizing CD has been included as a secondary endpoint in large, multi-center studies. The CLASSIC I trial examined the efficacy of adalimumab in patients with moderate to severe CD, including 32 patients with perianal disease [167]. At week 4 of treatment, 8% of patients receiving adalimumab showed fistula response, but no patients exhibited complete healing. However, the corresponding placebo group had a 33% fistula response with 17% reported as achieving complete healing. Subsequently, the CHARM trial

examined the effect of adalimumab on fistula healing as a secondary outcome, reporting that 33% of treated patients showed complete fistula closure after 56 weeks of treatment versus only 13% in the placebo arm [168]. All patients demonstrating fistula closure at week 26 maintained this response to week 56, suggesting a durable effect of the treatment.

The PRECISE I and II trials were designed to evaluate the effect of certolizumab. Although fistula healing was a secondary endpoint of the PRECISE I study, patients undergoing treatment with certolizumab showed equivalent healing to the placebo group after 26 weeks of therapy (30% versus 31% fistula closure rate respectively) [169]. This was followed by the PRECISE II trial, an intention-to-treat analysis designed to evaluate the efficacy of certolizumab in the maintenance of clinical response in patients with active CD [170]. Few patients, however, exhibited draining fistulas. Despite this, 14% of patients in the intention-to-treat population were documented to have fistulas at baseline, and after 26 weeks of therapy, the authors reported that just over one third (36%) of these patients with fistulae achieved complete healing (versus 17% in the placebo group).

Surgical Management of Anorectal Crohn's Disease

Indications and General Principles

The decision for surgical intervention in patients suffering from perianal CD remains particularly challenging. As CD is a life-long and incurable debilitation, goals of therapy are to improve symptoms and quality of life in a thoughtful, non-invasive manner. Surgical intervention is warranted in certain situations, often when medical therapy has failed or is not capable of achieving desired results, or when sepsis needs to be drained. Particularly important is the acknowledgement that poor decision-making by the surgeon can create a worse situation for the patient than the morbid disease itself. A clinically useful scoring system for prediction of the outcome following surgery perianal Crohn's disease may assist with both preoperative selection of therapeutic options and counselling about prognosis following treatment [171].

Skin Tags

Anal skin tags are commonly encountered but are rarely symptomatic. They develop as edematous and bluish swellings as a result of lymphatic obstruction. Despite their common presence, they should not be excised, as this procedure often results in development of a non-healing, chronic anal ulcer.

Hemorrhoids

Many patients with perianal CD will report or be referred for prolapsing or symptomatic 'hemorrhoids', but the conditions rarely coexist. Conservative therapy should be implemented, with emphasis on control of diarrhea and symptom management. Varying outcomes have been reported regarding the success of surgery for symptomatic hemorrhoids in the setting of perianal CD. A recent review of 11 retrospective studies including 135 patients confirmed the great variation in the incidence of postoperative complications in this specific patient cohort [172]. Overall, a cumulative postoperative complication incidence of 17.1% was reported for CD patients across all studies.

Fissures and Ulcers

The majority of patients with CD-related anal fissures will exhibit symptoms and fortunately, most will respond to medical therapy. Healing is more likely in patients with minimal pain or acute onset of symptoms. When medical therapy is not successful, there is some evidence for proceeding to surgical therapy (fissurectomy or sphincterotomy), as some authors report healing with low morbidity [173]. Alternatively, Buchmann and colleagues suggest that CD-related fissures are self-limiting and best left alone [174]. In their series of 53 patients with symptomatic CD fissures, only 19% of patients still had symptoms after 10 years of follow-up.

Patients with painful or otherwise symptomatic cavitating anal ulcers may benefit from EUA and gentle removal of rolled edges. Care must be taken to refrain from extensive or aggressive debridement as this may lead to worsening symptoms, fecal incontinence and ultimately need for proctectomy.

Abscesses

The infectious origin of both abscess and fistula may be cryptoglandular, or from an anal fissure or ulcer. Regardless of etiology, patients often present with painful induration of the anoperineum, and require drainage of sepsis as a first step. Abscesses may present independently or in association with fistulae, and are more likely to develop or have complex features if rectal involvement is present [175, 176]. Inspection for the presence of a fistula at the time of sepsis drainage is generally not performed due to friability of tissues and concern for iatrogenic fistula creation. Moreover, the cumulative 2-year recurrence rate after initial drainage of an abscess is 54% [176] and a fistula is more likely to be identified if a recurrence of sepsis occurs.

Fistulae

Placebo-controlled clinical trials assessing the efficacy of varied therapeutic approaches have shown that spontaneous fistula healing is possible in the setting of CD, with a spontaneous fistula-healing rate of between 6 and 13% [158, 177]. Ideally, any therapeutic intervention for anoperineal Crohn's-related fistulae should achieve a higher fistula healing rate than this. There are a number of options available for the surgeon when encountered with a CD related anovaginal or anoperineal fistula.

Seton

A seton is best used in the presence of active inflammation after draining the sepsis, with the main aim being to prevent subsequent abscess formation. When combined with medical therapy, as mentioned above, there are reports of improvement in the disease and even complete healing [178–180]. In an ideal scenario, the seton will act as a bridge to a definitive surgical procedure. However, for a significant number of patients the seton will remain in situ long-term and many patients report a good quality of life in this instance. Removal of the seton results in recurrent symptoms in the majority of patients [179, 181, 182].

Fistulotomy

Most symptomatic simple, or low-lying, fistulas that occur in the absence of proctitis can be safely managed with fistulotomy [183]. Several studies support this approach in an appropriate setting i.e. the Crohn's patient with normal continence, who presents with a low trans-sphincteric or intersphincteric fistula. Levin et al. reported a favorable result in 18 of 21 patients undergoing fistulotomy for either a low trans-sphincteric or intersphincteric fistula [184]. Another study reported similar outcomes with the addition of postoperative metronidazole after fistulotomy for patients with Crohn's related fistulae [185]. In the rare event that an anal ulcer develops due to poor wound healing after fistulotomy, aggressive measures should be avoided. These are commonly minimally symptomatic and responsive to medical management.

Advancement Flap

Anorectal advancement flap provides a feasible option in patients who require repair but are at high risk of incontinence that would result from any sphincter muscle division. It has minimal risk of incontinence and does not increase the need for proctectomy. It is best suited for patients with minimal rectal mucosal inflammation or stenosis of the anal canal. The many differences in technique for rectal advancement flap are reflected in the wide range of outcomes reported in current literature. The preoperative placement of a draining seton to eliminate sepsis has been shown as a predictor of healing [186]. The postoperative confinement of bowel motions, use of postoperative antibiotics, or routine use of fecal diversion do not influence to healing [187].

Jarrar and Church reported that, if one abides by certain tenants of fistula treatment, advancement flap allows for quick healing with high success rate and opportunity for repeat repair in the event of recurrence, as it does not disturb anal anatomy. They reported long-term outcomes (mean follow up of 7 years) of 98 patients with perianal fistulas, 33 of whom had CD fistulae. Of the CD-related fistulas undergoing repair, 83% of anovaginal fistulas and 89% of perianal fistulas exhibited overall healing, supporting advance-

ment flap closure of CD-related fistulas as an effective option. They also report that quality of life was most dependent on ultimate healing of fistulas, and advocated for the surgeon to consider repeat attempts at advancement flap closure of CD-related fistulas (if clinically acceptable) in order to achieve ultimate healing [188]. Temporary fecal diversion is generally not required for healing after initial attempts at flap closure, unless excessive disease or fibrosis was noted at the time of flap creation.

A systematic review of 35 studies highlighting advancement flap closure was conducted by Soltani et al. and included evaluation of 91 patients with CD-related anoperineal fistulae. Average follow-up was 28.9 months, with overall success rates reported to be 64% (compared to 80.8% for cryptoglandular fistulae). They highlight the differences in technique among surgeons and institutions and the impact this may have on outcome differences [189].

Ligation of the Intersphincteric Tract (LIFT) Procedure

This procedure has gained popularity, since first reported by Rojanasakul in 2007 [190], however it has mainly been in the non-Crohn's population. Although encouraging results have been reported with healing in 57–83% of patients with cryptoglandular fistulous disease [191–193], there has been only one specific study to date looking at a CD patient population [194]. In this prospective study, Gingold and colleagues report encouraging results in 15 patients. At 2 months postoperatively, 60% of patients (9 of 15) were healed and complete healing was seen in 67% (8 of 12 patients) at 1-year follow up. Further studies are warranted and awaited.

Fistula Plug

In 2012, O'Riordan and colleagues performed a systematic review focusing specifically on comparing patients with cryptoglandular disease and CD [195]. In 530 patients, 42 of whom had a diagnosis of CD, the healing rates were equivocal in each group, 54.8% and 54.3% respectively, across a variable follow-up of between 3 and 24 months. High failure rates (4–41%) due to extrusion of the plug had been reported in a prior systematic review [196]. There have been small series reporting the use of a fistula plug in recto-vaginal and pouch-vaginal fistulae in IBD patients, with healing rates of 58% (7 of 12 patients) and 88% (6 of 7 patients) at follow-up of 4 and 6 months [197, 198].

Fibrin Glue

The initial reports on fibrin glue were in relation to cryptoglandular fistulae with encouraging results of 68–85% healing at 1 year [199–201], albeit other authors subsequently found these results difficult to reproduce [202–204]. A multicenter, randomized controlled trial assessed both the efficacy and safety profiles of heterologous fibrin glue injected into perianal fistulous tracts in patients with CD [205]. Active perianal sepsis was excluded based on either MRI or ultrasound and patients with both simple and complex fistulae were randomized to receive fibrin glue injections (n = 36) or observation only (n = 41) following seton removal. Clinical remission at 8 weeks following seton removal was observed in only 38% of patients in the fibrin glue group, although this compared favorably with 16% in the observation only group. Four patients (12%) in the fibrin glue group were reported as having adverse events. This 'success' rate was similar to a retrospective study from Loungnarath and colleagues who reported an early recurrence rate of 31% (4 of 13 patients) in patients with complex perianal CD fistulae following glue injection [206]. The newest therapy to be investigated is the injection of mesenchymal stem cells. A randomized controlled trial of 212 patients revealed remission in 50% of the 107 patients in whom mesenchymal stem cells were injected around their Crohn's disease associated fistulas as compared to only 35% of the 105 patients in whom placebo was injected. More trials are being conducted to determine the role of mesenchymal stem cells in the treatment of perianal Crohn's disease associated fistula-in-ano [207].

Diversion

A diverting ostomy has been employed as both a temporary and permanent measure. However, it must be noted for both clinicians and patients alike that almost 50% of these ostomies are never reversed. Anal canal stricture and complex peri-

anal fistulous disease are predictors of permanent diversion [208]. In patients in whom fecal diversion is utilized, there is often an initial remission of the disease process but this unfortunately is not a lasting effect [209], with 21 of 31 patients (68%) undergoing proctectomy in this series at a median of 20 months following fecal diversion. Thus, in the setting of perianal disease for which surgical repair is to be attempted (e.g. an advancement flap), this should be undertaken at or shortly after proposed temporary ostomy formation.

Proctectomy

The reported rate of proctectomy to treat anorectal Crohn's disease varies between 10 and 20% of cases [141]. The indication for proctectomy is usually a failure of medical therapy, a failure of localized surgical therapy, or severe and unresponsive rectal pathology. The presence of perineal CD (spontaneous perineal ulceration, non-healing, painless fissure or waxy perineal edema) has been shown to be a poor prognostic factor and increase the likelihood of proctectomy [210]. In this cohort of 72 patients, the 19 patients with perineal involvement had a higher rate of proctectomy (26 versus 3.7%) than their counterparts in whom the perineum was normal. Wound healing following proctectomy often proves troublesome. A series of 145 patients with CD undergoing proctocolectomy detailed a persistent perineal sinus in 33 (23%) of patients, only 9 of whom ultimately achieved complete healing despite one or more subsequent operative interventions [211]. A recent American College of Surgeons National Surgical Quality Improvement Program database (ACS-NSQIP) looked at outcomes following surgery for anorectal abscess and fistula in CD patients between 2005 and 2010 [212]. Of the 345 patients with documented CD, the rate of proctectomy of 46% was higher than aforementioned reports with a further 8% of patients undergoing diversion.

Summary of Anorectal Crohn's Disease

Anorectal Crohn's disease is complex and can present with many different manifestations in the rectum, anus and perineum. Undoubtedly, recent advances in medical therapy have added to the treatment armamentarium, but nonetheless many of the manifestations are managed primarily by the colorectal surgeon. As a surgeon, one should abide by the 'less is more' approach, especially in the initial operative management of this patient cohort. First and foremost, eradication of sepsis is the cornerstone of management and is often then followed by medical therapy. Once medical therapy fails or the response is lost, the operative strategies are many, but success rates remain variable and complications arising from too aggressive an approach may render the patient in a worse condition than that in which they presented. A focused approach to maximize the functional outcome for the patient while minimizing both disease and iatrogenic complications must remain the primary goal of management.

References

1. Lie MRKL, Kanis SL, Hansen BE, Jannake van der Woude C. Drug therapies for ulcerative proctitis: systematic review and meta-analysis. Inflamm Bowel Dis. 2014;20:2157–78.
2. Meucci G, Vecchi M, Astegiano M, Beretta L, Cesari P, Dizioli P, Ferraris L, Panelli MR, Prada A, Sostegni R, de Franchis R. The natural history of ulcerative proctitis: a multicenter, retrospective study. Gruppo di Studio per le Malattie Infiammatorie Intestinali (GSMII). Am J Gastroenterol. 2000;95:469–73.
3. Moum B, Ekbom A, Vatn MH, Elgjo K. Change in the extent of colonoscopic and histological involvement in ulcerative colitis over time. Am J Gastroenterol. 1999;94:1564–9.
4. Satsangi J, Silverberg MS, Vermiere S, Colombel JF. The Montreal classification of inflammatory bowel disease: controversies, consensus, and implications. Gut. 2006;55:749–53.
5. Abraham C, Cho JH. Inflammatory bowel disease. N Engl J Med. 2009;361:2066–78.
6. Ordas I, Eckmann L, Talamini M, Baumgart DC, Sandborn WJ. Ulcerative colitis. Lancet. 2012;380:1606–19.
7. Thompson AI, Lees CW. Genetics of ulcerative colitis. Inflamm Bowel Dis. 2011;17:831–48.
8. Garcia Rodriguez LA, Ruigomez A, Panes J. Acute gastroenteritis is followed by an increased risk of inflammatory bowel disease. Gastroenterology. 2006;130:1588–94.
9. Porter CK, Tribble DR, Aliaga PA, Halvorson HA, Riddle MS. Infectious gastroenteritis and

risk of developing inflammatory bowel disease. Gastroenterology. 2008;135:781–6.
10. Takeuchi K, Smale S, Premchand P, Maiden L, Sherwood R, Thjodleifsson B, Bjornsson E, Bjarnason I. Prevalence and mechanism of non-steroidal anti-inflammatory drug-induced clinical relapse in patients with inflammatory bowel disease. Clin Gastroenterol Hepatol. 2006;4:196–202.
11. Kurata JH. Dietary and other risk factors of ulcerative colitis. A case-control study in Japan. Epidemiology Group of the Research Committee of Inflammatory Bowel Disease in Japan. J Clin Gastroenterol. 1994;19:166–71.
12. Neuman MG, Nanau RM. Inflammatory bowel disease: role of diet, microbiota, life style. Transl Res. 2012;160:29–44.
13. Mahid SS, Minor KS, Soto RE, Hornung CA, Galandiuk S. Smoking and inflammatory bowel disease: a meta-analysis. Mayo Clin Proc. 2006;81:1462–71.
14. Koutrobakis IE, Vlachonikolis IG. Appendectomy and the development of ulcerative colitis: results of a metaanalysis of published case-control studies. Am J Gastroenterol. 2000;95:171–6.
15. Hart AL, Al-Hassi HO, Rigby RJ, Bell SJ, Emmanuel AV, Knight SC, Kamm MA, Stagg AJ. Characteristics of intestinal dendritic cells in inflammatory bowel diseases. Gastroenterology. 2005;129:50–65.
16. Takahashi F, Das KM. Isolation and characterization of a colonic auto-antigen specifically recognized by colon tissue-bound immunoglobulin G from idiopathic ulcerative colitis. J Clin Invest. 1985;76:311–8.
17. Fuss IJ, Heller F, Boirivant M, Leon F, Yoshida M, Fichtner-Feigl S, Yang Z, Exley M, Kitani A, Blumberg RS, Mannon P, Strober W. Nonclassical CD1d-restricted NK T cells that produce IL-13 characterize an atypical Th2 response in ulcerative colitis. J Clin Invest. 2004;113:1490–7.
18. Appleyard CB, Hernandez G, Rios-Bedoya CF. Basic epidemiology of inflammatory bowel disease in Puerto Rico. Inflamm Bowel Dis. 2004;10:106–11.
19. Yang S, Hong WS, Min YI, Kim HY, Yoo JY, Rhee PL, Rhee JC, Chang DK, Song IS, Jung SA, et al. Incidence and prevalence of ulcerative colitis in the Songpa-Kangdong District, Seoul, Korea, 1986-1997. J Gastorenterol Hepatol. 2000;15:1037–42.
20. Molinie F, Gower-Rousseau C, Yzet T, Merle V, Grandbastien B, Marti R, Lerebours E, Dupas JL, Colombel JF, Salomez JL, et al. Opposite evaluation in incidence of Crohn's disease and ulcerative colitis in Northern France (1988-1999). Gut. 2004;53:843–8.
21. Lakatos PL. Recent trends in the epidemiology of inflammatory bowel diseases: up or down? World J Gastroenterol. 2006;12:6102–8.
22. Jess T, Frisch M, Simonsen J. Trends in overall and cause-specific mortality among patients with inflammatory bowel disease from 1982 to 2010. Clin Gastroenterol Hepatol. 2013;11:43–8.
23. Cosnes J, Gower-Rousseau C, Seksik P, Cortot A. Epidemiology and natural history of inflammatory bowel diseases. Gastroenterology. 2011;140:1785–94.
24. Souza MH, Troncon LE, Rodrigues CM, Viana CF, Onofre PH, Monteiro RA, Passos AD, Martinelli AL, Meneghelli UG. Trends in the occurrence (1980-1999) and clinical features of Crohn's disease and ulcerative colitis in a university hospital in south-eastern Brazil. Arq Gastroenterol. 2002;39:98–105.
25. Pant C, Anderson MP, Deshpande A, Grunow JE, O'Connor JA, Philpott JR, Sferra TJ. Trends in hospitalizations of children with inflammatory bowel disease within the United States from 2000 to 2009. J Investig Med. 2013;61:1036–8.
26. Prideaux L, Kamm MA, De Cruz PP, Chan FK, Ng SC. Inflammatory bowel disease in Asia: a systematic review. J Gastroenterol Hepatol. 2012;27:1266–80.
27. Betteridge JD, Armbruster SP, Maydonovitch C, Veerappan GR. Inflammatory bowel disease prevalence by age, gender, race, and geographic location in the U.S. military health care population. Inflamm Bowel Dis. 2013;19:1421–7.
28. Russel MG, Dorant E, Volovics A, Brummer RJ, Pop P, Muris JW, Bos LP, Limonard CB, Stockbrugger RW. High incidence of inflammatory bowel disease in The Netherlands: results of a prospective study. The South Limburg IBD Study Group. Dis Colon Rectum. 1998;41:33–40.
29. Truelove SC, Witts LJ. Cortisone in ulcerative colitis; final report on a therapeutic trial. Br Med J. 1955;2:1041–8.
30. Hanauer SB. Inflammatory bowel disease. N Engl J Med. 1996;334:841–8.
31. Meyers S, Janowitz HD. The "natural history" of ulcerative colitis: an analysis of the placebo response. J Clin Gastroenterol. 1989;11:33–7.
32. Regueiro MD. Diagnosis and treatment of ulcerative proctitis. J Clin Gastroenterol. 2004;38:733–40.
33. Tortora A, Purchiaroni F, Scarpellini E, et al. Colitides. Eur Rev Med Pharmacol Sci. 2012;16:1795–805.
34. Nielsen OH, Vainer B, Rask-Madsen J. Non-IBD and noninfectious colitis. Nat Clin Pract Gastroenterol Hepatol. 2008;5:28–39.
35. Hoentjen F, Rubin DT. Infectious proctitis: when to suspect it is not inflammatory bowel disease. Dig Dis Sci. 2012;57:269–73.
36. Schultheiss TE, Lee WR, Hunt MA, et al. Late GI and GU complications in the treatment of prostate cancer. Int J Radiat Oncol Biol Phys. 1997;37:3–11.
37. Henson C. Chronic radiation proctitis: issues surrounding delayed bowel dysfunction post-pelvic radiotherapy and an update on medical treatment. Ther Adv Gastroenterol. 2010;3:359–65.
38. Peeters ST, Heemsbergen WD, van Putten WL, et al. Acute and late complications after radiotherapy for prostate cancer: results of a multicenter randomized trial comparing 68 Gy to 78 Gy. Int J Radiat Oncol Biol Phys. 2005;61:1019–34.

39. Tagkalidis PP, Tjandra JJ. Chronic radiation proctitis. ANZ J Surg. 2001;71:230–7.
40. Geraghty JM, Talbot IC. Diversion colitis: histological features in the colon and rectum after defunctioning colostomy. Gut. 1991;32:1020–3.
41. Whelan RL, Abramson D, Kim DS, et al. Diversion colitis. A prospective study. Surg Endosc. 1994;8:19–24.
42. Orsay CP, Kim DO, Pearl RK, et al. Diversion colitis in patients scheduled for colostomy closure. Dis Colon Rectum. 1993;36:366–7.
43. Harig JM, Soergel KH, Komorowski RA, et al. Treatment of diversion colitis with short-chain-fatty acid irrigation. N Engl J Med. 1989;320:23–8.
44. Korelitz BI, Cheskin LJ, Sohn N, et al. The fate of the rectal segment after diversion of the fecal stream in Crohn's disease: its implications for surgical management. J Clin Gastroenterol. 1985;7:37–43.
45. Tas A, Koklu S, Cakal B, Yildiz F, Aktas S. Psoriatic colitis mimicking ulcerative proctitis in an elderly patient. Chin Med J. 2012;125:2080.
46. Tas A, Aydin YY, Koklu MAS, Mahallesi E. Hydrogen peroxide exposure mimicking ulcerative proctitis. Dig Liver Dis. 2011;43:331.
47. Desoubeaux G, Gaillard J, Boree-Moreau D, Bailly E, Andres CR, Chandenier J. Gastrointestinal symptoms resembling ulcerative proctitis caused by larvae of the drone fly Eristalis tenax. Pathogens Global Health. 2014;108:158–63.
48. Wu X, Liu X, Katz S, Shen B. Pathogenesis, diagnosis and management of ulcerative proctitis, chronic radiation proctopathy and diversion proctitis. Inflamm Bowel Dis. 2015;21:703–15.
49. Reese GE, Constantinides VA, Simillis C, et al. Diagnostic precision of anti-Saccharomyces cerevisiae antibodies and perinuclear antineutrophil cytoplasmic antibodies in inflammatory bowel disease. Am J Gastroenterol. 2006;101:2410–22.
50. Farmer RG, Easley KA, Rankin GB. Clinical patterns, natural history, and progression of ulcerative colitis. A long-term follow-up of 1116 patients. Dig Dis Sci. 1993;38:1137–46.
51. Ayres RC, Gillen CD, Walmsley RS, Allan RN. Progression of ulcerative proctosigmoiditis: incidence and factors influencing progression. Eur J Gastroenterol Hepatol. 1996;8:555–8.
52. Kim B, Park SJ, Hong SP, Kim TI, Kim WH, Cheon JH. Proximal disease extension and related predicting factors in ulcerative proctitis. Scand J Gastroenterol. 2014;49:177–83.
53. Anzai H, Hata K, Kishikawa J, Ishii H, Nishikawa T, Tanaka T, Tanaka J, Kiyomatsu T, Kawai K, Nozawa H, Kazama S, Yamaguchi H, Ishihara S, Sunami E, Kitayama J, Watanabe T. Clinical pattern and progression of ulcerative colitis in the Japanese population: a retrospective study of incidence and risk factors influencing progression. Color Dis. 2015;18:O97–102.
54. Henriksen M, Jahnsen J, Lygren I, Sauar J, Kjellevold O, Schulz T, Vatn MH, Moum B, IBSEN Study Group. Ulcerative colitis and clinical course: results of a 5-year population-based follow-up study (the IBSEN study). Inflamm Bowel Dis. 2006;12:543–50.
55. Ekbom A, Helmick C, Zack M, Adami HO. Ulcerative colitis and colorectal cancer. A population-based study. N Engl J Med. 1990;323:1228–33.
56. Kornbluth A, Sachar DB, The Practic Parameters Committee of the American College of Gastroenterology. Ulcerative colitis practice guidelines in adults: American college of gastroenterology, practice parameters committee. Am J Gastroenterol. 2010;105:501–23.
57. Lie MRKL, Kanis SL, Hansen BE, Janneke van der Woude C. Drug therapies for ulcerative proctitis: systematic review and meta-analysis. Inflamm Bowel Dis. 2014;10:2157–78.
58. Cohen RD, Dalal SR. Systematic review: rectal therapies for the treatment of distal forms of ulcerative colitis. Inflamm Bowel Dis. 2015;21:1719–36.
59. Loew BJ, Siegel CA. Foam preparations for the treatment of ulcerative colitis. Curr Drug Deliv. 2012;9:338–44.
60. Campieri M, De Franchis R, Bianchi Porro G, et al. Mesalazine (5-aminosalicylic acid) suppositories in the treatment of ulcerative proctitis or distal proctosigmoiditis. A randomized controlled trial. Scand J Gastroenterol. 1990;25:663–8.
61. Campieri M, Gionchetti P, Belluzzi A, et al. Topical treatment with 5-aminosalicylic in distal ulcerative colitis by using a new suppository preparation. A double-blind placebo controlled trial. Int J Color Dis. 1990;5:79–81.
62. Pokrotnieks J, Marlicz K, Paradowski L, et al. Efficacy and tolerability of mesalazine foam enema (Salofalk foam) for distal ulcerative colitis: a double-blind, randomized, placebo-controlled study. Aliment Pharmacol Ther. 2000;14:1191–8.
63. van Hees PAM, Bakker JH, van Tongeren JHM. Effect of sulphapyridine, 5-aminosalicylic acid, and placebo in patient with idiopathic proctitis: a study to determine the active therapeutic moiety of sulphasalazine. Gut. 1980;21:632–5.
64. Watanabe M, Nishino H, Sameshima Y, et al. Randomised clinical trial: evaluation of the efficacy of mesalazine (mesalamine) suppositories in patients with ulcerative colitis and active rectal inflammation – a placebo-controlled study. Aliment Pharmacol Ther. 2013;38:264–73.
65. Williams CN, Haber G, Aquino JA. Double-blind, placebo-controlled evaluation of 5-asa suppositories in active distal proctitis and measurement of extent of spread using 99mTc-labeled 5-asa suppositories. Dig Dis Sci. 1987;32:71S–5S.
66. Andus T, Kocjan A, Muser M, et al. Clinical trial: a novel high-dose 1 g mesalamine suppository (Salofalk) once daily is as efficacious as a 500-mg suppository thrice daily in active ulcerative proctitis. Inflamm Bowel Dis. 2010;16:1747–56.
67. Larnet M, Ptak T, Dallaire C, et al. Efficacy and safety of mesalamine 1 g HS versus 500 mg BID

suppositories in mild to moderate ulcerative proctitis: a multicenter randomized study. Inflamm Bowel Dis. 2005;11:625–30.
68. Campieri M, Gionchetti P, Belluzzi A, et al. 5-Aminosalicylic acid as enemas or suppositories in distal ulcerative colitis. J Clin Gastroenterol. 1988;10:406–9.
69. Eliakim R, Tulassay Z, Kupcinskas L, et al. Clinical trial: randomized-controlled clinical study comparing the efficacy and safety of a low-volume vs. a high-volume mesalazine foam in active distal ulcerative colitis. Aliment Pharmacol Ther. 2007;26:1237–49.
70. Marshall JK, Thabane M, Steinhart AH, Newman JR, Anand A, Irvine EJ. Rectal 5-aminosalicylic acid for induction of remission in ulcerative colitis. Cochrane Database Syst Rev. 2010;20:CD004115.
71. d'Albasio G, Paoluzi P, Campieri M, et al. Maintenance treatment of ulcerative proctitis with mesalazine suppositories: a double blind placebo-controlled trial. Am J Gastroenterol. 1998;93:799–803.
72. d'Arienzo A, Panarese A, d'Armiento FP, et al. 5-aminosalicylic acid suppositories in the maintenance of remission in idiopathic proctitis or proctosigmoiditis: a double-blind placebo-controlled clinical trial. Am J Gastroenterol. 1990;85:1079–82.
73. Hanauer SB, Good LI, Goodman MW, et al. Long-term use of mesalamine (Rowasa suppositories in remission maintenance in ulcerative proctitis). Am J Gastroenterol. 2000;95:1749–54.
74. Marshall JK, Thabane M, Steinhart AH, Newman JR, Anand A, Irvine EJ. Rectal 5-aminosalicylic acid for maintenance of remission in ulcerative colitis. Cochrane Database Syst Rev. 2012;11:CD004118.
75. Gionchetti P, Rizzello F, Venturi A, et al. Comparison of oral with rectal mesalazine in the treatment of ulcerative proctitis. Dis Colon Rectum. 1998;41:93–7.
76. Hanauer SB, Sandborn WJ, Kornbluth A, et al. Delayed-release oral mesalamine at 4.8g/day (800mg table) for the treatment of moderately active ulcerative colitis; the ASCEND II trial. Am J Gastroenterol. 2005;100:2478–85.
77. Nilsson A, Danielsson A, Lofberg R, et al. Olsalazine versus sulphasalazine for relapse prevention in ulcerative colitis: a multicenter study. Am J Gastroenterol. 1995;90:381–7.
78. Travis SPL, Tysk C, de Silva HJ, et al. Optimum dose of olsalazine for maintaining remission in ulcerative colitis. Gut. 1994;35:1282–6.
79. Richter JM, Arshi NK, Oster G. Oral 5-aminosalicylate, mesalamine suppository and mesalamine enema as initial therapy for ulcerative proctitis in clinical practice with quality of care implications. Can J Gastroenterol. 2016;2016:6928710.
80. Seibold F, Fournier N, Beglinger C, Swiss IBD Cohort Study Group, et al. Topical therapy is underused in patients with ulcerative colitis. J Crohns Colitis. 2014;8:56–63.
81. Kane SV. Systematic review: adherence issues in the treatment of ulcerative colitis. Aliment Pharmacol Ther. 2006;23:577–85.
82. Gross V, Bar-Meir S, Lavy A, The International Budesonide Study Group, et al. Budesonide foam vs. hydrocortisone acetate foam in the treatment of active ulcerative proctosigmoiditis. Aliment Pharmacol Ther. 2006;23:303–12.
83. Hammond A, Andus T, Gierend M, German Budesonide Foam Study Group, et al. Controlled, open, randomized multicenter trial comparing the effects of treatment on quality of life, safety and efficacy of budesonide foam and betamethasone enemas in patients with active distal ulcerative colitis. Hepato-Gastroenterology. 2004;51:1345–9.
84. Hartmann F, Stein J, The BudMesa-Study Group. Clinical trial: controlled, open, randomized multicenter study comparing the effects of treatment on quality of life, safety and efficacy of budesonide or mesalazine enemas in active left-sided ulcerative colitis. Aliment Pharmacol Ther. 2010;32:368–76.
85. Biancone L, Gionchetti P, Del Vechhio Blanco G, et al. Beclomethasone dipropionate versus mesalazine in distal ulcerative colitis: a multicenter, randomized, double-blind study. Dig Liver Dis. 2007;39:329–37.
86. Gionchetti P, D'Arienzo A, Rizzello F, The Italian BDP Study Group, et al. Topical treatment of distal active ulcerative colitis with beclomethasone dipropionate or mesalamine: a single-blind randomized controlled trial. J Clin Gastroenterol. 2005;39:291–7.
87. Lindgren S, Lofberg R, Bergholm L, et al. Effect of budesonide enema on remission and relapse rate in distal ulcerative colitis and proctitis. Scand J Gastroenterol. 2002;37:705–10.
88. Hanauer SB, Robinson M, Pruitt R, U.S. Budesonide Enema Study Group, et al. Budesonide enema for the treatment of active, distal ulcerative colitis and proctitis: a dose-ranging study. Gastroenterology. 1998;115:525–32.
89. Danielsson A, Edsbacker S, Lofberg R, et al. Pharmocokinetics of budesonide enema in patients with distal ulcerative colitis or proctitis. Aliment Pharmacol Ther. 1993;7:401–7.
90. Danielsson A, Lofberg R, Persson T, et al. A steroid enema, budesonide, lacking systemic side effects for the treatment of ulcerative colitis or proctitis. Scand J Gastroenterol. 1992;27:9–12.
91. Cobden I, al-Mardini H, Zaitoun A, et al. Is topical therapy necessary in acute distal colitis? Double-blind comparison of high-dose oral mesalazine versus steroid enemas in the treatment of active distal ulcerative colitis. Aliment Pharmacol Ther. 1991;5:513–22.
92. Mulder CJJ, Fockns P, Meijer JWR, van der Heide H, Wiltink EHH, Tytgat GNJ. Beclomethasone dipropionate (3mg) versus 5-aminosalicylic acid (2g) versus the combination of both (3mg/2g) as retention enemas in active ulcerative colitis. Eur J Gastroenterol Hepatol. 1996;8:549–53.

93. Guslandi M, Giollo P, Testoni PA. A combination of rectal beclomethasone dipropionate and mesalazine in ulcerative proctitis. Scand J Gastroenterol. 2008;43:639–40.
94. Gecse KB, Lakatos PL. Ulcerative proctitis: an update on the pharmacotherapy and management. Expert Opin Pharmacother. 2014;15:1565–73.
95. Bitton A. Medical management of ulcerative proctitis, proctosigmoiditis, and left-sided colitis. Semin Gastrointest Dis. 2001;12:263–74.
96. Love MA, Rubin PH, Chapman ML, Present DH. 6-mercaptopurine is effective in intractable proctosigmoiditis. Gastroenterology. 1995;100:A832.
97. Sandborn WJ, Tremaine WJ, Schroeder KW, et al. A placebo-controlled trial of cyclosporine enemas for mildly to moderately active left-sided ulcerative colitis. Gastroenterology. 1994;106:1429–35.
98. Ardizzone S, Petrillo M, Antonacci CM, Bianchi Porro G. Sucralfate and hydrocortisone enemas in the treatment of active ulcerative proctitis – a randomized single-blind comparative study. Aliment Pharmacol Ther. 1996;10:957–60.
99. Rutgeerts P, Sandborn WJ, Feagan BG, Reinisch W, Olson A, Johanns J, Travers S, Rachmilewitz D, Hanauer SB, Lichtenstein GR, de Villiers WJ, Present D, Sands BE, Colombel JF. Infliximab for induction and maintenance therapy for ulcerative colitis. N Engl J Med. 2005;353:2462–76.
100. Bouguen G, Roblin X, Bourreille A, et al. Infliximab for refractory ulcerative proctitis. Aliment Pharmacol Ther. 2010;31:1178–85.
101. Molnar T, Farkas K, Nagy F, et al. Topically administered infliximab can work in ulcerative proctitis despite the ineffectiveness of intravenous induction therapy. Am J Gastroenterol. 2009;104:1857–8.
102. Lawrance IC, Copeland TS. Rectal tacrolimus in the treatment of resistant ulcerative proctitis. Aliment Pharmacol Ther. 2008;28:1214–20.
103. van Dieren JM, van Bodegraven AA, Kuipers EJ, et al. Local application of tacrolimus in distal colitis: feasible and safe. Inflamm Bowel Dis. 2009;15:193–8.
104. Schmidt KJ, Herrlinger KR, Emmrich J, et al. Short-term efficacy of tacrolimus in steroid-refractory ulcerative colitis-experience in 130 patients. Aliment Pharmacol Ther. 2013;37:129–36.
105. Makiyama K, Takeshima F, Hamamoto T. Efficacy of rebamipide enemas in distal ulcerative colitis and proctitis: a prospective study report. Dig Dis Sci. 2005;50:2323–9.
106. Furuta R, Ando T, Watanabe O, Maeda O, Ishiguro K, Ina K, Kusugami K, Goto H. Rebamipide enema therapy as a treatment for patients with active distal ulcerative colitis. J Gastroenterol Hepatol. 2007;22:261–7.
107. Sinha A, Nightingale J, West KP, et al. Epidermal growth factor enemas with oral mesalamine for mild-to-moderate left-sided ulcerative colitis or proctitis. N Engl J Med. 2003;349:350–7.
108. Kono T, Nomura M, Kasai S, et al. Effect of escabet sodium enema on mildly to moderately active ulcerative proctosigmoiditis: an open-label study. Am J Gastroenterol. 2001;96:793–7.
109. Arlander E, Ost A, Stahlberg D, et al. Ropivacaine gel in active distal ulcerative colitis and proctitis – a pharmacokinetic and exploratory clinical study. Aliment Pharmacol Ther. 1996;10:73–81.
110. Ng SC, Lam YT, Tsoi KK, et al. Systematic review: the efficacy of herbal therapy in inflammatory bowel disease. Aliment Pharmacol Ther. 2013;38:854–63.
111. Fukunaga K, Ohda Y, Hida N, et al. Placebo controlled evaluation of Xilei San, a herbal preparation in patients with intractable ulcerative proctitis. J Gastroenterol Hepatol. 2012;27:1808–15.
112. Zhang F, Li Y, Xu F, Chu Y, Zhao W. Comparison of Xilei-san, a Chinese herbal medicine, and dexamethasone in mild/moderate ulcerative proctitis: a double-blind randomized clinical trial. J Altern Complement Med. 2013;19:838–42.
113. Actis GC, Rosina F, Pellicano R. A case of appendectomy as main therapeutic intervention for complex co-morbid ulcerative colitis. Int J Color Dis. 2015;30:1747–8.
114. Bolin TD, Wong S, Crouch R, Engelman JL, Riordan SM. Appendicectomy as a therapy for ulcerative proctitis. Am J Gastroenterol. 2009;104:2476–82.
115. Shen B. Diagnosis and management of postoperative ileal pouch disorders. Clin Colon Rectal Surg. 2010;23:259–68.
116. Kariv R, Remzi FH, Lian L, et al. Preoperative colorectal neoplasia increases risk for pouch neoplasia in patients with restorative proctocolectomy. Gastroenterology. 2010;139:806–12.
117. Shen B, Lashner BA, Bennett AE, et al. Treatment of rectal cuff inflammation (cuffitis) in patients with ulcerative colitis following restorative proctocolectomy and ileal pouch-anal anastomosis. Am J Gastroenterol. 2004;99:1527–31.
118. Wu B, Lian L, Li Y, Remzi FH, Liu X, Kiran RP, Shen B. Clinical course of cuffitis in ulcerative colitis patients with restorative proctocolectomy and ileal pouch-anal anastomoses. Inflamm Bowel Dis. 2013;19:404–10.
119. Economou M, Pappas G. New global map of Crohn's disease: genetic, environmental, and socioeconomic correlations. Inflamm Bowel Dis. 2008;14:709–20.
120. Loftus EV Jr, Silverstein MD, Sandborn WJ, Tremaine WJ, Harmsen WS, Zinsmeister AR. Crohn's disease in Olmsted County, Minneosta, 1940-1993: incidence, prevalence, and survival. Gastroenterology. 1998;114:1161–8.
121. Kappelman MD, Rifas-Shiman SL, Kleinman K, Ollendorf D, Bousvaros A, Grand RJ, et al. The prevalence and geographic distribution of Crohn's disease and ulcerative colitis in the United States. Clin Gastroenterol Hepatol. 2007;5:1424–9.
122. Binder V. Epidemiology of IBD during the twentieth century: an integrated view. Best Pract Res Clin Gastroenterol. 2004;18:463–79.

123. Hellers G, Bergstrand O, Ewerth S, Holmstrom B. Occurrence and outcome after primary treatment of anal fistulae in Crohn's disease. Gut. 1980;21:525–7.
124. Jostins L, Ripke S, Weersma RK, et al. Host-microbe interactions have shaped the genetic architecture of inflammatory bowel disease. Nature. 2012;491:119–24.
125. Swidsinski A, Loening-Baucke V, Herber A. Mucosal flora in Crohn's disease and ulcerative colitis – an overview. J Physiol Pharmacol. 2009;60(suppl 6): 61–71.
126. Gersemann M, Wehkamp J, Stange EF. Innate immune dysfunction in inflammatory bowel disease. J Intern Med. 2012;271:421–8.
127. Rutgeerts P, Goboes K, Peeters M, Hiele M, Penninckx F, Aerts R, et al. Effect of fecal diversion on recurrence of Crohn's disease in the neoterminal ileum. Lancet. 1991;338:771–4.
128. Ekbom A, Montgomery SM. Environmental risk factors (excluding tobacco and microorganisms): critical analysis of old and new hypotheses. Best Pract Res Clin Gastroenterol. 2004;18:497–508.
129. Jantchou P, Monnet E, Carbonnel F. Environmental risk factors in Crohn's disease and ulcerative colitis (excluding tobacco and appendicectomy). Gastroenterol Clin Biol. 2006;30:859–67.
130. Melum E, Franke A, Karlsen TH. Genome-wide association studies – a summary for the clinical gastroenterologist. World J Gastroenterol. 2009;15:5377–96.
131. Barrett JC, Hansoul S, Nicolae DL, et al. Genome-wide association defines more than 30 distinct susceptibility loci for Crohn's disease. Nat Genet. 2008;40:955–62.
132. Brochard C, Siproudhis L, Wallenhorst T, Cuen D, d'Halluin PN, Garros A, Bretagne JF, Bouguen G. Anorecatl stricture in 102 patients with Crohn's disease: natural history in the era of biologics. Aliment Pharmacol Ther. 2014;30:796–803.
133. Church JM, Fazio VW, Lavery IC, Oakley JR, Milsom JW. The differential diagnosis and comorbidity of hidradenitis suppurativa and perianal Crohn's disease. Int J Color Dis. 1993;8:117–9.
134. Schwartz DA, Wiersema MJ, Dudiak KM, et al. A comparison of endoscopic ultrasound, magnetic resonance imaging, and exam under anesthesia for evaluation of Crohn's perianal fitulas. Gastroenterology. 2001;121:1064–72.
135. Schaefer O, Lohrmann C, Langer M. Assessment of anal fistulas with high-resolution subtraction MR-fistulography: comparison with surgical findings. J Magn Reson Imaging. 2004;19:91–8.
136. Beets-Tan RG, Beets GL, van der Hoop AG, et al. Preoperative MR imaging of anal fistulas: does it really help the surgeon? Radiology. 2001;218:75–84.
137. Crohn BB, Ginzberg L, Oppenheimer GD. Regional ileitis: a pathologic and clinical entity. JAMA. 1932;99:1323.
138. Colles A. Practical observations upon certain diseases of intestines, colon and rectum. Dublin Hosp Rep. 1830;5:131.
139. Penner A, Crohn BB. Perianal fistulae as a complication of regional ileitis. Ann Surg. 1938;108:867–73.
140. McClane SJ, Rombeau JL. Anorectal Crohn's disease. Surg Clin North Am. 2001;81:169–83.
141. Sandborn WJ, Fazio VW, Feagan BG, Hanauer SB, American Gastroenterological Association Clinical Practice Committee. AGA technical review on perianal Crohn's disease. Gastroenterology. 2003;125:1508–30.
142. Schwartz DA, Loftus EV Jr, Tremaine WJ, et al. The natural history of fistulizing Crohn's disease in Olmsted County, Minnesota. Gastroenterology. 2002;1222:875–80.
143. Cosnes J, Cattan S, Blain A, et al. Long-term evolution of disease behavior of Crohn's disease. Inflamm Bowel Dis. 2002;8:244–50.
144. Roberts PL, Schoetz DJ Jr, Pricolo R, Veidenheimer MC. Clinical course of Crohn's disease in older patients. A retrospective study. Dis Colon Rectum. 1990;33:458–62.
145. American Gastroenterological Association Clinical Practice Committee. American Gastroenterological Association medical position statement: perianal Crohn's disease. Gastroenterology. 2003;125:1503–7.
146. Beaugerie L, Seksik P, Nion-Larmurier I, Gendre JP, Cosnes J. Predictors of Crohn's disease. Gastroenterology. 2006;130:650–6.
147. Rankin GB, Watts HD, Melnyk CS, Kelley ML Jr. National Cooperative Crohn's Disease Study: extraintestinal manifestations and perianal complications. Gastroenterology. 1979;77:914–20.
148. Gelbmann CM, Rogler G, Gross V, et al. Prior bowel resections, perianal disease, and a high initial Crohn's disease activity index are associated with corticosteroid resistance in active Crohn's disease. Am J Gastroenterol. 2002;97:1438–45.
149. Neilsen OH, Rogler G, Hahnloser D, Thomsen O. Diagnosis and management of fistulizing Crohn's disease. Nat Clin Prac Gastroenterol Hepatol. 2009;6:92–106.
150. Sparberg M, Kirnser JB. Long term corticosteroid therapy for regional enteritis: an analysis of 58 courses in 54 patients. Am J Dig Dis. 1966;11:865–80.
151. Vavricka SR, Rogler G. Fistula treatment: the unresolved challenge. Dig Dis. 2010;28:556–64.
152. Jakobovits J, Schuster MM. Metronidazole therapy for Crohn's disease and associated fistulae. Am J Gastroenterol. 1984;79:533–40.
153. Brandt LJ, Bernstein LH, Boley SJ, Frank MS. Metronidazole therapy for perianal Crohn's disease: a follow-up study. Gastroenterology. 1982;83:383–7.
154. Turunen U, Farkkila M, Seppala K. Long-term treatment of peri-anal or fistulous Crohn's disease with ciprofloxacin. Scand J Gastroenterol. 1989;24:144.
155. Wolf J. Ciprofloxacin may be useful in Crohn's disease. Gastroenterology. 1990;98:A212.
156. Solomon M, McLeod R, et al. Combination ciprofloxacin and metronidazole in severe perianal Crohn's disease. Can J Gastroenterol. 1993;7:571–3.

157. Thia KT, Mahaevan U, Feagan BG, Wong C, Cockeram A, Bitton A, Bernstein CN, Sandborn WJ. Ciprofloxacin or metronidazole for the treatment of perianal fistulas in patients with Crohn's disease: a randomized, double-blind, placebo-controlled pilot study. Inflamm Bowel Dis. 2009;15:17–24.
158. Bressler B, Sands BE. Review article: medical therapy for fistulizing Crohn's disease. Aliment Pharmacol Ther. 2006;24:1283–93.
159. Bar F, Sina C, Fellerman K. Thiopurines in inflammatory bowel disease revisited. World J Gastroenterol. 2013;19:1699–706.
160. Lecomte T. Predictive factors of response of perianal Crohn's disease to azathioprine and 6-mercaptopurine. Dis Colon Rectum. 2003;46:1469–147.
161. Pearson DC, May GR, Fick GH, Sutherland LR. Azathioprine and 6-mercaptopurine in Crohn's disease: a meta-analysis. Ann Intern Med. 1995;123:132–42.
162. Present DH, Korelitz BI, Wisch N, Glass JL, et al. Treatment of Crohn's disease with 6-mercaptopurine: a long-term, randomized, double blind study. N Engl J Med. 1980;302:981–7.
163. Dejaco C, Harrer M, Waldhoer T, et al. Antiobiotics and azathioprine for the treatment of perianal fistulas in Crohn's disease. Aliment Pharmacol Ther. 2003;18:1113–20.
164. Topstad DR, Panaccione R, et al. Combined seton placement, infliximab infusion, and maintenance immunosuppressives improve healing rate in fitsulizing anorectal crohns disease: a single center experience. Dis Colon Rectum. 2003;46:577–83.
165. Present DH, Rutgeerts P, Targan S, et al. Infliximab for the treatment of fistulas in patients with Crohn's disease. N Engl J Med. 1999;340:1398–405.
166. Sands B, Van Deventer S, Bernstein C. Long-term treatment of fistulizing Crohn's disease: response to infliximab in ACCENT II trials through 54 weeks. Gastroenterology. 2002;122:A81.
167. Hanauer SB, Sandborn WJ, Rutgeerts P, et al. Human anti-tumor necrosis factor monoclonal antibody (adalimumab) in Crohn's disease: the CLASSIC-I trial. Gastroenterology. 2006;130:323–33.
168. Colombel JF, Schwartz DA, Sandborn WJ, et al. Adalimumab for the treatment of fistulas in patients with Crohn's disease. Gut. 2009;58:940–8.
169. Sandborn WJ, Feagan BG, Stoinov S, et al. Certolizumab pegol for the treatment of Crohn's disease. N Engl J Med. 2007;357:228–38.
170. Schreiber S, Lawrance IC, Thomsen OO, et al. Randomised clinical trial: certolizumab pegol for fistulas in Crohn's disease – subgroup results from a placebo-controlled study. Aliment Pharmacol Ther. 2011;33:185–19.
171. Pikarsky AJ, Gervaz P, Wexner SD. Perianal Crohn disease: a new scoring system to evaluate and predict outcome of surgical intervention. Arch Surg. 2002;137(7):774–7.
172. Cracco N, Zinicola R. Is haemorrhoidectomy in inflammatory bowel disease harmful? An old dogma re-examined. Color Dis. 2014;16:516–9.
173. Fleshner PR, Schoetz DJ Jr, Roberts PL, et al. Anal fissure in Crohn's disease: a plea for aggressive management. Dis Colon Rectum. 1995;38:1137–43.
174. Buchmann P, Keighley MR, Allan RN, et al. Natural history of perianal Crohn's disease. Ten year follow-up: a plea for conservatism. Am J Surg. 1980;140:642–4.
175. Bergstrand O, Ewerth S, Hellers G, et al. Outcome following treatment of anal fistulae in Crohn's disease. Acta Chir Scand Suppl. 1980;500:43–4.
176. Makowiec F, Jehle EC, Becker HD, et al. Perianal abscess in Crohn's disease. Dis Colon Rectum. 1997;40:443–340.
177. Pascua M, Su C, Lweis JD, Brensinger C, Lichtenstein GR. Meta-analysis: factors predicting post-operative recurrence with placebo therapy in patients with Crohn's disease. Aliment Pharmacol Ther. 2008;28:545–56.
178. Sangwan YP, Schoetz DJ Jr, Murray JJ, Roberts PL, Coller JA. Perianal Crohn's disease. Results of local surgical treatment. Dis Colon Rectum. 1996;39:529–35.
179. Faucheron JL, Saint-Marc O, Guiber L, Parc R. Long-term seton drainage for high anal fistulas in Crohn's disease – a sphincter-saving operation? Dis Colon Rectum. 1996;39:208–11.
180. Thornton M, Solomon MJ. Long-term indwelling seton for complex anal fistulas in Crohn's disease. Dis Colon Rectum. 2005;48:459–63.
181. Buchanan GN, Owen HA, Torkington J, Lunniss PJ, Nicholls RJ, Cohen CR. Long-term outcome following loose-seton technique for external sphincter preservation in complex anal fistula. Br J Surg. 2004;91:476–80.
182. Eitan A, Koliada M, Bickel A. The use of the loose seton technique as a definitive treatment for recurrent and persistent high trans-sphincteric anal fistulas: a long-term outcome. J Gastrointest Surg. 2009;13:1116–9.
183. Halme L, SAinio AP. Factors related to frequency, type, and outcome of anal fistulas in Crohn's disease. Dis Colon Rectum. 1995;38:55–9.
184. Levin DH, Surrell J, Mazier WP. Surgical treatment of anorectal fistula in pateints with Crohn's disease. Surg Gynecol Obstet. 1989;169:133–6.
185. Fuhrman GM, Larach SW. Experience with perirectal fistulas in patients with Crohn's disease. Dis Colon Rectum. 1989;32:847–8.
186. Sonoda T, Hull T, Piedmonte MR, Fazio VW. Outcomes of primary repair of anorectal and rectovaginal fistulas using the endorectal advancement flap. Dis Colon Rectum. 2002;45:1622–8.
187. Mizrahi N, Wexner SD, Zmora O, Da Silva G, Efron J, Weiss EG, Vernava AM, Nogueras JJ. Endorectal advancement flap: are there predictors of failure? Dis Colon Rectum. 2002;45:1616–21.

188. Jarrar A, Church J. Advancement flap repair: a good option for complex anorectal fistulas. Dis Colon Rectum. 2011;54:1537–41.
189. Soltani A, Kaiser AM. Endorectal advancement flap for cryptoglandular or Crohn's fistula-in-ano. Dis Colon Rectum. 2010;53:486–95.
190. Rojanasakul A. LIFT procedure: a simplified technique for fistula-in-ano. Tech Coloproctol. 2009;13:237–40.
191. Bleier JI, Moloo H, Goldberg SM. Ligation of the intersphincteric fistula tract: an effective new technique for complex fistulas. Dis Colon Rectum. 2010;53:43–6.
192. Ooi K, Skinner I, Croxford M, Faragher I, McLaughlin S. Managing fistula-in-ano with ligation of the intersphincteric fistula tract procedure: the Western Hospital experience. Color Dis. 2012;14:599–603.
193. Shanwani A, Nor AM, Amri N. Ligation of the intersphincteric fistula tract (LIFT): a sphincter-saving technique for fistula-in-ano. Dis Colon Rectum. 2010;53:39–42.
194. Gingold DS, Murrell ZA, Fleshner PR. A prospective evaluation of the ligation of the intersphincteric tract procedure for complex anal fistula in patients with Crohn's disease. Ann Surg. 2014;260:1057–61.
195. O'Riordan JM, Datta I, Johnston C, Baxter NN. A systematic review of the anal fistula plug for patients with Crohn's and non-Crohn's related fistula-in-ano. Dis Colon Rectum. 2012;55:351–8.
196. Garg P, Song J, Bhatia A, Kalia H, Menon GR. The efficacy of anal fistula plug in fistula-in-ano: a systematic review. Color Dis. 2010;12:965–70.
197. Gonsalves S, Sagar P, Lengyel J, Morrison C, Dunham R. Assessment of the efficacy of the rectovaginal button fistula plug for the treatment of ileal pouch-vaginal and rectovaginal fistulas. Dis Colon Rectum. 2009;52:1877–81.
198. Ellis CN. Outcomes after repair of rectovaginal fistulas using bioprosthetics. Dis Colon Rectum. 2008;51:1084–8.
199. Cintron JR, Park JJ, Orsay CP, Pearl RK, Nelson RL, Abcarian H. Repair of fistulas-in-ano using autologous fibrin tissue adhesive. Dis Colon Rectum. 1999;42:607–13.
200. Cintron JR, Park JJ, Orsay CP, et al. Repair of fistulas-in-ano using fibrin adhesive: long-term follow-up. Dis Colon Rectum. 2000;43:944–9.
201. Park JJ, Cintron JR, Orsay CP, et al. Repair of chronic anorectal fistulae using commercial fibrin sealant. Arch Surg. 2000;135:166–9.
202. Swinscoe MT, Ventakasubramaniam AK, Jayne DG. Fibrin glue for fistula-in-ano: the evidence reviewed. Tech Coloproctol. 2005;9:89–94.
203. Zmora O, Neufeld D, Ziv Y, et al. Prospective, multicenter evaluation of highly concentrated fibrin glue in the treatment of complex cryptogenic perianal fistulas. Dis Colon Rectum. 2005;48:2167–72.
204. Sehgal R, Koltun WA. Fibrin glue for the treatment of perianal fistulous Crohn's disease. Gastroenterology. 2010;138:2216–9.
205. Grimaud JC, Munoz-Bongrand N, Siproudhis L, Abramowitz L, Senejoux A, Vitton V, Gambiez L, Flourie B, Hebuterne X, Louis E, Coffin B, De Parades V, Savoye G, Soule JC, Bouhnik Y, Colombel JF, Contou JF, Francois Y, Mary JY, Lemann M. Groupd d'Etude therapeutique des affections inflammatories du tube digestif. Gastroenterology. 2010;138:2275–81.
206. Loungnarath R, Dietz DW, Mutch MG, Birnbaum EH, Kodner IJ, Fleshner JW. Fibrin glue treatment of complex anal fistulas has low success rate. Dis Colon Rectum. 2004;47:432–6.
207. Panés J, García-Olmo D, Van Assche G, Colombel JF, Reinisch W, Baumgart DC, Dignass A, Nachury M, Ferrante M, Kazemi-Shirazi L, Grimaud JC, de la Portilla F, Goldin E, Richard MP, Leselbaum A, Danese S, ADMIRE CD Study Group Collaborators. Expanded allogeneic adipose-derived mesenchymal stem cells (Cx601) for complex perianal fistulas in Crohn's disease: a phase 3 randomised, double-blind controlled trial. Lancet. 2016;388(10051):1281–90. https://doi.org/10.1016/S0140-6736(16)31203-X. Epub 2016 Jul 29.
208. Galandiuk S, Kimberling J, Al-Mishlab TG, Stromberg AJ. Perianal Crohn's disease: predictors of need for permanent diversion. Ann Surg. 2005;241:796–801. discussion 801-802
209. Yamamoto T, Allan RN, Keighley MR. Effect of fecal diversion alone on perianal Crohn's disease. World J Surg. 2000;24:1258–62. discussion 1262-1263
210. Figg RE, Church JM. Perineal Crohn's disease: an indicator of poor prognosis and potential proctectomy. Dis Colon Rectum. 2009;52:646–50.
211. Yamamoto T, Bain IM, Allan RN, Keighley MR. Persistent perineal sinus after proctocolectomy for Crohn's disease. Dis Colon Rectum. 1999;42:96–101.
212. Causey MW, Nelson D, Johnson EK, Maykel J, Davis B, Rivadeneira DE, Champagne D, Steele SR. An NSQIP evaluation of practice patterns and outcomes following surgery for anorectal abscess and fistula in patients with and without Crohn's disease. Gastroenterol Rep. 2013;1:58–63.

Other Proctitides

30

Giovanna Dasilva and Radhika Smith

Introduction

Proctitis, or inflammation of the rectum, can come from a myriad of causes including infection, exposure to radiation, proximal diversion of the fecal stream, medications and idiopathic conditions. Symptoms typically include blood per rectum, tenesmus, and diarrhea, and like all other pathologies treated by a colorectal surgeon, the evaluation and management requires a thorough history and a complete physical with a full endoscopic exam when appropriate.

General Evaluation

The evaluation of patients with proctitis in the outpatient or the emergency room setting should be performed using a systematic evaluation.

History

All patients should have a complete history taken to develop and narrow a differential diagnosis. Questions regarding the patient's general health, immunosupression, and constitutional symptoms such as fever, weight loss, and night sweats should be ascertained. A thorough gastrointestinal history should focus on consistency, caliber, and frequency of bowel movements with a note of any changes from baseline. The presence of symptoms such as mucus, blood per rectum and pain in the abdominal, pelvic and/or perianal region should be determined and the duration of these symptoms assessed. Risk factors for sexually transmitted disease and a history of anoreceptive intercourse should be considered. Many key factors in the history can suggest the etiology of rectal inflammation. History of travel to endemic regions and exposure to sick contacts may suggest an infectious etiology. Use of non-steroidal anti-inflammatory drugs (NSAIDs), antibiotics, a history of pelvic radiation, and recent administration of chemotherapy can intimate an iatrogenic causes of symptoms. Furthermore, patients who are immunocompromised or have a history of HIV are at risk for specific infections such as cryptosporidiosis or cytomegalovirus and practitioners must have a high index of suspicion when evaluating these patients.

Physical Exam

Following a full history, an essential part of patient evaluation is a thorough physical exam. The patient should be placed in the lateral decubitus or

G. Dasilva (✉)
Department of Colorectal Surgery, Cleveland Clinic Florida, Weston, FL, USA
e-mail: dasilvg@ccf.org

R. Smith
Department of Colorectal Surgery, University of Chicago Medical Center, Chicago, IL, USA

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_30

in the prone position. The perianal skin should be fully evaluated for abscess, fissures and fistulas. Skin changes such as erythema and excoriations may be related to chronic diarrhea often found in proctitis. Patients with herpes or syphilis may also present with lesions on the perianal skin or anal margin. Digital exam should be routinely preformed unless the patient experiences significant perianal pain. Pain on exam, fluctuance, or induration may suggest perianal abscess or another infectious process. Sphincter tone, the presence of any mass or internal ulceration, and the presence of anal stenosis should be evaluated. Anoscopy should be performed following digital exam. The anorectal mucosa should be thoroughly inspected in all four quadrants for irregularities, friability, internal openings, and ulcerations. Complex perianal fistulas may be cryptoglandular in origin from chronic diarrhea, related to Crohn's disease, or from specific infectious etiologies such as amebiasis, tuberculosis or actinomycosis.

Endoscopic Evaluation

If further examination is required, flexible sigmoidoscopy should be completed without bowel preparation to maintain any exudates and prevent washout of any organism to be biopsied or cultured. The mucosa should be inspected for erythema, contact friability, telangectasias, erosions, ulcerations, bleeding, purulence, or exudates. Cultures and biopsies should be taken and the region of abnormality should be documented. If severe inflammation is encountered, endoscopy should proceed with extreme caution to avoid perforation.

Stool and Blood Testing

Stool should be routinely cultured in patients presenting with diarrhea and proctitis. Frequently encountered organisms include *Salmonella typhi*, *Shigella*, *Aeromonas hydrophelia*, *Campylobacter jejuni*, and *Yersinia enterocolitis*. Three specimens should be sent from different bowel movements. Patients at risk for sexually transmitted infection should have any mucopurulent discharge sent for Neisseria gonorrhea and Chlamydia culture (see Chap. 27). Fungal cultures should be submitted in immunocompromised patients. Similarly, viral infections are typically found in patients who are immunosuppressed and are more prevalent in the homosexual male population. Specific pathogens include cytomegalovirus and herpes simplex. Microscopic analysis for stool ova and parasites is also indicated in patients with chronic diarrhea and proctitis. Multiple samples should be sent to prevent false negatives from intermittent shedding.

If history, anorectal examination, and stool studies do not reveal the source of symptoms complete mucosal evaluation and upper gastrointestinal evaluation with endoscopy should be performed.

Infectious Etiology

Clostridium difficile

Clostridium difficile (c. difficile) is an anaerobic, gram-positive rod that may be a part of the normal milieu of the colon. *C. difficile* can be pathologic with alterations in the normal flora of the colon following the administration of antibiotics or after fecal oral transmission. It is the leading cause of infectious diarrhea in hospitals in the developed world, including up to 20% of reported antibiotic-associated diarrhea and nearly all incidences of pseudomembranous colitis [1]. The prevalence and severity of *c. difficile* infection (CDI) has dramatically increased since early 2000, which was felt to be related to the emergence of more virulent strains of the bateria [2]. The incidence of CDI has increased by 200% between 2000 and 2005, and has continued to raise almost exponentially every year [3].

The presentation of CDI can be highly variable. Patients can be asymptomatic carriers without clinical manifestations or can develop severe life threatening colitis. In all patients with diarrhea, CDI should be suspected. A history should be obtained to determine exposure to antibiotics within the last 3 months, contact with infected individuals, or recent hospitalizations. Symptoms include diarrhea, abdominal pain, and distention. In about 5–10% of patients, severe infections can

be associated with diarrhea, multi-organ system failure, and sepsis. While any antibiotic can cause CDI, the most common class of antibiotics include penicillins, clindamycin, fluoroquinolones, and third-generation cephalosporins [4].

A complete physical examination including thorough abdominal examination and digital rectal exam should be performed and early surgical consultation is of paramount importance. The presence of peritonitis has been associated with a mortality rate of up to 80% and should mandate serious consideration of surgical intervention following aggressive fluid resuscitation [5].

Laboratory testing including complete blood count and liver and renal function can help determine severity of infection and associated sepsis. The most reliable diagnostic study for patients with suspected CDI is polymerase chain reaction (PCR)-based stool assays. If an urgent result is required, endoscopy can also be performed. Infection most commonly involves the colon but can also cause active proctitis. The endoscopic finding typically associated with CDI is pseudomembranes covering the colonic mucosa (Fig. 30.1). It is important to note pseudomembranes are only present in 45–55% of patients with positive stool studies [6]. The primary benefit of a diagnostic lower endoscopy is to exclude other types of colitides, such as cytomegalovirus, graft-versus-host disease, inflammatory bowel disease (IBD), and ischemic colitis [7]. CT scan can also be adjunctive to assess degree and extent of inflammation but is not required.

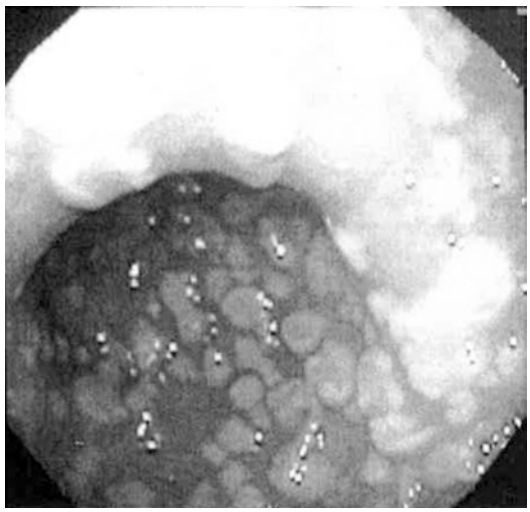


Fig. 30.1 Endoscopic appearance of pseudomembranes

Treatment should consist of early diagnosis followed by fluid resuscitation and early administration of antibiotics. Initial antibiotic therapy consists of either metronidazole or vancomycin. For mild-to-moderate disease in fit patients, metronidazole should be used to limit the development of vancomycin resistance. More severe or complicated disease such as those in patients with leukocytosis (>15,000 cells/μL), leukopenia (<4000 cells/μL), bandemia (>10% bands), or elevated serum creatinine (>1.5 mg/dL) should be treated with oral vancomycin. Fidoxamicin, an oral macrocyclic antibiotic, has similar efficacy with a decreased recurrence rate and can also be used in the treatment of CDI. Once stable, patients should be treated with a total of 10–14 days of antibiotics although this is not supported by prospective data.

Probiotics also have a role in the treatment of CDI. They reestablish the GI flora that has been deranged after treatment with antibiotics that typically incites *c. difficile* colitis. Early randomized controlled trials and systematic reviews demonstrated no improvement in the treatment or prevention of infection [8, 9]. However, a subsequent meta-analysis of 20 trials and a Cochrane Review of 31 studies have demonstrated a decreased incidence in *C. difficile*-associated diarrhea, though not CDI, with the use of probiotics [10, 11].

Patients with symptoms refractory to medical therapy, or with evidence of shock, megacolon, peritonitis, or perforation should be treated with emergent surgery. Early surgical intervention in patients with severe, complicated disease is of paramount importance in decreasing morbidity and mortality rates. Subtotal colectomy with end ileostomy is the operative procedure of choice for CDI. In this setting, subtotal colectomy has had mortality rates cited as high as 80%, and small series have suggested laparoscopic diversion with antegrade lavage [12]. Despite excellent success in these small series, there have been no randomized controlled trials to support this treatment.

Patients with refractory CDI for whom conventional treatments have failed may also be considered for fecal transplantation. Fresh stool from healthy donors is directly infused into the cecum through colonoscopy. Alternative routes include nasogastric tubes, nasoduodenal tubes, or retention enema. This technique works by restoring the normal colonic flora and reestablishing balance in the colon. The rates of success are very promising from 83 to 92% after a single treatment [13–15]. Follow up trails have reported complete remission in 70–100% of patients [13]. Studies have also found fecal transplant when used with vancomycin to be more successful than oral vancomycin with and without bowel lavage in eradication of CDI [16].

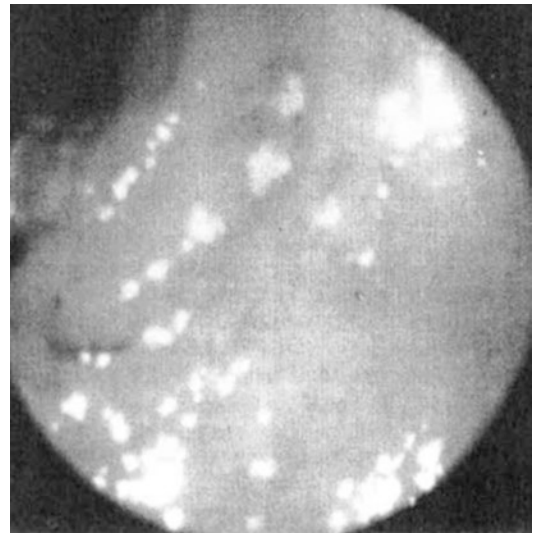


Fig. 30.2 Endoscopic appearance of *Entamoeba histolytica*

Entamoeba histolytica

Entamoeba histolytica (*E. histolytica*) is the most common cause of protozoan-induced infectious diarrhea. Worldwide, approximately 10% of people are colonized and in the US the carrier rate is about 5% [17].

Ingestion of the cyst of *E. histolytica* from contaminated food or water precedes infection. This is a daily occurence among patients in poor areas in the developing world and should be considered in any patient with recent travel or immigration from to those areas with diarrhea. Infection and colonization is also more common in institutionalized individuals.

Once the cyst is ingested, excystation in the intestinal lumen produces trophozoites that use the galactose and *N*-acetyl-D-galactosamine (Gal/GalNAc)–specific lectin to adhere to colonic and rectal mucin [18]. This process allows the trophozoite to permeate the intestinal mucous layer [19]. The parasite engages the colonic and rectal epithelium by binding to *N*-acetyl-D-galactosamine on O-linked cell-surface oligosaccharides and begins to kill epithelial cells, neutrophils, and lymphocytes [18]. This mechanism causes an intense inflammatory response that leads to proctocolitis, which manifests as diarrhea as both the trophozoite and the cysts are shed in the stool; however patients may be asymptomatic. The cysts are resilient outside the human host and go on to infect other patients once ingested. In a small percentage of patients the parasite invades the colonic wall and can disseminate to the liver leading to an amebic liver abscess.

Symptomatic amebic colitis is typically mild with several weeks of cramping abdominal pain, weight loss, and diarrhea. The disease can however present on a spectrum ranging from no symptoms to severe life threatening illness. Asymptomatic infection should be treated because of its potential to progress to invasive disease and resulting liver abscess.

Microscopic detection of trophozites in the stool is the most common modality used to diagnosis infection with *E. histolytica*. These motile trophozoites with ingested red cells should be documented, and three negative smears are required to rule out the disease. Other tests include serology such as indirect hemagglutination, immunoelectrophoresis, and enzyme-linked immunosorbent assay (ELISA). Endoscopic evaluation of the colon should be performed without bowel prep to preserve trophozoites in the colonic mucosa. Diffuse erythema with small round ulcers covered with yellow exudates is a typical finding (Fig. 30.2). Biopsies of these lesions should be taken on the margins of the lesions and will demonstrate flasked shaped ulcers with a small mucosal opening and a wide submucosal base (Fig. 30.3).

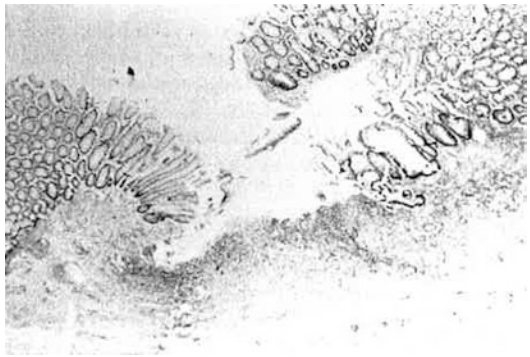


Fig. 30.3 Classic flasked shaped ulcers seen with *Entamoeba histolytica*

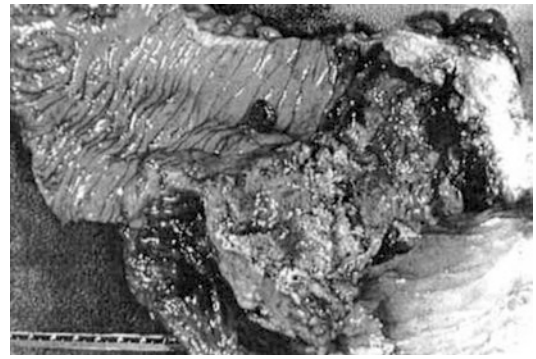


Fig. 30.5 Gross appearance of colonic ameboma

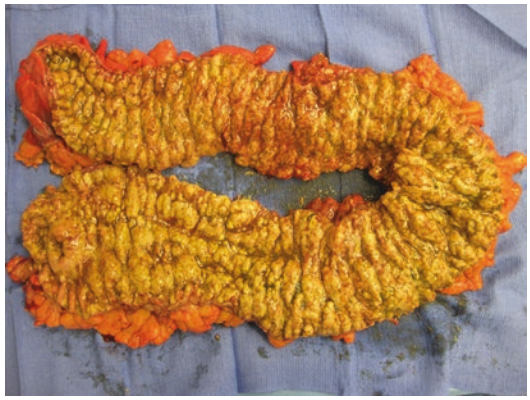


Fig. 30.4 Fulminant *C. difficule* colitis

Treatment is dependent on the severity of the illness. Oral metronidazole 750 mg three times daily for 10 days is the first line therapy for patients with mild disease with a very favorable response. In the case of more severe or fulminant amebic colitis, broad spectrum antibiotics can be added to prevent translocation (Fig. 30.4). Patients who develop an acute abdomen, severe and refractory gastrointestinal bleeding, or toxic megacolon need surgical intervention with subtotal colectomy.

Other clinical manifestations include the presence of an ameboma (Fig. 30.5). This inflammatory mass has fibrosis and granulomatous changes, which rarely cause complete obstruction, but can be confused with a neoplastic process, and cause bleeding, pain or serve as the lead point of intussusception. Rarely, *E. histolytica* can cause perianal fistula.

Amebic liver abscess should be primarily managed with oral antibiotics. Occasionally, precutaneous drainage is required as an adjunct therapy. Drainage of the abscess should be considered in patients who do not respond to antibiotics or who are at high risk for rupture including abscess >5 cm or lesions in the left lobe of the liver [20].

Shigella

Shigella causes about 500,000 cases annually of diarrhea in the United States [21]. The most common species in the US is S*higella sonnei*. Symptoms include diarrhea, fever, abdominal pain and tenesmus. They start 1–2 days after exposure and last approximately 1 week. Post-infectious irritable bowel syndrome can last several months after the initial course. Long-term consequences after *shigella* infections include post-infectious arthritis (after infection with *Shigella flexneri)*, bacteremia, seizures, and hemolytic-uremic syndrome.

Shigellosis is diagnosed by stool culture and endoscopic findings show non-specific findings including inflamed, friable, and ulcerated mucosa.

Most cases of Shigellosis are self-limited however the addition of antibiotics can shorten clinical illness and limit the time of active shedding of the disease. The antibiotic of choice is fluoroquinolones for three days. However, longer courses are indicated in patients with S. dysenteriae type 1 or with HIV coinfection [22]. Of note, antibiotic resistance is common with *Shigella* and should be adjusted to sensitivities when stool culture is available.

Salmonella

Salmonella is a gram-negative pathogen that is the most common cause of food born enterocolitis in the US. The CDC estimates the annual incidence of acute salmonella infection to be approximately 1.2 million people a year, and that this infection is responsible for 450 deaths in the US, annually [23].

Transmission of Salmonella is typically through a contaminated food or water source but fecal-oral contamination can also occur. It is most commonly seen in the US when the food ingested is raw or undercooked, particularly eggs, beef, seafood, and poultry. Additionally, exposure to turtles, snakes, lizards, and baby birds may lead to inoculation. Infection with the strain *salmonella typhi* is most commonly related to travel to endemic areas. Vulnerable patient populations include children under five years of age, patients who have undergone abdominal organ transplant, and those with lymphoproliferative disorders, AIDS, and sickle cell disease. The use of antibiotics and antacids and the presence of inflammatory bowel disease can also make patients susceptible by altering the normal host defense mechanism to these infections.

Typically salmonella presents as self-limited enteritis causing fever, abdominal pain, tenesmus, vomiting, and diarrhea. Some strains of salmonella including *S. typhi* and *S. paratyphi* can cause systemic illness. Invasive Salmonella can occur in 8% of patients with confirmed infections and may manifest as bacteremia, meningitis, osteomyelitis, and septic arthritis.

Salmonella can be diagnosed by culturing the stool. Once the stool culture is positive, the state runs serotyping and DNA fingerprinting on the Salmonella isolates. This is also reported to the Centers for Disease Control (CDC) for public health surveillance. Serotyping followed by reporting can help track an outbreak to a common contaminated source and can also help scientists and clinicians understand the pathophysiology and epidemiology behind different strains of salmonella.

Most cases of Salmonella are self-limited. Oral rehydration is of paramount importance for successful outpatient therapy. Patients younger than two and older than 65 years of age are vulnerable to significant and lethal effects related to fluid and electrolyte losses. Given the delay related to culture positive diagnosis, antibiotics are not recommended for the treatment of salmonella in immunocompetent individuals. However, if patients do require antibiotics for severe virulent infection or immunosuppression, fluoroquinolones are generally the most appropriate medication. Alternatives include trimethoprim-sulfamethoxazole, cefixime, or azithromycin.

Campylobacter

Campylobacter infection with *Campylobacter jejuni* or *Campylobacter coli* is another source of acute enterocolitis. These organisms can live in numerous animal hosts, and contamination of water or food supply, commonly poultry, can lead to outbreak.

The clinical manifestations of campylobacter infection are indistinguishable from Salmonellae or *Shigella*. Patients typically present with secretory diarrhea, fever, abdominal pain, and nausea. Diarrhea is self-limited and lasts for approximately seven days. In some patients, pain can be predominant in the right lower quadrant and the diagnosis can be mistaken for appendicitis.

There is an increased incidence of Campylobacter infection in patients with HIV [24, 25]. Interestingly, a cohort study of over 13,000 patients with documented Salmoneall or Campylobacter gastroenteritis reported that both have a short and long term increased risk for the development of inflammatory bowel disease [26]. While the risk was highest during the first year after infection, it remained elevated during the entire 15-year follow-up.

The diagnosis is established by stool culture, and, similar to treatments for other causes of infectious diarrhea, treatment with oral rehydration is typically sufficient and antibiotics are not required. Antibiotics may be indicated in selected cases with severe disease or in patients who are elderly, pregnant, or immunocompromised and therefore at risk for severe disease.

Two major late onset complications of Campylobacter infection are reactive arthritis and Guillain-Barré syndrome.

Non-Infectious Etiology

Diversion Proctitis

Diversion proctitis, also known as disuse proctitis, is a common sequela of surgical exclusion of the rectum following stoma creation (Fig. 30.6). This entity was only first described in 1972 [27] and the term diversion colitis was coined by Glotzer et al. in 1981 [28].

The exact etiology of this process is poorly understood. The most commonly held belief is that the inflammation is related to the deprivation of the rectal mucosa of short chained fatty acids, specifically butyrate, derived by bacterial fermentation of dietary starch and protein. Others suspect the changes of proctitis occur as a result of bacterial overgrowth or a change in the gut flora after diversion. An increase in nitrate reducing bacteria found in patients with diversion may suggest that proctitis could be a direct result of nitric oxide toxicity [29]. Ischemia has also been implicated in the cause [30]. Another role of short chain fatty acids on the coloncytes includes the production of nitric oxide which at physiologic doses has vasodilatory effects on the mucosa. The absence of these substances has been proposed to result in ischemia leading to inflammation.

Most commonly, patients are asymptomatic and diversion proctitis is an incidental finding in the pre-operative evaluation for stoma reversal. Endoluminal changes in the colon and rectum have been reported with an incidence as high as 91% of diverted patients [31]. These findings typically include pale mucosa with contact or pneumatic friability or mucosal erythema with exudates and edema. Patients with more severe changes may have petechia, ulcerations, inflammatory polyps, or mucosal nodules. Despite the high prevalence, patients are rarely symptomatic. Those who do experience symptoms may complain of hematochezia, rectal discharge, or tenesmus related to inflammation or may have discomfort from impaction of mucus.

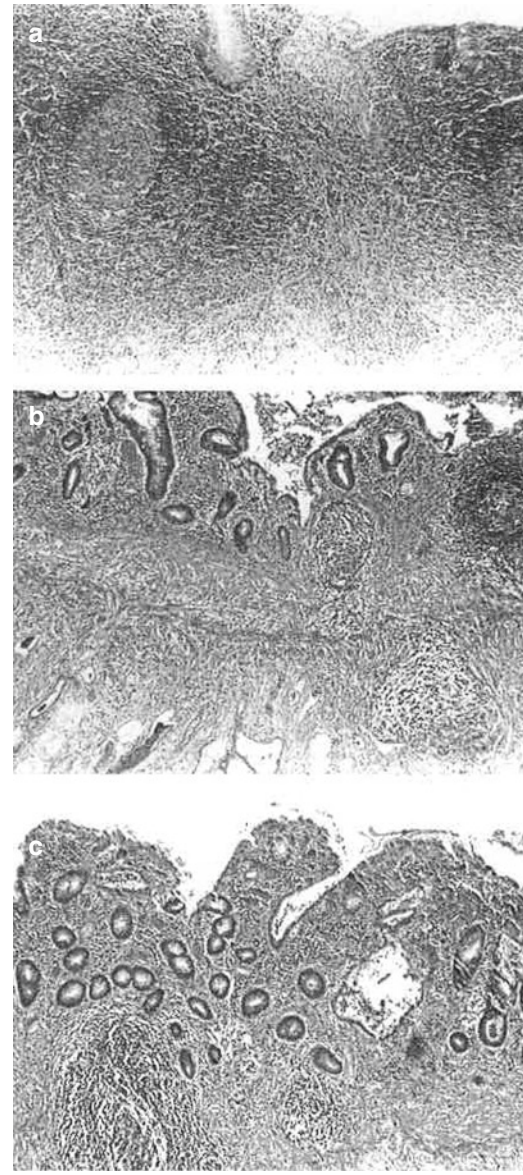


Fig. 30.6 Diversion colitis with lymphoid addredates limited to the mucosa

Histologic findings on biopsy include changes of mild acute or chronic inflammation. This includes the presence of crypt abscesses, lymphoid nodules, and changes in crypt architecture or atrophy with the hallmark finding of follicular lymphoid hyperplasia [31–34]. On surgical resection of these specimens, all of the inflammatory changes are limited to the mucosa of the diverted segment [35].

Patients with diversion proctitis will have normal colonic mucosa proximal to the stoma and will have resolution of endoscopic findings after restoration of intestinal continuity. Patients who are symptomatic regardless of the severity of the endoscopic findings require no treatment. For patients who are unable to be returned to continuity, and have significant symptoms, short chain fatty acid enema solution can be administered to the effected segment for effective relief. Harig et al. [36] demonstrated this effect in a very small controlled trial in 1981. Their solution consisted of sodium acetate, sodium propionate, and sodium n-butyrate mixed with normal saline and sodium hydroxide. Patients self-administered 60 mL of the solution twice daily. On serial endoscopy they demonstrated reversal of inflammation in all patients in 4–6 weeks. Short chain fatty acids have also been found to stimulate mucosal cell proliferation and potentiate regeneration when administered into the rectal stump following Hartmann's procedure [37]. Other proposed treatments include the administration of 5-aminosalicylic acid (5-ASA) or steroid enemas if the administration of short chain fatty acid enema solution is not effective. In patients requiring prolonged diversion, consideration should be given to periodic screening of the diverted segment for neoplasia. Theoretically, chronic inflammation from long standing and untreated diversion proctitis could be potentially carcinogenic; however, this suspicion has not been proven.

Solitary Rectal Ulcer Syndrome (SRUS)

Solitary rectal ulcer syndrome (SRUS) is a rare syndrome with a poorly understood pathophysiology. The proposed etiology relates to straining on defecation. This repetitive trauma is thought to lead to ischemic injury to the mucosa of the rectal wall. Many conditions which cause chronic straining and mucosal injury have been associated with SRUS including rectal prolapse and intussusception, paradoxical contraction or non-relation of the puborectalis muscle, chronic constipation, and recurrent attempts at manual disimpaction.

A thorough history regarding the patient's bowel function and associated symptoms must be ascertained. As previously mentioned, patients with SRUS often report a history of straining with sensation of incomplete evacuation, pelvic fullness, or obstructed defecation. Patients may experience pelvic pain or tenesmus, and if SRUS is found in the setting of rectal prolapse, patients may also note incontinence. Rectal bleeding and mucus per rectum may be present. Many patients however are asymptomatic and rectal ulcers are found incidentally on endoscopic examination.

Since many of the symptoms appreciated by patients with SRUS can also be harbingers of malignancy, colonoscopy with biopsies of any abnormal lesions should be completed in appropriate patients (Fig. 30.7). The diagnosis of SRUS is typically made with endoscopic visualization and biopsy. Despite the designation of SRUS, lesions of SRUS can be single or multiple. Lesions can range in appearance and present as small areas of mucosal inflammation, large ulcerations, or pedunculated masses (Fig. 30.8). They are classically found on the anterior rectal wall within 10 cm of the anal verge. Classic findings on histologic evaluation include surface serration, crypt distortion, and fibromuscular obliteration of the lamina propria. After the diagnosis of SRUS is confirmed, imaging with decfecogram or magnetic resonance defecography is often obtained for evaluation of pelvic floor function and coordination.

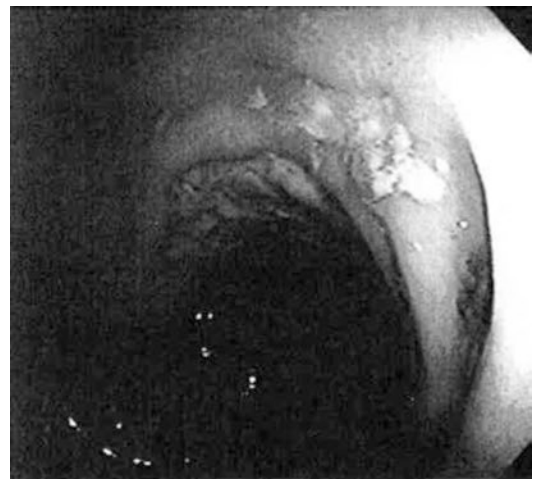


Fig. 30.7 Endoscopic appearance of a solitary rectal ulcer

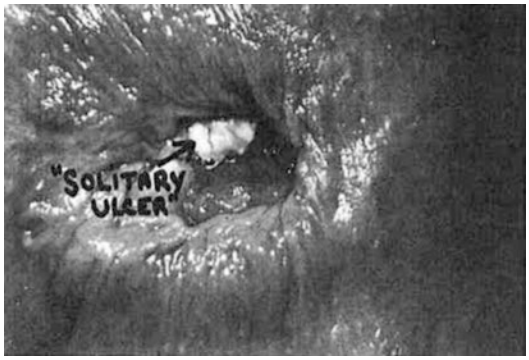


Fig. 30.8 Prolapsing solitary rectal ulcer

As with most functional disorders, after malignancy has been excluded, treatment consists of biofeedback therapy and management of hard stools. Mild cases can be treated with increased dietary and supplemental fiber and water. A stepwise approach to constipation should be taken. Medical therapies include botox injection, steroids enemas, and sulfasalazine enemas. Ulcers attributed to rectal prolapse may require perineal or abdominal surgical intervention. If symptoms are severe or refractory to medical therapy, end colostomy is also an option for relief of symptoms.

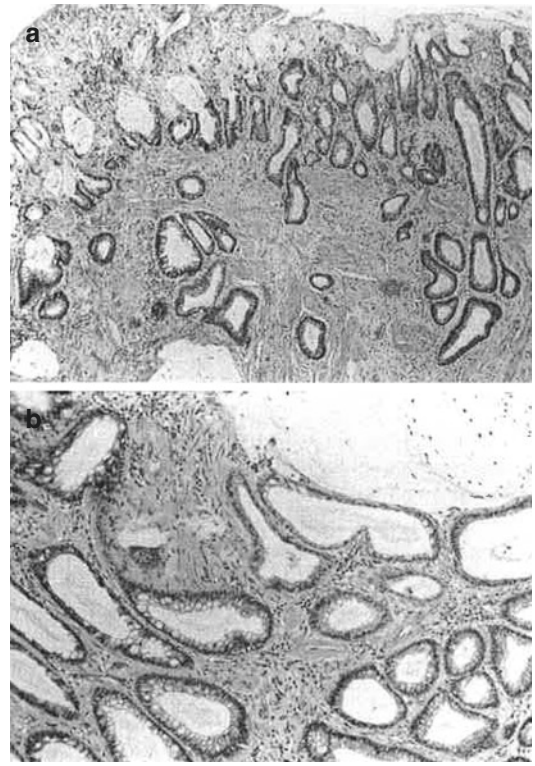


Fig. 30.9 Histologic appearance of colitis cystic profunda. Note dissecting pools of mucus and fibromuscular obliteration of the lamina propria

Proctitis Cystica Profunda

Proctitis cystica profunda, also known as colitis cystic profunda, is a rare benign disorder of the rectum. Similar to SRUS, proctitis cystica profunda is an entity characterized by the presence of submucosal mucous containing cysts. Lesions can be localized with discrete submucosal polypoid collections beneath the muscularis propria, or they can be diffuse (Fig. 30.9). Their appearance may be similar to other more aggressive pathologies including mucinous adenocarcinoma, carcinoid heterotopic pancreatic tissue, or rectal polyps and lesions should be excised for exclusion.

Symptoms of proctitis cystica profunda are variable and nonspecific and include hematochezia, tenesmus, proctalgia, mucus per rectum, constipation, and obstructive defecation. Since these lesions are submucosal, endoscopic findings usually include a polypoid lesion with normal overlying mucosa, however they can also be ulcerated and edematous. Imaging typically reveals a discrete lesion with no evidence of underlying invasion. Loss of perirectal fat and thickening of levator ani muscles can also be seen [38, 39]. Proctitis cystica profunda is associated with internal rectal intussusception in 45–80% of cases [40] and with rectal prolapse in up to 54% of cases [38, 41].

Diagnosis is made though histologic analysis of the cyst, which is lined by atrophic mucosa and mucinous epithelium with surrounding fibrosis [42, 43]. The overlying epithelium may demonstrate benign hyperplasia with a decreased number of goblet cells and the cysts contain inspissated mucin with dystrophic calcification [44]. There is significantly increased collagen deposition in the submucosa and the muscularis is very thickened. Early changes show replacement of the lamina

propria by fibroblasts arranged at right angles to the muscularis mucosa [42, 43]. These lesions have been associated with malignancy, therefore careful pathologic assessment is of paramount importance [45].

Treatment of proctitis cystica profunda is aimed at symptom reduction and should start with dietary changes and addition of medications to avoid constipation and straining. Bulking agents and stool softeners are used initially and should be escalated to laxatives and more aggressive bowel regimen, as needed. Patients should also undergo biofeedback therapy to help with obstructive defecation. The role of surgical therapy is limited after the exclusion of malignancy. Treatment of rectal prolapse and diversion for evacuatory dysfunction are viable considerations for symptom control in these patients but do not offer cure for this underlying functional disorder.

Radiation Proctopathy

Radiation proctopathy (RP), also incorrectly referred to as radiation proctitis, is the result of inadvertent damage to the rectum following radiation therapy to the pelvis in the treatment of other pelvic organ malignancies. The most common primary indication for pelvic radiation is prostate cancer, but RP can be seen following treatment of cervical, bladder, testicular and uterine cancer. It is a common condition caused by mucosal damage that manifests at least six months after treatment. It can be highly morbid and may be very difficult to treat. The incidence of RP is difficult to determine given the lack of prospective studies in this field. Additionally, little concensus exists on the exact definition and classification of RP. Nevertheless, the incidence is estimated to range from 2% to 20% [46, 47].

Risk factors for the development of RP include the mechanism of radiation delivery and the patient's medical comorbidities. External beam radiation confers a higher rate of rectal penetration with a greater risk for RP when compared to brachytherapy [48]. Newer conformal radiation therapy techniques have improved the delivery of radiation therapy and allow for more precise treatment of the primary tumor with less collateral damage to the surrounding organs [49]. Other risk factors for the development of RP include patients who have a history of inflammatory bowel disease, diabetes mellitus, hypertension or peripheral vascular disease. The development of RP is also more common in patients who develop severe acute mucositis of the rectum [50].

Symptoms of RP include diarrhea, fecal urgency, tenesmus, or hematochezia. Patients may also develop severe fecal incontinence due to the lack of rectal compliance. There is no evidence of an acute inflammatory process, making radiation proctitis a common misnomer. Symptoms typically occur six months or longer after the administration of pelvic radiation. Bleeding occurs with irritation of friable and ischemic rectal mucosa and from the rupture of telangiectasia that form as a result of exposure to radiation [51]. Bleeding can be severe and can result in the need for transfusion. The diagnosis is made endoscopically with classic findings that include mucosal pallor, telangiectasias, spontaneous bleeding, edema, and friability. Other findings may include ulcers, strictures, and fistula formation [52].

A variety of treatment options are available for the management of RP and the treatment algorithm should be determined by the patient's symptomatology (Table 30.1). Rectal bleeding is generally most responsive to cautery or sclerosing agents to obliterate telangiectasias while intractable pain, large rectal ulcers, and refractory bleeding generally require surgical management.

Medical Therapy

Anti-inflammatory agents are usually unsuccessful for the management of severe RP but may be useful in mild cases. Medications such as sulfasalazine or 5-ASA in combination with either an oral or rectal steroid have shown some benefit. Sucralfate enemas have also been used for this indication as its cytoprotective effects stimulate prostaglandins synthesis, increase production of epidermal growth factor, and promote local blood flow to enable healing [53, 54].

Table 30.1 Treatments for radiation proctopathy

Medical therapy
5-Aminosalicylic acid (5-ASA)
• Suppositories or enemas
• Oral
Corticosteroid enemas
Sucralfate
• Oral
• Enemas
Antioxidants
Short chain fatty acid enemas
Prostaglandins
Endoscopic therapy
• KTP laser
• Argon laser
• Nd:YAG laser
• BiCAP
• Heater probe
• Endoscopic banding
• Cryotherapy
• Radiofrequency ablation
• Argon plasma coagulation
Other therapies
• Hyperbaric oxygen
• Formalin

A small prospective study examined the effects of combined oral and rectal 5-ASA on RP. The authors found an improvement in bleeding and endoscopic burden of disease with a decrease in telangiectasias and mucosal friability. They were unable to demonstrate an improvement in pain, tenesmus, or frequency [55]. A randomized prospective study of patients with RP compared the treatment effects of oral sulfasalazine with rectal prednisolone enemas to twice daily rectal sucralfate enemas and oral placebo. While the study numbers were small, both the intervention arms showed clinical improvement and endoscopic healing with sucralfate enemas had a greater degree of improvement [56]. However, a recent randomized controlled trial evaluated the effects of sucralfate following argon plasma coagulation (APC) in patients with RP whose primary symptom was hemorrhage [57]. In this single-institution randomized, placebo-controlled, double-blind study all patients received APC and were randomized to oral sucralfate or placebo. Patients had a statistical improvement with APC alone and additional sucralfate treatment did not seem to influence their outcome.

Antioxidants such as vitamins A, C, and E have been shown to also be beneficial in the treatment of RP through their role against oxidative stress. In a very small prospective study on the effects of long term administration of vitamin E and vitamin C, benefits were seen in the treatment of bleeding, diarrhea, and urgency [58]. They also noted that 65% of patients had an overall improvement in lifestyle and these symptoms were sustained at 1 year in those patients who were seen at follow up. There was no significant improvement in rectal pain. Another randomized controlled trial found significantly reduced symptoms of RP with orally administered vitamin A when compared to placebo [59]. Seven of the 10 patients randomized to the treatment arm showed improvement and five patients in the placebo arm were crossed over to receive vitamin A supplementation and all showed improvement.

Short chain fatty acids have been found to have a trophic effect on colonic mucosa and stimulate cell proliferation and differentiation. In a small prospective, randomized, double-blind trial comparing short chain fatty acid enemas with placebo, patients treated with short chain fatty acid showed a significant decrease in the number of days with rectal bleeding and an improvement of endoscopic healing [60]. Hemoglobin was also significantly higher in treated patients. Additionally, patients treated with short chain fatty acid showed sustained healing for up to six months after cessation of treatments. However, another randomized, double-blind, placebo-controlled trial compared patients given butyric acid enemas to those given placebo and found no significant difference [61].

Another sequela of radiation includes bacterial overgrowth. Often times this can cause symptoms of diarrhea, malabsorption and bloating and the use of antibiotics may decrease symptoms. Small trials have looked at the use of metronidazole in concert with anti-inflammatory agents and steroids and found a sustained reduction in symptoms [62].

Prostaglandins have been shown to increase mucosal blood flow, which can have a protective effect. Misoprostol suppositories have been

shown to prevent proctitis and decrease symptoms following the development of acute and chronic proctitis in small trials, but larger studies have shown no change in symptoms with an increase in rectal bleeding [63, 64].

Hyperbaric oxygen has an angiogenic effect on the colonic mucosa and benefit has been suggested by improving tissue perfusion. In a multicenter randomized controlled double-blind trial hyperbaric oxygen demonstrated an absolute risk reduction of 32% [65].

One of the most effective treatments for bleeding associated with radiation proctopathy is topical formalin therapy. By acting as a sclerosing agent, formalin seals telangiectasias of the effected mucosa. Formalin has been applied in two ways. The dab method directly applies 4–10% formalin using a cotton tip applicator under direct visualization [66, 67]. The formalin-soaked swab is passed through an anoscope and applied to the friable mucosa for 20–30 s. Since formalin is a sclerosing agent, care must be taken to avoid the surrounding healthy tissue. This can usually be done in the office. Another option is 60 cc of 2–4% formalin solution instilled into the rectum via a catheter. It is left in place for a few minutes that irrigated out. This method usually requires some type of anesthetic [68]. Success rates of 75% or greater in cessation or improvement in bleeding are commonly reported in the literature.

Endoscopic Therapy

Endoscopic therapy aims to control bleeding from radiation proctopathy. Advanced endoscopic options include potassium titanyl phosphate (KTP) laser, argon laser, neodymium:yttrium-aluminum-garnet (Nd:YAG) laser, BiCAP, heater probe, endoscopic band ligation, cryotherapy, and radiofrequency ablation. Formalin can also be applied through an endoscope.

KTP, Nd:YAG, and argon lasers works through thermal destruction and coagulation of bleeding vessels that result after radiation exposure. The laser fiber is advanced into the working channel of an endoscope and the affected tissue is treated in a pulsatile fashion. The depth of thermal effect is dependent on the duration of pulses on the tissue, the power setting, and the light wavelength. Complications of laser therapy, seen after prolonged exposure, include strictures, transmural necrosis, perforation, and fistula. They occur in approximately 15% of effected patients and the minimal amount of energy required for treatment is recommended to avoid adverse effects of treatment [69].

APC is the most frequently used technique for thermal coagulation of radiation disease. Inert argon gas is delivered through a probe which is inserted through the working channel of the endoscope. The probe is applied over, but not on, the mucosal surface, which creates coagulation of the bleeding tissue. Full bowel prep must be done prior to the procedure due to the risk of combustion. APC has had great success in the literature. Reports have shown this technique to successfully reduce symptoms of bleeding in 80–90% of cases, and improve diarrhea and tenesmus in 60–75% [70–72]. Patients often require multiple treatments of APC to attain meaningful symptom reduction and formalin has also been used in coordination.

Additional methods for endoscopic coagulation include contact therapy through heater and BiCAP probes. Both units work through paired conduction of either elective current or heat to coagulate actively bleeding tissue. Contact therapy has advantages of less collateral tissue damage when compared to other laser options. Randomized prospective trials have compared management of patients with bleeding RP with either heater probe or BiCAP [73]. After a median of four sessions, severe bleeding episodes were significantly reduced after both BiCAP and heater probe without a statistically significant difference between the two methods. Another prospective randomized trial compared APC and BiCAP to control bleeding [74]. Both modalities were found to be effective in controlling symptoms but there was an increased rate of total complications in the BiCAP group, albeit none major.

Cryotherapy, the application of liquid nitrogen or carbon dioxide at cold temperatures, has also been used to treat bleeding with RP. Cryotherapy spray is applied for 5 s directly to the mucosa in three rounds for a total of 15 s. Traditionally, cryospray generators are cumbersome and less mobile than mobile units. Nitrogen and carbon dioxide tanks last approximately

2 weeks and, given the incidence of RP, can be an impractical therapy. A prospective study of ten patients with hemorrhagic RP treated with cryoablation had reduction in the endoscopic severity of rectal telangiectasias and subjective clinical scores [75].

Radiofrequency ablation (RFA) has also been used to thermally ablate tissue and treat bleeding RP. Initially used in the treatment of esophageal dysplasia and for gastric hemostasis, RFA has been extrapolated to uses in the lower GI tract. An electrode catheter is placed into the working channel of a gastroscope and applied directly to tissues requiring hemostasis. One benefit of RFA treatment is the potential for reepithelization of the treated tissue. This prevents rebleeding without stenosis or ulceration. Similarly, the RFA catheter applies radiofrequency energy to a superficial depth of field. This permits collateral damage to surrounding mucosa and also prevents deep tissue injury. Studies regarding the use of RFA in RP have all been small case series for bleeding refractory to medical therapies and other endoscopic modalities [76–78]. While more studies are required, RFA appears to be a safe and effective therapy.

Medication-Related Colitis

Nonsteroidal anti-inflammatory drugs (NSAIDs) have been shown to cause inflammatory changes in the gastrointestinal and colorectal mucosa and have been associated with proctitis. Ibuprofen, diclofenac, and aspirin account for approximately 85% of cases, and toxic effect is not dose related [79, 80]. The underlying pathophysiology is not clearly understood, but is felt to be related to the inhibition of cyclooxygenase and prostaglandin synthesis and impairment of oxidative phosphorylation. Proctitis is most commonly seen with rectal administration of NSAIDs, but inflammatory changes for orally administered medication is seen in the upper GI tract and on the right colon because of enterohepatic circulation [81].

Typically patients present with abdominal pain, tenesmus, diarrhea, bleeding and a history of recent NSAID use. Endoscopy may be normal in up to 45% of cases or may reveal nonspecific changes including inflammation, erosion, or concentric stricture. Histology is also non-specific with mixed inflammatory cell infiltrates, crypt distortion and microabscesses, mucus depletion, and mucosal erosions [82]. Diagnosis is one of exclusion in patients with a positive history of NSAID use and stool analysis negative for other infectious etiologies.

Treatment consists of withdrawal of NSAIDs and antibiotics to prevent translocation. Symptoms are self-limited.

References

1. Bartlett JG. Clinical practice. Antibiotic-associated diarrhea. N Engl J Med. 2002;346:334–9.
2. Denève C, Janoir C, Poilane I, Fantinato C, Collignon A. New trends in Clostridium difficile virulence and pathogenesis. Int J Antimicrob Agents. 2009;33(suppl 1):S24–8.
3. Lesperance K, Causey MW, Spencer M, Steele SR. The morbidity of Clostridium difficile infection following elective colonic resection: results from a national population database. Am J Surg. 2011;201:141–8.
4. Schwaber MJ, Simhon A, Block C. et.al. Risk factors for Clostridium difficile carriage and C. difficile–associated disease on the adult wards of an urban tertiary care hospital. Eur J Clin Microbiol Infect Dis. 2000;19:9–15.
5. Klipfel AA, Schein M, Fahoum B, Wise L. Acute abdomen and Clostridium difficile colitis: still a lethal combination. Dig Surg. 2000;17:160–3.
6. Gerding DN, Olson MM, Peterson LR, et al. Clostridium difficile-associated diarrhea and colitis in adults: a prospective case-controlled epidemiologic study. Arch Intern Med. 1986;146:95–100.
7. Burkart NE, Kwaan MR, Shepela C, et al. Indications and relative utility of lower endoscopy in the management of Clostridium difficile infection. Gastroenterol Res Pract. 2011;2011:626582.
8. Miller M. The fascination with probiotics for Clostridium difficile infection: lack of evidence for prophylactic or therapeutic efficacy. Anaerobe. 2009;15:281–4.
9. Guarino A, Lo Vecchio A, Canani RB. Probiotics as prevention and treatment for diarrhea. Curr Opin Gastroenterol. 2009;25:18–23.
10. Johnston BC, Ma SS, Goldenberg JZ, et al. Probiotics for the prevention of Clostridium difficile-associated diarrhea: a systematic review and meta-analysis. Ann Intern Med. 2012;157:878–88.
11. Goldenberg JZ, Ma SS, Saxton JD, et al. Probiotics for the prevention of Clostridium difficile-associated diarrhea in adults and children. Cochrane Database Syst Rev. 2013;5:CD006095.

12. Neal MD, Alverdy JC, Hall DE, Simmons RL, Zuckerbraun BS. Diverting loop ileostomy and colonic lavage: an alternative to total abdominal colectomy for the treatment of severe, complicated Clostridium difficile associated disease. Ann Surg. 2011;254:423–7.
13. Guo B, Harstall C, Louie T, Veldhuyzen van Zanten S, Dieleman LA. Systematic review: faecal transplantation for the treatment of Clostridium difficile-associated disease. Aliment Pharmacol Ther. 2012;35:865–75.
14. Gough E, Shaikh H, Manges AR. Systematic review of intestinal microbiota transplantation (fecal bacteriotherapy) for recurrent Clostridium difficile infection. Clin Infect Dis. 2011;53:994–1002.
15. Brandt LJ, Aroniadis OC, Mellow M, et al. Long-term follow-up of colonoscopic fecal microbiota transplant for recurrent Clostridium difficile infection. Am J Gastroenterol. 2012;107:1079–87.
16. van Nood E, Vrieze A, Nieuwdorp M, et al. Duodenal infusion of donor feces for recurrent Clostridium difficile. N Engl J Med. 2013;368:407–15.
17. Walsh JA. Problems in recognition and diagnosis of amebiasis: estimation of the global magnitude of morbidity and mortality. Rev Infect Dis. 1986;8(2):228–38.
18. Parveen H, Mukhtar S, Azam A. Novel ferrocenyl linked pyrazoline analogs as potent antiamoebic agents. J Heterocyclic Chem. 2016;53:473–8. https://doi.org/10.1002/jhet.v53.2.
19. Flores MS, Carrillo P, Tamez E, Rangel R, Rodríguez EG, Maldonado MG, Isibasi A, Galán L. Diagnostic parameters of serological ELISA for invasive amoebiasis, using antigens preserved without enzymatic inhibitors. Exp Parasitol. 2016;161:48–53.
20. van Sonnenberg E, Mueller PR, Schiffman HR, et al. Intrahepatic amebic abscesses: indications for and results of percutaneous catheter drainage. Radiology. 1985;156:631–5.
21. Scallan E, Hoekstra RM, Angulo FJ, Tauxe RV, Widdowson MA, Roy SL, Jones JL, Griffin PM. Foodborne illness acquired in the United States--major pathogens. Emerg Infect Dis. 2011;17(1):7–15.
22. Bennish ML, Salam MA, Khan WA, Khan AM. Treatment of shigellosis: III. Comparison of one- or two-dose ciprofloxacin with standard 5-day therapy. A randomized, blinded trial. Ann Intern Med. 1992;117(9):727.
23. https://www.cdc.gov/salmonella/general/technical.html. Accessed 13 Nov 2016.
24. Sorvillo FJ, Lieb LE, Waterman SH. Incidence of campylobacteriosis among patients with AIDS in Los Angeles County. J Acquir Immune Defic Syndr. 1991;4:598.
25. Tee W, Mijch A. Campylobacter jejuni bacteremia in human immunodeficiency virus (HIV)-infected and non-HIV-infected patients: comparison of clinical features and review. Clin Infect Dis. 1998;26:91.
26. Gradel KO, Nielsen HL, Schønheyder HC, Ejlertsen T, Kristensen B, Nielsen H. Increased short- and long-term risk of inflammatory bowel disease after salmonella or campylobacter gastroenteritis. Gastroenterology. 2009;137(2):495.
27. Glotzer DJ, Glick ME, Goldman H. Proctitis and colitis following diversion of the faecal stream. Gastroenterology. 1981;80:438–41.
28. Morson BP, Dawson MP. Gastrointestinal pathology. 1st ed. London: Blackwell Scientific Publications; 1972.
29. Neut C, Guillemot F, Colombel JF. Colombel nitrate reducing bacteria in diversion colitis: a clue to inflammation. Dig Dis Sci. 1997;42(12):2577–80.
30. Villanacci V, Talbot IC, Rossi E, Basotti G. Ischaemia: a pathogenetic clue in diversion colitis. Color Dis. 2006;9:601–5.
31. Whelan RL, Abramson D, Kim DS, Hashmi HF. Diversion colitis. A prospective study. Surg Endosc. 1994;8(1):19–24.
32. Geraghty JM, Talbot IC. Diversion colitis: histological features in the colon and rectum after defunctioning colostomy. Gut. 1991;32:1020–3.
33. Komorowski RA. Histologic spectrum of diversion colitis. Am J Surg Pathol. 1990;14:548–54.
34. Yeong ML, Bethwaite PB, Prasad J, Isbister WH. Lymphoid follicular hyperplasia-a distinctive feature of diversion colitis. Histopathology. 1991;19:55–61.
35. Murray FE, O'Brien MJ, Birkett DH, Kennedy SM, LaMont JT. Diversion colitis. Pathologic findings in a resected sigmoid colon and rectum. Gastroenterology. 1987;93:1404–8.
36. Harig JM, Soergel KH, Komorowski RA, Wood CM. Treatment of diversion colitis with short-chain-fatty acid irrigation. N Engl J Med. 1989;320(1):23–8.
37. Mortensen FV, Langkilde NC, Joergensen JC, et al. Short-chain fatty acids stimulate mucosal cell proliferation in the closed human rectum after Hartmann's procedure. Int J Color Dis. 1999;14:150–4.
38. Kayaçetin E, Kayaçetin S. Colitis cystica profunda simulating rectal carcinoma. Acta Chir Belg. 2005;105:306–8.
39. Valenzuela M, Martín-Ruiz JL, Alvarez-Cienfuegos E, Caballero AM, Gallego F, Carmona I, Rodríguez-Téllez M. Colitis cystica profunda: imaging diagnosis and conservative treatment: report of two cases. Dis Colon Rectum. 1996;39:587–90.
40. Dolar E, Kiyici M, Yilmazlar T, Gürel S, Nak SG, Gülten M. Colitis cystica profunda. Turk J Gastroenterol. 2007;18:206–7.
41. Abid S, Khawaja A, Bhimani SA, Ahmad Z, Hamid S, Jafri W. The clinical, endoscopic and histological spectrum of the solitary rectal ulcer syndrome: a single-center experience of 116 cases. BMC Gastroenterol. 2012;12:72.
42. Madigan MR, Morson BC. Solitary ulcer of the rectum. Gut. 1969;10(2):871–81.
43. Rutter KRP, Riddell RH. The solitary ulcer syndrome of the rectum. Clin Gastroenterol. 1975;4:505–30.

44. Ayantunde AA, Strauss C, Sivakkolunthu M, Malhotra A. Colitis cystica profunda of the rectum: an unexpected operative finding. World J Clin Cases. 2016;4(7):177–80. https://doi.org/10.12998/wjcc.v4.i7.177.
45. Mitsunaga M, Izumi M, Uchiyama T, Sawabe A, Tanida E, Hosono K, Abe T, Shirahama K, Kanesaki A, Abe M. Colonic adenocarcinoma associated with colitis cystica profunda. Gastrointest Endosc. 2009;69:759–60. discussion 760–761
46. Johnston MJ, Robertson GM, Frizelle FA. Management of late complications of pelvic radiation in the rectum and anus: a review. Dis Colon Rectum. 2003;46:247–59.
47. Leiper K, Morris AI. Treatment of radiation proctitis. Clin Oncol. 2007;19:724–9.
48. Do NL, Nagle D, Poylin VY. Radiation proctitis: current strategies in management. Gastroenterol Res Pract. 2011;2011:917941.
49. Sarin A, Safar B. Management of radiation proctitis. Gastroenterol Clin N Am. 2013;42:913–25.
50. Tagkalidis PP, Tjandra JJ. Chronic radiation proctitis. ANZ J Surg. 2001;71:230–7.
51. Lenz L, Rohr R, Nakao F, Libera E, Ferrari A. Chronic radiation proctopathy: a practical review of endoscopic treatment. World J Gastrointest Surg. 2016;8(2):151–60.
52. Denton AS, Andreyev HJ, Forbes A, Maher EJ. Systematic review for non-surgical interventions for the management of late radiation proctitis. Br J Cancer. 2002;87:134–43.
53. Henriksson R, Franzén L, Littbrand B. Effects of sucralfate on acute and late bowel discomfort following radiotherapy of pelvic cancer. J Clin Oncol. 1992;10(6):969–75.
54. O'Brien PC, Franklin CI, Dear KB, et al. A phase III double-blind randomized study of rectal sucralfate suspension in the prevention of acute radiation proctitis. Radiother Oncol. 1997;45(2):117–23.
55. Seo EH, Kim TO, Kim TG, et al. The efficacy of the combination therapy with oral and topical mesalazine for patients with the first episode of radiation proctitis. Dig Dis Sci. 2011;56(9):2672–7.
56. Kochhar R, Patel F, Dhar A, et al. Radiation-induced proctosigmoiditis. Prospective, randomized, double-blind controlled trial of oral sulfasalazine plus rectal steroids versus rectal sucralfate. Dig Dis Sci. 1991;36(1):103–7.
57. Chruscielewska-Kiliszek MR, Regula J, Polkowski M, Rupinski M, Kraszewska E, Pachlewski J, Czaczkowska-Kurek E, Butruk E. Sucralfate or placebo following argon plasma coagulation for chronic radiation proctitis: a randomized double blind trial. Color Dis. 2013;15(1):e48–55.
58. Kennedy M, Bruninga K, Mutlu EA, Losurdo J, Choudhary S, Keshavarzian A. Successful and sustained treatment of chronic radiation proctitis with antioxidant vitamins E and C. Am J Gastroenterol. 2001;96(4):1080–4.
59. Ehrenpreis ED, Jani A, Levitsky J, Ahn J, Hong J. A prospective, randomized, double-blind, placebo-controlled trial of retinol palmitate (vitamin A) for symptomatic chronic radiation proctopathy. Dis Colon Rectum. 2005;48(1):1–8.
60. Pinto A, Fidalgo P, Cravo M, Midões J, Chaves P, Rosa J, et al. Short chain fatty acids are effective in short term treatment of chronic radiation proctitis. Dis Colon Rectum. 1999;42:788–96.
61. Talley NA, Chen F, King D, Jones M, Talley NJ. Short-chain fatty acids in the treatment of radiation proctitis: a randomized, double-blind, placebo-controlled, cross-over pilot trial. Dis Colon Rectum. 1997;40(9):1046–50.
62. Cavcić J, Turcić J, Martinac P, et al. Metronidazole in the treatment of chronic radiation proctitis: clinical trial. Croat Med J. 2000;41(3):314–8.
63. Khan AM, Birk JW, Anderson JC, et al. A prospective randomized placebo-controlled double-blinded pilot study of misoprostol rectal suppositories in the prevention of acute and chronic radiation proctitis symptoms in prostate cancer patients. Am J Gastroenterol. 2000;95(8):1961–6.
64. Hille A, Schmidberger H, Hermann RM, et al. A phase III randomized placebo-controlled, double blind study of misoprostol rectal suppositories to prevent acute radiation proctitis in patient with prostate cancer. In J Radiat Oncol Biol Phys. 2005;63:1488–93.
65. Clarke RE, Tenorio LM, Hussey JR, et al. Hyperbaric oxygen treatment of chronic refractory radiation proctitis: a randomized and controlled double-blind crossover trial with long-term follow-up. Int J Radiat Oncol Biol Phys. 2008;72(1):134–43.
66. Nelamangala Ramakrishnaiah VP, Javali TD, Dharanipragada K, Reddy KS, Krishnamachari S. Formalin dab, the effective way of treating haemorrhagic radiation proctitis: a randomized trial from a tertiary care hospital in South India. Color Dis. 2012;14(7):876–82.
67. Ismail MA, Qureshi MA. Formalin dab for haemorrhagic radiation proctitis. Ann R Coll Surg Engl. 2002;84(4):263–4.
68. Ma T-H, Yuan Z-X, Zhong Q-H, Wang H-M, Qin Q-Y, Chen X-X, Wang J-P, Wang L. Formalin irrigation for hemorrhagic chronic radiation proctitis. World J Gastroenterol. 2015;21(12):3593–8.
69. Swaroop VS, Gostout CJ. Endoscopic treatment of chronic radiation proctopathy. J Clin Gastroenterol. 1998;27:36–40.
70. Sebastian S, O'Connor H, O'Morain C, Buckley M. Argon plasma coagulation as first-line treatment for chronic radiation proctopathy. J Gastrol Hepatol. 2004;19:1169–73.
71. Tam W, Moore J, Schoeman M. Treatment of radiation proctitis with argon plasma coagulation. Endoscopy. 2000;32:667–72.
72. Tjandra JJ, Sengupta S. Argon plasma coagulation is effective in the treatment of refractory radiation proctitis. Dis Colon Rectum. 2001;44:1759–65.

73. Jensen DM, Machicado GA, Cheng S, Jensen ME, Jutabha R. A randomized prospective study of endoscopic bipolar electrocoagulation and heater probe treatment of chronic rectal bleeding from radiation telangiectasia. Gastrointest Endosc. 1997;45: 20–5.
74. Moawad FJ, Maydonovitch CL, Horwhat JD. Efficacy of cryospray ablation for the treatment of chronic radiation proctitis in a pilot study. Dig Endosc. 2013;25:174–9.
75. Hou JK, Abudayyeh S, Shaib Y. Treatment of chronic radiation proctitis with cryoablation. Gastrointest Endosc. 2011;73:383–9.
76. Nikfarjam M, Faulx A, Laughinghouse M, Marks JM. Feasibility of radiofrequency ablation for the treatment of chronic radiation proctitis. Surg Innov. 2010;17:92–4.
77. Zhou C, Adler DC, Becker L, Chen Y, Tsai TH, Figueiredo M, Schmitt JM, Fujimoto JG, Mashimo H. Effective treatment of chronic radiation proctitis using radiofrequency ablation. Ther Adv Gastroenterol. 2009;2:149–56.
78. Eddi R, Depasquale JR. Radiofrequency ablation for the treatment of radiation proctitis: a case report and review of literature. Ther Adv Gastroenterol. 2013;6:69–76.
79. Gleeson MH, Davis AJ. Non-steroidal anti-inflammatory drugs, aspirin and newly diagnosed colitis: A case-control study. Aliment Pharmacol Ther. 2003;17:817–25.
80. Geramizadeh B, Taghavi A, Banan B. Clinical, endoscopic and pathologic spectrum of non-steroidal anti-inflammatory drug-induced colitis. Indian J Gastroenterol. 2009;28:150–3.
81. Aftab AR, Donnellan F, Zeb F, Kevans D, Cullen G, Courtney G. NSAID-induced colopathy. A case series. J Gastrointestin Liver Dis. 2010;19:89–91.
82. Tonolini M. Acute nonsteroidal anti-inflammatory drug-induced colitis. J Emerg Trauma Shock. 2013;6(4):301–3.

Pelvic Floor Disorders Related to Urology and Gynecology

31

Nouf Y. Akeel, Brooke Gurland, and Tracy Hull

Introduction

Pelvic floor disorders (PFDs) are common in women. The term PFDs includes a variety of anatomic and functional disorders associated with bladder and bowel storage, continence and evacuation, sexual dysfunctions, pelvic organ prolapse (POP), and pelvic pain disorders. PFDs can have major impact on a woman's physical and psychological well-being.

Prevalence of Multicompartment Disorders

In a large population-based cohort study [1], the estimated lifetime risk of surgery for either urinary incontinence (UI) or POP was 20% in females by the age of 80. Multicompartment pelvic floor symptoms and anatomic findings were commonly reported. In a cross-sectional study, patients who presented to a urogynecology clinic complaining of either pelvic organ prolapse or urinary incontinence were evaluated for functional bowel and anorectal disorders using the Rome II Modular questionnaire [2]. Of the 302 subjects, 36% reported constipation, 12% fecal incontinence (FI), 20% proctalgia fugax, 5% levator ani syndrome, and 4% pelvic floor dyssynergia. Rortveit et al. [3] showed that at least a single pelvic floor condition was reported by 34% of 2106 women older than 40 years. Both UI and FI were reported by 9% and both UI and POP by 7%. Among those with FI, 60% reported more than one condition. Gonzalez-Argente et al. [4] looked at the prevalence of UI and genital prolapse in patients operated for FI or rectal prolapse. They found a statistically significant higher prevalence of UI and genital prolapse (54% and 17.6% respectively) in patients operated for FI and in patients operated for rectal prolapse (65.6%, 34.3% respectively) compared to a control group of females (30%,12.5% respectively). Twenty three percent of the patients in the study groups had both UI and genital prolapse.

These findings support the need of approaching PFDs in the context of a multidisciplinary team in order to improve the quality of care. Kapoor et al. [5] reported the outcomes of 113 patients who were managed in combined multidisciplinary pelvic floor clinic. The average number of clinic visits was 2.4 (range 1–10, median 2 visits). There was a mean of 3 symptoms per patient. One-fourth (29/113) of the patients had combined surgery for colorectal and

N. Y. Akeel · T. Hull
Department of Colorectal Surgery, Cleveland Clinic Foundation, Cleveland, OH, USA
e-mail: akeeln@ccf.org; hullt@ccf.org

B. Gurland (✉)
Department of Colorectal Surgery, Cleveland Clinic Foundation, Cleveland, OH, USA

Division of Colorectal Surgery, Stanford University, Stanford, CA, USA
e-mail: bgurland@stanford.edu

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_31

urogynecological disorders. Abdominal sacrocolpopexy with rectopexy was performed in 23 patients and external anal sphincter repair with colposuspension/ tension free vaginal tape was performed in 6 patients. This resulted in cost savings and a single recovery period. Seventy three percent of the patients enrolled found the care provided to them to be excellent/good, 12% were satisfied and 6% were unsatisfied.

Risk Factors

The pathophysiology of pelvic floor disorders is complex, multifactorial and it has been linked to parity and vaginal delivery [6–8]. The passage of the fetus can lead to stretching and damage the pudendal nerve, connective tissues and muscles of the pelvic floor and anal sphincter complex [9, 10]. Other risk factors include obesity, congenital or acquired connective tissue abnormalities, ageing, hysterectomy, menopause and factors associated with chronically raised intra-abdominal pressure [7, 8, 11]. The use of estrogen/progestin replacement therapy was associated with an increased risk of stress and urge incontinence [12].

Clinical Evaluation

History

The description of functional symptoms should be focused in four primary areas: (1) lower urinary tract, (2) bowel, (3) sexual, and (4) other local symptoms (Table 31.1) [13]. The provider should inquire about medications, medical history (e.g. diabetes, connective tissue disease, chronic cough, IBS, irradiation) and past surgical history (e.g. anorectal and pelvic surgery, hysterectomy and POP repair), history of spine injury or back surgery, smoking history, and menstrual history. A detailed obstetric history should include number of childbirths, method of delivery (vaginal vs. cesarean section), history of prolonged labor, history of tear or episiotomy, the use of instruments like forceps or ventouse, and the weight of the newborn. The impact of the symptoms on the quality of life should be assessed.

Table 31.1 Functional symptoms [13, 20]

Lower urinary tract dysfunction	
Urine incontinence (stress, urge, postural, mixed, continuous, insensible, coital)	
Post-micturition leakage	
Urgency, frequency, hesitancy, dysuria, nocturia	
Altered bladder sensation	
Straining, difficulty to initiate the void	
Interrupted/slow stream	
Urinary tract infection	
Incomplete emptying and the need to immediately re-void	
Applying vaginal pressure/ reduce a prolapse	
Position-dependent micturition	
Bowel dysfunction	
Constipation	*Incontinence*
Straining	Loss of gas vs. liquid vs. solid
Rectal pain	Unaware loss of stool vs attempts to control (passive vs. urge)
Incomplete evacuation	Urgency
Applying vaginal pressure/digitation	Soiling after defecation
Rectal bleeding	
Prolapsed tissue through the anus	
Sexual dysfunction	
Dyspareunia	
Obstructed intercourse	
Vaginal laxity	
Loss or decrease in libido	
Local symptoms	
Pelvic/vaginal pressure, pain or heaviness	
Sensation or awareness of tissue/ mass protrusion from the vagina	
Low back pain	
Abdominal pressure or pain	

There are a number of scoring systems that can be useful in evaluating the severity of the disease and the treatment outcomes such as Fecal Incontinence Severity Index (FISI), Wexner score, Incontinence Impact Questionnaire, Urogenital distress inventory and the Medical Outcomes Survey (SF-36), prolapse Quality of Life (P-QOL) and Sheffield Prolapse Symptoms Questionnaire and Pelvic Organ Prolapse/Urinary Incontinence Sexual Function Questionnaire (PISQ) [11, 14–16]. The use of a bladder and/or bowel diary is of value in the initial evaluation of FI and UI and the assessment of treatment outcomes [17, 18].

Physical Examination

A systematic and through examination begins with a general exam, focused neurological exam and then complete abdominopelvic exam including perineum, vagina and anorectum. The exam may need to be performed in different positions including left lateral, lithotomy, prone, standing, or sitting on a commode chair. Asking the patient about the position that will show the maximum descent of the prolapse or pelvic problem is helpful. It is also helpful to inspect the underclothes for staining/soiling. Other things to note include the skin looking for signs of irritation and scars, signs of genital atrophy, urethral diverticulum, fistula, and the bulbocavernosus and anal reflexes. During the inspection, the patient is asked to contract the pelvic muscles and to strain and cough. The examiner noting movement of the perineum, leak from the urethra or the anus; and pelvic or rectal prolapse. It is recommended to perform the cough stress test in all patients presenting with SUI [19]. The patient can be supine or standing and having a full bladder or following retrograde filling of at least 300 ml of water. On digital anorectal exam integrity of the sphincters and resting and squeeze sphincter pressures are noted. Digital rectal-vaginal examination (digitate the rectum and vagina at the same time) while the patient is straining or standing may be useful to differentiate between a high rectocele and an enterocele [13].

The Pelvic Organ Prolapse Quantification (POP-Q) is a standardized site-specific system for describing, quantitating, and staging pelvic support in females [13]. This system has been approved by the International Continence Society, the American Urogynecologic Society, and the Society of Gynecologic Surgeons for the description of female pelvic organ prolapse and pelvic floor dysfunction. This system allows for the specific description of an individual woman's pelvic support and permits accurate follow up of the prolapse over time by the same or different examiner. It contains a series of 9 measurements grouped together in combination. Six points on the vagina are located with reference to the plane of the hymen and measurements of the perineal body, genital hiatus and total vaginal length (Table 31.2, Figs. 31.1 and 31.2).

The prolapse should be described in terms of segments of the vaginal wall rather than the organs that lie behind it. Thus, the term "anterior vaginal wall prolapse" is more accurate instead of "cystocele" especially in women who had prior prolapse repair. The severity can be assessed using the following staging system [20]:

Stage 0: No prolapse is demonstrated.

Stage I: Most distal portion of the prolapse is more than 1 cm above the level of the hymen.

Stage II: The most distal portion of the prolapse is situated between 1 cm above the hymen and 1 cm below the hymen.

Stage III: The most distal portion of the prolapse is more than 1 cm beyond the plane of the hymen but everted at least 2 cm less than the total vaginal length.

Table 31.2 The pelvic organ prolapse quantification (POP-Q) system

Points/ measurements	Definitions
Anterior vagina	*Aa:* the midline of the anterior vaginal wall 3 cm proximal to the external urethral meatus (urethrovesical crease) Ba: the most distal position of any part of the upper anterior vaginal wall from the vaginal cuff or anterior vaginal fornix to point Aa
Superior vagina	*C:* the most distal edge of the cervix or the leading edge of the vaginal cuff after hysterectomy D: the posterior fornix (or pouch of Douglas) in a women who still has a cervix
Posterior vagina	*Bp:* the most distal position of any part of the upper posterior vaginal wall from the vaginal cuff or posterior vaginal fornix to point Ap *Ap:* the midline of the posterior vaginal wall 3cm proximal to the hymen
Genital hiatus (gh)	From the midline of the external urethral meatus to the posterior midline hymen
Perineal body (pb)	From the posterior margin of the genital hiatus to the midline opening
Total vaginal length (tvl)	The greatest depth of the vagina in centimeters when point C or D is reduced to its full normal position

anterior wall **Aa**	anterior wall **Ba**	cervix or cuff **C**
genital hiatus **gh**	perineal body **pb**	total vaginal length **tvl**
posterior wall **Ap**	posterior wall **Bp**	posterior fornix **D**

Fig. 31.1 Prolapse quantification. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2007-2016. All Rights Reserved

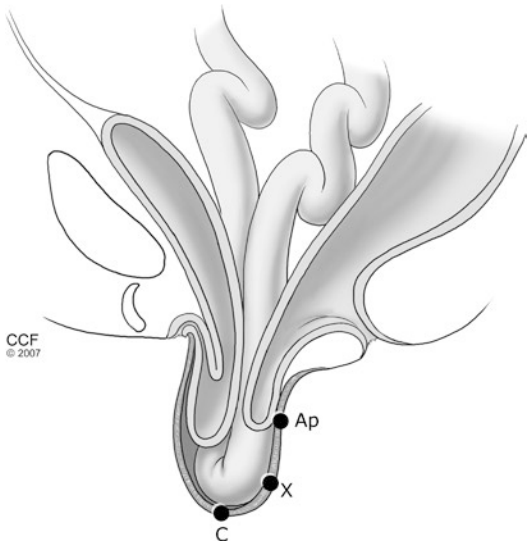


Fig. 31.2 Pelvic organ prolapse: enterocele. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2007-2016. All Rights Reserved

Stage IV: Complete eversion or eversion at least within 2 cm of the total length of the lower genital tract is demonstrated.

The Q-tip test is used to assess urethral mobility by inserting Q-tip swab into the urethra and observe its movement with elevating the intra-abdominal pressure. Urethral hypermobility is defined as a urethral displacement ≥30° from the horizontal when the patient is in the lithotomy position while straining [19, 21]. The lack of urethral mobility was one of the clinical predictors of treatment failure 1 year after mid urethral sling surgery [22]. Urethral mobility can also be assessed by POP-Q examination (point Aa) [23] and voiding cystourethrography [24].

Measurement of the postvoid residual urine volume (normal <150 ml) is recommended in patients with incontinence or emptying dysfunction. This can be measured by either inserting a catheter or performing a surface ultrasound [19, 25]. High residual volume indicates detrusor underactivity or bladder outlet obstruction or a combination of both and can lead to overflow incontinence which may mimics SUI [26, 27].

Investigations

In most cases of middle and anterior compartment problems, the diagnosis can be made by clinical evaluation and this will dictate what additional workup is needed. Laboratory investigations can be valuable in some situation where underlying medical disease is suspected which may include hypothyroidism, urinary tract infection (UTI), electrolytes disturbance, and diabetes. Imaging for pelvic floor symptoms includes ultrasound of the bladder and anal sphincter, voiding cystourethrography, video defocography or cystocolpodefecography and dynamic pelvic floor MRI [24]. Functional tests include anal physiology and urodynamic testing. This chapter will focus on the workup of anterior and middle compartment disorders.

Further work-up for uncomplicated stress urinary incontinence (SUI) usually does not require more than screening for UTI, positive cough stress test and normal postvoid residual volume. Uncomplicated SUI patients have leakage of urine with stress (increasing the lower abdominal pressure) without urgency or voiding symptoms such as retention and difficulty emptying. They also have not had prior anti-incontinence, POP, or radical pelvic surgery; recurrent urinary tract infections; and medical conditions that can affect the lower urinary tract [19, 25, 28].

Urodynamic studies (UDS) are composed of a number of physiology tests, which examine bladder filling, urine storage and emptying. The tests are post-void residual, uroflowmetry, cystometry, pressure-flow studies (PFS), videourodynamic studies, electromyography and urethral function tests (Valsalva leak point pressure, urethral pressure profile). These tests can be done in combination or separately [27]. Testing is considered before starting treatment in patients with complicated SUI or when the diagnosis is unclear or prior to prolapse repair [19, 25]. Although it has shown that UDS does not correlate with treatment outcomes in SUI, it may modify treatment plans or assist with counseling patients about to undergo irreversible treatments [27, 29]. When conservative treatment for urinary dysfunction disorders fail, UDS could have a role in confirming the clinical diagnosis (for example in overactive bladder and urge urinary incontinence). UDS may also demonstrate components of SUI or bladder outlet obstruction [27].

Imaging may also assist in the clinical assessment of PFD as in some people it may be easy to underestimate or misdiagnose the site of prolapse. It may also uncover some additional defecation disorders [20, 30, 31]. Transabdominal, perineal, introital and transvaginal ultrasound can be used to assess bladder neck descent/mobility, proximal urethral opening during coughing or during valsalva, PVR, structural abnormalities of the bladder or urethra, descent of pelvic organs, levator ani muscle defects/avulsion and hiatal ballooning [20]. MRI has been shown to be more sensitive than physical examination in pelvic organ prolapse assessment and grading, and allows the detection of ligamentous and muscular pelvic floor structures in detail [20, 31]. Dynamic MRI allows visualization of the bladder neck position and the delineation of cystoceles has been shown to have good correlation with the data obtained from lateral cystourethrography [32].

Management of Urinary Incontinence

Urinary incontinence is defined as involuntary loss of urine that is both objectively demonstrable and a social or hygienic problem for the patient. Types include stress, urge, postural, mixed, continuous and insensible. It affects 50% of women at some point in their lives with 30–80% complaining of SUI [33]. SUI is a complaint of involuntary leakage of urine with coughing, sneezing or physical exertion [20]. On examination stress leakage can be observed, when there is involuntary leakage of fluid from the urethra synchronous with effort or physical exertion, or during sneezing or coughing [34]. Urodynamic stress incontinence is diagnosed when involuntary leakage of urine occurs during filling cystometry associated with increased intra- abdominal pressure and in the absence of a detrusor contraction [20]. Urge urinary incontinence is involuntary loss of urine associated with a sudden, strong "urgent" desire to void [35] (which sometimes is a part of overactive bladder syndrome which is characterized by urgency and frequency with or without incontinence) [36]. Mixed urinary incontinence is involuntary leakage of urine associated with urgency, exertion, effort, sneezing and coughing.

UI is associated with a weakness of the pelvic floor support structures, damage to the bladder sphincter mechanism, or both. These factors may lead to bladder neck hypermobility and rotational descent of the proximal urethra with associated intrinsic sphincter deficiency [37].

Conservative Interventions

Patients should be considered initially for a trial of non-surgical management [37]. This includes the following:

Lifestyle Modification

Weight loss, smoking cessation, avoiding straining and treating constipation are initially recommended. These changes may be combined with limiting oral fluid and caffeine intake. Loss of 5–10% of baseline weight has been shown to reduce 50% of the incontinence episodes [38].

Behavioral Therapy

Bladder training (timed and prompted voiding) in which the patient urinates (or is reminded to urinate) according to a predetermined schedule can improve symptoms and may also an initially advised [17, 39].

Physical Therapy

Physical therapy includes pelvic floor muscle training (PFMT) with or without biofeedback and has been reported to improve symptoms. The exact treatment plan is individualized and could involve muscle-clenching exercises to strengthen the pelvic floor muscles, stabilize the urethra and increases urethral closure pressures [17]. PFMT can focus on coordination and improving core strength. A trial of supervised PFMT for a minimum of 3 months as a first-line treatment is typically considered [17]. Women with SUI or UI (all types) who had PFMT were compared to a group treated with medication, or placebo. Overall the PFMT group reported cure or improvement, better quality of life, fewer leakage episodes per day and less urinary leakage [40]. However, these benefits were not maintained when re-evaluated at long-term follow-up [41] and there is insufficient evidence to support adding PFMT to other treatment modalities [37]. However there is variation in protocols and training of therapists. Standardization may improve results.

Incontinence Pessaries

These have been trialed but are shown to be modestly effective (for a more in depth description see the later the section on its use in POP). There is no high quality evidence to support its efficacy in incontinent patients however it may be useful in women who are poor surgical candidates or those that do not wish to have surgery [39].

Pharmacotherapy

Anticholinergic agents (oxybutynin, tolterodine, fesoterodine, trospium, solifenacin, and darifenacinare) are the main medications prescribed for urgency urge incontinence and overactive bladder syndrome that does not respond to lifestyle modification and PFMT [39].

The anticholinergic medications can have adverse side effects such as constipation, impaired cognition, sedation, and blurred vision. These symptoms have led to 43–83% of patients discontinuing the medication within the first 30 days [42]. These agents should not be prescribed in patients with narrow angle glaucoma and frail older women with multiple medical comorbidities, functional impairments in activities of daily living, or any cognitive impairment [39]. Anticholinergic drugs should also not be offered to women with isolated stress urinary incontinence without the symptoms of overactive bladder [43].

Mirabegron is a selective β3-adrenergic agonist that relaxes the bladder detrusor muscle. There have been less reported side effects and therefore it seems to be better tolerated. For patients with SUI and MUI, duloxetine is a serotonin- norepinephrine reuptake inhibitor (SNRI) that can be offered to patients who are not surgical candidates or those who do not desire surgical intervention [39, 44]. A recent systematic review and meta-analysis of randomized controlled trials comparing duloxetine with placebo for SUI showed that a significant efficacy was seen in women treated with specific doses of duloxetine. The adverse effects such as nausea, constipation, dry mouth, somnolence, insomnia, and dizziness were commonly reported and limited the patients' compliance [17, 45].

Botulinum toxin A typically injected into the bladder wall is an effective treatment for patients who are refractory to conservative measures and drugs. It improves urge incontinence episodes, urgency, frequency, quality of life, nocturia, and urodynamic testing parameters [46].

Bulking Agents

These have been injected around an incompetent urethra in an attempt to improve UI. These agents have included GAX collagen, autologous fat, and carbon-coated beads, silicon, polytetrafluoroethylene paste, calcium hydroxylapatite, hyaluronic acid, and injectable microballoons. The injection is done under local anesthesia using either transurethral or periurethral techniques [39]. The results are variable and typically follow up has been short. It can be considered in elderly and in failed continence surgery [19]. If the desired degree of improvement is not attained repeated injections have been described [19].

Sacral Nerve Stimulation (SNS)

SNS with the InterStim® is approved by the Food and Drug Administration (FDA) for urinary

retention, overactive bladder with or without urinary urge incontinence and fecal incontinence. Therapeutic success was reported in 82% of implanted patients that had OAB, 68% in patients who had urgency/frequency and 77% in patients who had UUI at 12 months. Sixty percent reported reduction in the number of leaks/day, 64% achieved normal voiding patterns (<8 voids/day) and complete continence was achieved in 36% at 12 months. Patients also reported significant improvement in Quality of Life. The most frequent complications after implantation were undesirable change in stimulation (12%), implant site pain (7%), and implant site infection (3%). In one study, three serious events were reported during test stimulation: implant site infection, skin infection, and respiratory arrest during surgery. There was one event of implant site erosion. Other rare complications occurring ≤1% were implant site erythema, lead fracture, paresthesia, and lead migration/dislodgement. Overall infection rate after permanent implantation was 4%. The permanent explant rate after full system implantation was 5%. Explantation was performed due to complications and/or patient request [47].

Surgery For Urinary Incontinence

Surgery is offered to SUI patients who failed conservative measures. The most commonly performed procedures are midurethral slings (MUS), pubovaginal (traditional suburethral) slings (PVS), and Burch colposuspension (BC). MUS is preferable because it is less invasive, has a shorter operative time and a shorter recovery. Additionally cures are comparable to PVS and BC [17, 19]. The slings can be placed using either retropubic (Tension-free Vaginal Tape, TVT) or transobturator (Transobturator Tape, TOT) approaches (Figs. 31.3 and 31.4). Subjective cure rates are 43–92% in TOT and 51–88% in TVT. Complications of sling procedures are generally low. TOT is reported to have lower bladder perforation, vascular/ visceral injuries, postoperative voiding dysfunction, operative time and blood loss. However, groin pain is higher in TOT [33].

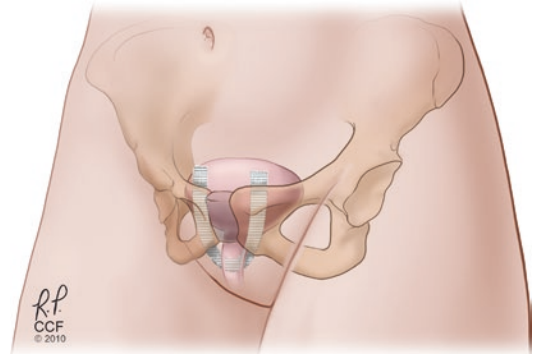


Fig. 31.3 Tension-free vaginal tape. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2007-2016. All Rights Reserved

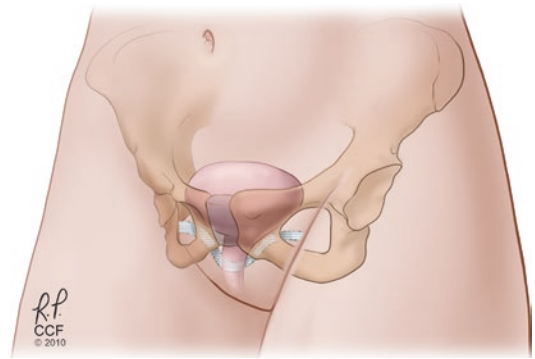


Fig. 31.4 Transobturator tape. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2007-2016. All Rights Reserved

Management of Pelvic Organ Prolapse

POP is defined as the descent of one or more of the following areas of the mid pelvis: anterior vaginal wall, posterior vaginal wall, uterus (cervix), or the apex of the vagina (vaginal vault or cuff scar after hysterectomy) [20, 34].

Pelvic Floor Muscle Training

Non-surgical treatment can be offered to patients with mild prolapse. After supervised PFMT for 6 months, 3D-ultrasound showed increased muscle volume, narrowing of the levator hiatus, shorter muscle length, and elevation of the rest-

ing position of the bladder and rectum [48]. Pooling data from 4 trials comparing PFMT versus controls found that PFMT improved the degree of prolapse by 17% compared to no PFMT. Two trials that measured pelvic floor muscle function found improvement in function in the PFMT group compared to the control group. Additionally, urinary outcomes (urodynamics, frequency and bother of symptoms, or symptom score) were improved with PFMT in some of the trials. The data is inconclusive when exploring the benefit of PFMT with surgery compared to surgery alone [49].

Pessary

The device is considered for women who desire minimal intervention [50] or are unfit to undergo reconstructive surgery due to comorbid conditions [51]. It can also be used as a temporary measure to improve symptoms until surgery is performed. It can additionally be utilized to screen for occult SUI and predict voiding symptoms after surgical correction [52]. Seventy-five percent of patients successfully retain the pessary [53]. When a pessary has been successfully placed, women have reported improvement in the awareness of a vaginal lump (71%), prolapse (53%), urgency (38%), SUI (23%), UUI (29%), fecal urgency (23%), FI (20%), bowel emptying (28%), frequency in sexual activity (7%) and sexual satisfaction (10%) [53]. Complications due to use of a pessary are usually minor [51, 52] and include vaginal discomfort or pain, vaginal discharge or mild bleeding [53]. Vaginal erosion has been reported and can be treated with pessary removal and local estrogen (cream or tablet) [52].

Surgery for POP

Surgery is frequently recommended for advanced or symptomatic POP. However, surgical outcomes should be thoroughly discussed as some women may experience postoperative worsening of existing symptoms or the surgical intervention may produce new symptoms. One example is that symptomatic posterior POP is a common finding 5 years after abdominal sacrocolpopexy (ASC) in some women [54]. Even posterior compartment surgical intervention can be associated with a new awareness of symptoms. An example of this is that uterine prolapse with or without an enterocele has been found to be troublesome following a perineal repair of rectal prolapse [55].

Generally there are three surgical approaches to POP surgery; vaginal, abdominal and obliterative procedures. The operative choice depends on a number of factors including site and severity of the prolapse; symptomatic priority, urinary, bowel or sexual function; the patient's overall health and performance status; surgeon preference [11] and history of previous reconstructive or anti-incontinence surgery. It is preferable to repair any coexistent pelvic defect/problem simultaneously [56]. The following section will discuss the surgical approach to POP according to the affected compartment.

Apical Vaginal Prolapse

Apical prolapse includes cervical prolapse (or vaginal cuff prolapse in women who underwent a previous hysterectomy). Abdominal sacral colpopexy (ASC) is the gold standard for the treatment of apical prolapse [50, 57]. In a Cochrane review (56 RCT, n = 5954) [11], ASC was associated with the lowest recurrence rate when compared to vaginal sacrospinous colpopexy, vaginal uterosacral suspension and transvaginal polypropylene mesh (Fig. 31.5). The rate of dyspareunia was lower in ASC than vaginal sacrospinous colpopexy. Reoperation rate was also lower in ASC versus high vaginal uterosacral suspension and transvaginal repair with polypropylene mesh. However, abdominal sacral colpopexy had a longer operating time, longer recovery time and increased cost. A recent meta-analysis [57] (12 studies, n = 4757) found open and minimally invasive (laparoscopic and robotic) sacropexy were equally effective in terms of point-C POP-Q measurements and recurrence rate. Minimally invasive sacropexy surgery had a lower transfusion rate, shorter length of hospital stay and less blood loss. In another comparison, sacrospinous hysteropexy and vaginal hysterectomy with suspension of the uterosacral

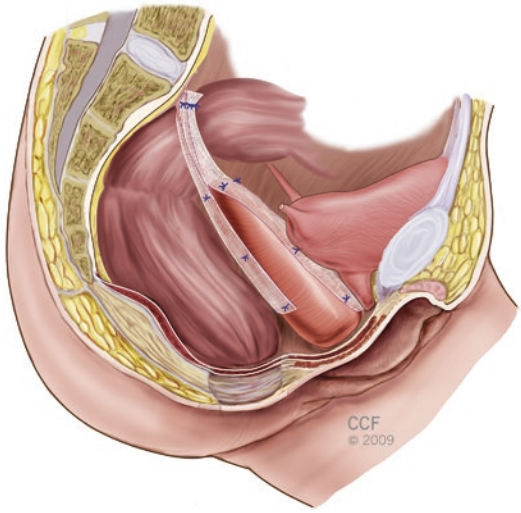


Fig. 31.5 Abdominal sacral colopexy. Reprinted with permission, Cleveland Clinic Center for Medical Art & Photography © 2007-2016. All Rights Reserved

ligaments were found comparable at 12 months in terms of anatomic recurrence, quality of life, subjective outcome, hospital stay, recovery, complications, and sexual functioning [58].

Anterior Compartment Prolapse (Cystocele)

The use of mesh has decreased the recurrence rate compared to native tissue repair in this compartment. Standard anterior repair was associated with more recurrence on examination and awareness of prolapse versus when polypropylene (permanent) mesh repair was utilized. However, the reoperation rate was similar and there were no differences in quality of life data or de novo dyspareunia [11]. Compared to native tissue repair, transobturator mesh repair had a significantly higher blood loss, operating time, recurrences in apical or posterior compartment and de novo stress urinary incontinence. Mesh erosions were reported in 11.4%, with surgical interventions being performed in 6.8% [11]. Native tissue repair was compared to total, anterior, or posterior polypropylene kit meshes for vaginal prolapse in multiple compartments. There was no difference in awareness of prolapse between the groups. The recurrence rate on examination was higher in the native tissue repair group compared to the transvaginal polypropylene mesh group. The mesh erosion rate was 18%, and 9% required reoperation for mesh erosion [11]. Combined continence procedures are recommended as 55% and 33% of stage 2 POP and stage 3 POP patients, respectively have SUI [11, 59]. It is important to remember that stress continent patients before surgery had an predictable 36–80% risk of developing de novo SUI symptoms after the surgical correction of prolapse [60, 61]. The etiology of this seems to be that SUI sometimes is masked by the urethral kinking or compression due to the prolapse [36, 56, 60]. The outcome on bladder function was evaluated in 16 trials. Twelve percent of women developed de novo symptoms of bladder overactivity and 9% de novo voiding dysfunction. Patients with stress UI or occult UI have benefited from having a concomitant continence surgery (RR 7.4, 95% CI 4.0–14), (RR 3.5, 95% CI 1.9–6.6), respectively [11]. Vaginal vault suspension procedures should be considered as well when correcting the anterior vaginal wall as in many cases of advanced anterior vaginal prolapse (vaginal wall was at least 2 cm outside the hymen) there is an associated apical defect [62]. Follow-up data on patients who had undergone a combined apical prolapse procedure and cystocele repair had a significantly lower prolapse reoperation rate after 10 years versus those who had undergone an isolated anterior repair (11.6 vs. 20.2 %, $p < 0.01$) [63].

Posterior Compartment Prolapse

Managing posterior compartment dysfunction is challenging. This is mainly because patients present with non-specific symptoms that are inconsistent with the anatomic findings [64–66]. More than 80% of asymptomatic females have a rectocele on defecography [66]; therefore repair of a rectocele should be carefully contemplated as it may not address the patient's symptoms. Hicks et al. [65] showed that 71% of patients who had a rectocele responded favorably to fiber supplementation and biofeedback therapy and they suggested considering the surgical option as a last resort. Pessary placement may be of value to reduce bothersome vaginal bulging in some women. For patients who do not improve after conservative measures, surgery may be offered. Patients should

be counseled carefully and have realistic post-surgical expectations. The posterior vaginal repair can be addressed through the transvaginal, transanal, or transperineal approach. Transvaginal approaches are typically performed by a gynecologist. These are typically a site specific posterior colporrhaphy. Trasvaginal approaches have been shown to have fewer symptom recurrences and lower anatomical recurrence (when evaluated with a defecography) than a transanal repair [11]. A synthetic or biologic graft has been utilized to enhance the repair. These techniques had similar anatomic and functional outcomes when compared in a randomized trial of 106 patients [67]. The dyspareunia rate in this trial was 36% and was comparable among the groups [67]. Dyspareunia is speculated to be the result of the plication of the levator ani muscle performed during tranvaginal approaches [68, 69].

Summary

Pelvic floor dysfunction involving more than one compartment is common. Approaching PFDs in the context of a multidisciplinary team will improve the outcomes and quality of care.

References

1. Wu JM, Matthews CA, Conover MM, Pate V, Jonsson Funk M. Lifetime risk of stress urinary incontinence or pelvic organ prolapse surgery. Obstet Gynecol. 2014;123(6):1201–6.
2. Jelovsek JE, Barber MD, Paraiso MFR, Walters MD. Functional bowel and anorectal disorders in patients with pelvic organ prolapse and incontinence. Obstet Gynecol. 2005;193(6):2105–11.
3. Rortveit G, Subak LL, Thom DH, et al. Urinary incontinence, fecal incontinence and pelvic organ prolapse in a population-based, racially diverse cohort: prevalence and risk factors. Female Pelvic Med Reconstr Surg. 2010;16(5):278–83.
4. González-Argenté FX, Jain A, Nogueras JJ, Davila GW, Weiss EG, Wexner SD. Prevalence and severity of urinary incontinence and pelvic genital prolapse in females with anal incontinence or rectal prolapse. Dis Colon Rectum. 2001;44(7):920–5.
5. Kapoor DS, Sultan AH, Thakar R, Abulafi MA, Swift RI, Ness W. Management of complex pelvic floor disorders in a multidisciplinary pelvic floor clinic. Color Dis. 2008;10(2):118–23.
6. Quiroz LH, Munoz A, Shippey SH, Gutman RE, Handa VL. Vaginal parity and pelvic organ prolapse. J Reprod Med. 2010;55(3-4):93–8.
7. Hallock JL, Handa VL. The epidemiology of pelvic floor disorders and childbirth: an update. Obstet Gynecol Clin N Am. 2016;43(1):1–13.
8. Gyhagen M, Bullarbo M, Nielsen T, Milsom I. Prevalence and risk factors for pelvic organ prolapse 20 years after childbirth: a national cohort study in singleton primiparae after vaginal or caesarean delivery. BJOG. 2013;120(2):152–60.
9. Morkved S, Bo K. Effect of pelvic floor muscle training during pregnancy and after childbirth on prevention and treatment of urinary incontinence: a systematic review. Br J Sports Med. 2014;48(4):299–310.
10. Turner CE, Young JM, Solomon MJ, Ludlow J, Benness C. Incidence and etiology of pelvic floor dysfunction and mode of delivery: an overview. Dis Colon Rectum. 2009;52(6):1186–95.
11. Maher C, Feiner B, Baessler K, Schmid C. Surgical management of pelvic organ prolapse in women. Cochrane Database Syst Rev. 2013;4:CD004014.
12. Steinauer JE, Waetjen LE, Vittinghoff E, et al. Postmenopausal hormone therapy: does it cause incontinence? Obstet Gynecol. 2005;106(5 Pt 1):940–5.
13. Bump RC, Mattiasson A, Bø K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. Obstet Gynecol. 1996;175(1):10–7.
14. Jorge JMN, Wexner SD. Etiology and management of fecal incontinence. Dis Colon Rectum. 1993;36(1):77–97.
15. Shumaker SA, Wyman JF, Uebersax J, McClish D, Fantl JA. Health-related quality of life measures for women with urinary incontinence: the incontinence impact questionnaire and the urogenital distress inventory. Qual Life Res. 1994;3(5):291–306.
16. Jelovsek JE, Chen Z, Markland AD, et al. Minimum important differences for scales assessing symptom severity and quality of life in patients with fecal incontinence. Female Pelvic Med Reconstr Surg. 2014;20(6):342–8.
17. Syan R, Brucker BM. Guideline of guidelines: urinary incontinence. BJU Int. 2016;117(1):20–33.
18. Fisher K, Bliss DZ, Savik K. Comparison of recall and daily self-report of fecal incontinence severity. J Wound Ostomy Continence Nurs. 2008;35(5):515–20.
19. Medina CA, Costantini E, Petri E, et al. Evaluation and surgery for stress urinary incontinence: a FIGO working group report. Neurourol Urodyn. 2016;36(2):518–28.
20. Haylen BT, Maher CF, Barber MD, et al. An international urogynecological association (IUGA)/international continence society (ICS) joint report on the terminology for female pelvic organ prolapse (POP). Int Urogynecol J. 2016;27(2):165–94.

21. Karram MM, Bhatia NN. The Q-tip test: Standardization of the technique and its interpretation in women with urinary incontinence. Obstet Gynecol. 1988;71(6):807–11.
22. Richter HE, Litman HJ, Lukacz ES, et al. Demographic and clinical predictors of treatment failure one year after midurethral sling surgery. Obstet Gynecol. 2011;117(4):913–21.
23. Mattison ME, Simsiman AJ, Menefee SA. Can urethral mobility be assessed using the pelvic organ prolapse quantification system? an analysis of the correlation between point aa and Q-tip angle in varying stages of prolapse. Urology. 2006;68(5):1005–8.
24. Woodfield CA, Krishnamoorthy S, Hampton BS, Brody JM. Imaging pelvic floor disorders: trend toward comprehensive MRI. Am J Roentgenol. 2010;194(6):1640–9.
25. American College of Obstetricians and Gynecologists. Evaluation of uncomplicated stress urinary incontinence in women before surgical treatment. committee opinion No. 603. Obstet Gynecol. 2014;123(6):1403–7.
26. Garely AD, Noor N. Diagnosis and surgical treatment of stress urinary incontinence. Obstet Gynecol. 2014;124(5):1011–27.
27. Winters JC, Dmochowski RR, Goldman HB, et al. Urodynamic studies in adults: AUA/SUFU guideline. J Urol. 2012;188((6):2464–72.
28. Nygaard IE, Heit M. Stress urinary incontinence. Obstet Gynecol. 2004;104(3):607–20.
29. Sirls LT, Richter HE, Litman HJ, et al. The effect of urodynamic testing on clinical diagnosis, treatment plan and outcomes in women undergoing stress urinary incontinence surgery. J Urol. 2013;189(1):204–9.
30. Bitti GT, Argiolas GM, Ballicu N, et al. Pelvic floor failure: MR imaging evaluation of anatomic and functional abnormalities. Radiographics. 2014;34(2):429–48.
31. Goodrich MA, Webb MJ, King BF, Bamptom AE, Campbeau NG, Riederer SJ. Magnetic resonance imaging of pelvic floor relaxation: dynamic analysis and evaluation of patients before and after surgical repair. Obstet Gynecol. 1993;82(6):883–91.
32. Gufler H, DeGregorio G, Allmann K, Kundt G, Dohnicht S. Comparison of cystourethrography and dynamic MRI in bladder neck descent. J Comput Assist Tomogr. 2000;24(3):382–8.
33. Ford A, Rogerson L, Cody J, Ogah J. Mid-urethral sling operations for stress urinary incontinence in women (review). Cochrane Database Syst Rev. 2015;7:CD006375.
34. Haylen BT, De Ridder D, Freeman RM, et al. An international urogynecological association (IUGA)/ international continence society (ICS) joint report on the terminology for female pelvic floor dysfunction. Int Urogynecol J. 2010;21(1):5–26.
35. Lapitan MC, Cody JD. Open retropubic colposuspension for urinary incontinence in women. Cochrane Database Syst Rev. 2016;2:CD002912.
36. Ramanah R, Ballester M, Chereau E, Rouzier R, Daraï E. Effects of pelvic organ prolapse repair on urinary symptoms: a comparative study between the laparoscopic and vaginal approach. Neurourol Urodyn. 2012;31(1):126–31.
37. Ayeleke RO, Hay-Smith EJC, Omar MI. Pelvic floor muscle training added to another active treatment versus the same active treatment alone for urinary incontinence in women. status and date: New search for studies and content updated (no change to conclusions). Cochrane Database Syst Rev. 2015;11:CD010551.
38. Subak LL, Whitcomb E, Shen H, Saxton J, Vittinghoff E, Brown JS. Weight loss: a novel and effective treatment for urinary incontinence. J Urol. 2005;174(1):190–5.
39. Wood LN, Anger JT. Urinary incontinence in women. BMJ. 2014;349(15):4531–42.
40. Dumoulin C, Hay-Smith J, Habée-Séguin GM, Mercier J. Pelvic floor muscle training versus no treatment, or inactive control treatments, for urinary incontinence in women: a short version cochrane systematic review with meta-analysis. Neurourol Urodyn. 2015;34(4):300–8.
41. Bø K, Kvarstein B, Nygaard I. Lower urinary tract symptoms and pelvic floor muscle exercise adherence after 15 years. Obstet Gynecol. 2005;105(5 Part 1):999–1005.
42. Sexton C, Notte S, Maroulis C, et al. Persistence and adherence in the treatment of overactive bladder syndrome with anticholinergic therapy: a systematic review of the literature. Int J Clin Pract. 2011;65(5):567–85.
43. Anger JT, Scott V, Kiyosaki K, et al. Development of quality indicators for women with urinary incontinence. Neurourol Urodyn. 2013;32(8):1058–63.
44. National Collaborating Centre for Women's and Children's Health (UK). 2013.
45. Li J, Yang L, Pu C, Tang Y, Yun H, Han P. The role of duloxetine in stress urinary incontinence: a systematic review and meta-analysis. Int Urol Nephrol. 2013;45(3):679–86.
46. Olivera CK, Meriwether K, El-Nashar S, et al. Nonantimuscarinic treatment for overactive bladder: a systematic review. Obstet Gynecol. 2016;215(1):34–57.
47. Noblett K, Siegel S, Mangel J, et al. Results of a prospective, multicenter study evaluating quality of life, safety, and efficacy of sacral neuromodulation at twelve months in subjects with symptoms of overactive bladder. Neurourol Urodyn. 2014;35(2):246–51.
48. Braekken IH, Majida M, Engh ME, Bo K. Morphological changes after pelvic floor muscle training measured by 3-dimensional ultrasonography: a randomized controlled trial. Obstet Gynecol. 2010;115(2 Pt 1):317–24.
49. Hagen S, Stark D. Conservative prevention and management of pelvic organ prolapse in women. Cochrane Database Syst Rev. 2011;12:CD003882.

50. Alas AN, Anger JT. Management of apical pelvic organ prolapse. Curr Urol Rep. 2015;16(5):1–7.
51. Griebling TL. Vaginal pessaries for treatment of pelvic organ prolapse in elderly women. Curr Opin Urol. 2016;26(2):201–6.
52. Robert M, Schulz JA, Harvey M, et al. Technical update on pessary use. J Obstet Gynaecol. 2013;35(7):664–74.
53. Fernando RJ, Thakar R, Sultan AH, Shah SM, Jones PW. Effect of vaginal pessaries on symptoms associated with pelvic organ prolapse. Obstet Gynecol. 2006;108(1):93–9.
54. Grimes CL, Lukacz ES, Gantz MG, et al. What happens to the posterior compartment and bowel symptoms after sacrocolpopexy? Evaluation of 5-year outcomes from E-CARE. Female Pelvic Med Reconstr Surg. 2014;20(5):261–6.
55. Altemeier WA, Culbertson WR, Schowengerdt C, Hunt J. Nineteen years' experience with the one-stage perineal repair of rectal prolapse. Ann Surg. 1971;173(6):993–1006.
56. Grody MHT. Urinary incontinence and concomitant prolapse. Clin Obstet Gynecol. 1998;41(3):777–85.
57. De Gouveia DS, Claydon LS, Whitlow B, Dolcet Artahona MA. Laparoscopic versus open sacrocolpopexy for treatment of prolapse of the apical segment of the vagina: a systematic review and meta-analysis. Int Urogynecol J. 2016;27(1):3–17.
58. Detollenaere RJ, den Boon J, Stekelenburg J, et al. Sacrospinous hysteropexy versus vaginal hysterectomy with suspension of the uterosacral ligaments in women with uterine prolapse stage 2 or higher: multicentre randomised non-inferiority trial. BMJ. 2015;351:h3717.
59. Slieker-ten H, Marijke CPH, Pool-Goudzwaard AL, Eijkemans MJ, Steegers-Theunissen RP, Burger CW, Vierhout ME. The prevalence of pelvic organ prolapse symptoms and signs and their relation with bladder and bowel disorders in a general female population. Int Urogynecol J. 2009;20(9):1037–45.
60. Bump RC, Fantl JA, Hurt WG. The mechanism of urinary continence in women with severe uterovaginal prolapse: results of barrier studies. Obstet Gynecol. 1988;72(3):291–5.
61. Chaikin DC, Groutz A, Blaivas JG. Predicting the need for anti-incontinence surgery in continent women undergoing repair of severe urogenital prolapse. J Urol. 2000;163(2):531–4.
62. Rooney K, Kenton K, Mueller ER, FitzGerald MP, Brubaker L. Advanced anterior vaginal wall prolapse is highly correlated with apical prolapse. Obstet Gynecol. 2006;195(6):1837–40.
63. Eilber KS, Alperin M, Khan A, et al. Outcomes of vaginal prolapse surgery among female medicare beneficiaries: the role of apical support. Obstet Gynecol. 2013;122(5):981–7.
64. Hale DS, Fenner D. Consistently inconsistent, the posterior vaginal wall. Obstet Gynecol. 2015;214(3):314–20.
65. Hicks CW, Weinstein M, Wakamatsu M, Savitt L, Pulliam S, Bordeianou L. In patients with rectoceles and obstructed defecation syndrome, surgery should be the option of last resort. Surgery. 2014;155(4):659–67.
66. Shorvon P, McHugh S, Diamant N, Somers S, Stevenson G. Defecography in normal volunteers: results and implications. Gut. 1989;30(12):1737–49.
67. Paraiso MFR, Barber MD, Muir TW, Walters MD. Rectocele repair: a randomized trial of three surgical techniques including graft augmentation. Obstet Gynecol. 2006;195(6):1762–71.
68. Nieminen K, Hiltunen K, Laitinen J, Oksala J, Heinonen PK. Transanal or vaginal approach to rectocele repair: a prospective, randomized pilot study. Dis Colon Rectum. 2004;47(10):1636–42.
69. Lefevre R, Davila GW. Functional disorders: Rectocele. Clin Colon Rectal Surg. 2008;21(2):129–37.

Nursing Considerations

32

Bonnie Alvey

Introduction

In today's world of specialization in healthcare, rapid technological advances and public demand, nursing practice has grown more complex [1]. These changes resulted in challenges and new opportunities and has prompted nurses to move from a generalist to a specialist role. Specialized knowledge of anorectal surgery, allows a nurse to enhance patient care and excel as a valued team member. This chapter will discuss the specialized nurse caring for patients with a range of anorectal diseases and disorders.

Nursing Roles

As a health care provider the nurse's role is to facilitate high quality, responsive total patient care, while collaborating with physicians and health care providers to ensure effective teamwork. Nursing personnel serve in a number of roles that vary from a clinical nurse, often assisted by a medical technician to those with advanced degrees and the ability to practice independently. An increasing number of nurses are pursuing advanced practice degrees resulting in a greater number of nurse practitioners (NP), and clinical nurse specialists (CNS) also categorized as advanced practice clinicians (APC). Many will be employed in a specialty where they learn the specific skills and procedures related to that area. The advanced practice model as decribed by Hamric, et al has four main components: clinician, educator, resource/consultant, and researcher [2]. These practice roles cross over various clinical environments from the doctor's office to surgical units to community health centers and other settings.

The nurse specialist or advanced practitioner acts as a resource person by sharing clinical knowledge and assessment of the patient, and contributes to the decision making process for the patient's management [2]. Nurses with education and certification in wound, ostomy, and continence (WOC) nursing play an important role in the care of the anorectal patient population. Those WOC nurses with advanced practice degrees can provide additional services as allowed by their Board of Nursing's practice act. For this discussion, the nurse interaction can be arbitrarily divided into preoperative, intraoperative, and postoperative phases.

Preoperative

Anorectal problems encompass a wide range of diseases and disorders and when patients first seek help they are looking to the nurse to provide

B. Alvey (✉)
Enterostomal Therapy Clinic, Ochsner Medical Center, New Orleans, LA, USA
e-mail: balvey@ochsner.org

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4_32

reassurance and a level of comfort in a very uncomfortable setting. Some functional disorders such as rectal prolapse or fecal incontinence can be extremely distressing and embarrassing to individuals who consider themselves healthy and many will have suffered silently for years before seeking help [3]. These conditions not only disrupt lifestyle but also can lead to social isolation and fear. Patients seeking evaluation of anorectal disorders and undergoing an anorectal exam may experience fear, anxiety and or shame.

Bearing in mind the wide age range of patients who suffer from anorectal problems, along with the full social strata from which they may come, the infinite psychological fears, and the concerns and reactions they may manifest, it is critical that the nurse involved in their care possess understanding along with competent skills [3]. The care each patient receives must be individualized and personal, and never should the needs of the individual become lost in the treatment of the disease process.

The patient with a benign or malignant disease often verbalizes apprehension as to the extent of the disease, the magnitude of the surgical intervention, and possible sexual dysfunction following anorectal surgery, such as abdominoperineal resection. Some requiring a stoma face anxiety regarding changes in body image. Patients suffering from anorectal sexually transmitted diseases from anal receptive intercourse, homosexuality, or promiscuous lifestyle, have social, psychological, and physical needs [4].

As described in Chap. 2 an effective patient evaluation requires a detailed history and physical examination. While the nurse may not be eliciting all this information, patients often impart vital information to the nurse during their interaction.

Preparation for Examination

Patients with painful anal conditions such as fissures or abscesses do not require any mechanical cleansing, while patients who may require an endoscopic evaluation of the lower intestine often benefit from cleansing. To prepare the lower bowel and rectum for examination, one or two enemas, usually a phosphate solution, are used. This is an important task for the nurse or medical assistant, as they need to alleviate many of the patients' fears as they prepare them for the rectal exam. The nurse should familiarize the patient with the examination table and the position required for the rectal examination and procedure about to be performed. The instruments used for the examination should be out of view or covered. Although it should not be acutely painful, the nurse should discuss possible temporary discomfort during the insertion of the instruments.

Following the initial assessment and exam, further diagnostics may be necessary and the physician will inform the patient of any additional procedures. It is the nurse's role to ensure that the patient understands the proposed tests, procedure or surgical intervention that is recommended.

Preoperative Counseling

Preoperative counseling includes information, support, and assistance in coping with the proposed surgical intervention. The preoperative counseling endeavors are to ensure the patient that all efforts will be made to meet his or her needs, both physical and psychological. Explanation by the surgeon of the surgical procedure, the risks, benefits, possible complications, and alternatives, coupled with reinforcement and counseling by the nurse, helps to reduce anxiety while insuring an informed patient. Research has shown that a well informed patient experiences more confidence and less anxiety, which results in a more positive outcome and heightened sense of patient satisfaction [5]. In providing preoperative counseling to both patient and family the nurse should project empathy and understanding, have excellent communication skills and be sensitive to non-verbal communication. The family resources should be assessed, as should their current level of knowledge and readiness to learn.

Effective preoperative counseling should be succinct, well organized, and presented verbally and in writing. Items which should be covered include: any necessary radiological studies, anorectal physiological studies, electrocardiogram,

and laboratory studies; medical clearances; details of any bowel and antibiotic preparation; the anticipated procedure; and a summary of the anticipated hospital course. A brief discussion of potential problems should be included such as with an abdominoperineal resection, which can affect sexual function. The surgeon should initiate a candid discussion concerning the possibility of sexual dysfunction as most sexually active males will have concerns regarding impotence or retrograde ejaculation, therefore information about alternative sexual options and prosthetic devices should be given [4]. The nurse's role is to reinforce information given by the doctor and provide an opportunity for the patient to ask questions.

An important role of the nurse is to develop a teaching plan that begins in the preoperative counseling phase and continues beyond hospital discharge. Teaching methods that are personalized are always preferable. Typically verbal followed by written is employed and when possible video should be added. There are usually pre prepared institutional pamphlets or booklets with specific pre and postoperative instructions. Utilizing different forms of learning can help ensure that the patient fully understands the preoperative routines and what to expect following surgery. Further explanations should be offered regarding any planned drains, stomas, dressings, catheters, pain control methods, physical limitations and dietary restrictions. Studies have shown that a better-informed patient takes a more active role in making decisions and responds more positively to the surgical intervention [5].

Intraoperative

During office and hiospital procedures, the nurse will assist and as appropriate perform certain procedures. In addition to chaperoning, the nurse remains a patient advocate, and assures that the patient remains safe and comfortable throughout the encounter. The nurse is responsible for getting the patient prepared for the procedure or surgery and must be sure all the orders are implemented, such as IV antibiotics within one hour of start time, placement of anti embolism stockings, final check off and preparations. This can be a very anxious time for many patients, and organized care with thorough explanations can help allay some of the fear the patient may have. The nurse as the patient advocate should ensure the patients modesty and ensure privacy as much as possible.

Patient safety is most important and in the procedural setting the practice of "time out" is done for every procedure. This insures that the correct patient is having correct procedure and any site markings done. It involves a checklist for the team to check and double check. During the intraoperative phase, patients are vulnerable and at risk for non-surgical complications from improper positioning, such as nerve damage and pressure ulcer formation. It is typically nursing's responsibility to ensure safety and proper positioning of the patient for the duration of the surgery.

The patient undergoing an anorectal procedure is positioned either in the prone jack knife position, the modified left lateral position (Simms) or in the modified lithotomy position (see Chap. 2). In all positions certain areas of the body come under tremendous strain, and therefore it is essential that there is adequate protection and padding of all vulnerable areas of the body. Nursing considerations include adequate padding, correct positioning and reduction of pressure especially over boney prominences [6].

Any specimens from the procedure (e.g. biopsies, cultures, etc) must be accurately labeled and kept in an acceptable enviormnent. With appropriate documentation, they are transported to the laboratory.

Postoperative

General Considerations

Generally following any perianal or anal surgery, skin and wound care may be necessary. Wounds should be kept clean; patients are advised to shower and if possible use a hand held shower device for more direct ability to clean the area. The skin should be thoroughly and gently dried without undue rubbing the skin. If the area is too

painful to touch, a hairdryer may be useful but care must be taken when instructing on its use (i.e. use on cold air setting so as not to scald the skin). When there is any perianal discharge or moisture, there is a risk of perineal skin maceration and skin irritation. Thorough drying and use of a skin protectant such as barrier cream to peri-wound skin can reduce this risk.

Specifics of postoperative management are covered in Chap. 5.

Dietary Advice and Bowel Management

Following surgery, the nursing instructions given regarding diet are to help facilitate bowel movements without straining or great discomfort. The goal is for the patient to evacuate a soft stool on a regular basis. Many patients receive opiates for pain and therefore should be directed to take a laxative or stool softener to help prevent constipation. Some surgeons even advocate non-opiate based analgesics to avoid its constipating effects. Fiber is often suggested as bulking agent however patients need to be advised to drink 8–10 glasses of water per day to ensure the effectiveness of these agents. Polyethlene glycol (Miralax®, Bayer) one capful (17 g) in a glass of fluid is another useful option.

In minor anorectal procedures for conditions such as hemorrhoids, fissure, and pilonidal sinus, the nursing intervention and education is essential and can help in avoiding post treatment problems. For example patients following injection or banding of hemorrhoids require information advising them on their bowel habits, straining, time spent on the toilet, and diet. If the nurse informs and educates patients regarding the cause of their problem they feel in control and empowered which can help prevent further problems.

Home Healthcare

Home health may be needed but homecare benefits are subject to the patient's insurance policy and an over arching rule that the patient must be homebound. This can present challenges especially for patients in need of perianal or perinieal wound care. Often, the patient cannot do their own wound care but are not homebound therefore a caregiver must be identified and taught. Further challenges are many patients having same day surgery that requires post op dressings means the nurse should teach or "demonstrate" how to do the wound care before the patient leaves the facility.

When the patient is admitted, the discharge planning team may have more time to arrange and or teach someone any wound care needed. If the patient is deemed home bound, usually home health services can be obtained, however it is rare to be approved for daily nursing visits. Most home health agencies will make 1–3 visits a week. Again this is a benefit typically determined by the patient's health insurance coverage. If daily dressings are ordered or required, again that "other caregiver" must be available to perform the wound care on the days a home health nurse does not visit.

Intestinal Stomas

Despite many surgical advancements and early detection of cancer through screening, many people will need a fecal or uriary diversion either temporarily or permanently. Facing anorectal surgery is stressful, however most people have an even stronger stress response when told a fecal diversion or ostomy will be necessary. Those patients with possible ostomy creation will feel especially threatened by this major alteration and loss of a normal bodily function. Creation of a temporary or permanent stoma can generate extreme psychological stress [7]?

The ostomy specialist, is referred to as the wound, ostomy, continence (WOC) nurse or an Enterostomal therapist (ET) and has been trained and credentialed in this specialty. The WOC nurse can ensure that the appropriate information is provided to facilitate rehabilitation and return to optimal quality of life. Patients undergoing stoma formation surgery have many fears and concerns regarding their perceived altered body

image. The long term acceptance of an ostomy may be influenced by both preoperative and postoperative patient education [7]. Preoperative counseling can help dispel the doubts, fears, and negative feelings associated with an ileostomy or colostomy.

The patient with a stoma or planned ostomy surgery should receive education regarding the following:

- The anatomical and physiological changes relating to the stoma
- The structure, function and appearance of the stoma
- Management including pouching, peristomal skin management
- Ostomy supplies, reimbursement, and resources
- Dietary considerations with ostomy
- The potential impact on body image and self-esteem
- Sexuality concerns
- Available community resources for education, counseling and support.

In addition to the WOC nurse, there are numerous professional organizations that provide access to ostomy educational tools. The American College of Surgeons (ACS) has developed an education and skills kit for any patient facing a fecal or urinary diversion. This kit includes written information and skills along with a companion DVD. There are scissors, a model stoma and pouches in the kit for the patient to practice with before surgery in effort to make the post op training easier and less stressful. This kit is available at a nominal cost for shipping and can be requested through the ACS. It was developed through a grant and can be kept in the general surgeon or colon rectal surgeons office and given to the patient when they are being prepared for ostomy surgery (see Fig. 32.1).

It is up to the nurse to assess the needs of the patient and customize to that persons needs and readiness for information. Again, it is best to provide education in written form and include other valuable resources such as local

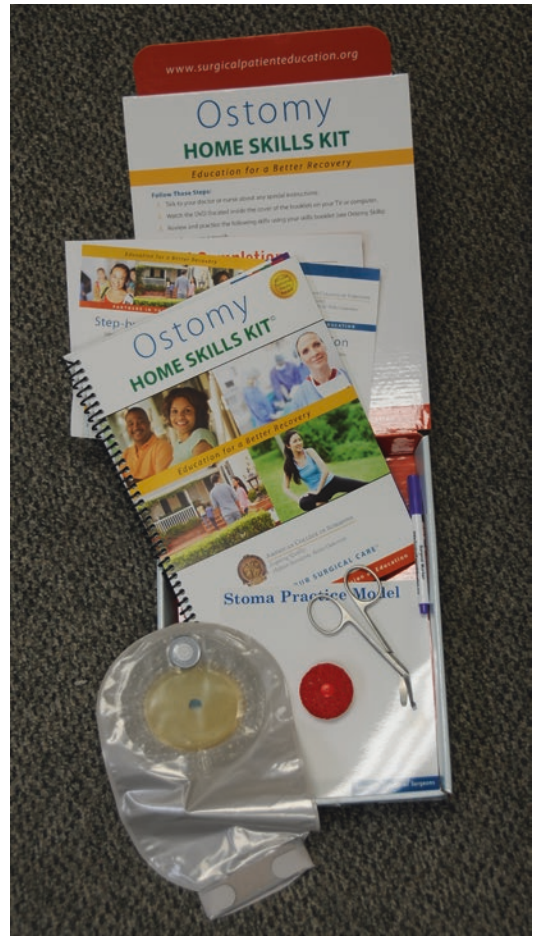


Fig. 32.1 ACS ileostomy instruction kit

UOAA chapters, ostomy visitors, community representatives, and Internet sites including those listed below.

The following organizations provide education and information:

- United Ostomy Association of America (UOAA)
- Wound Ostomy and Continence Nurses Society (WOCN)
- American Society of Colon and Rectal Surgeons (ASCRS)
- International Association for Enterostomal Therapy (IAET)
- American Cancer Society, (ACS)
- Crohns and Colitis Foundation of America, Inc. (CCFA)

Stoma Marking

The WOC or ET nurse is the best nurse equipped to provide ostomy instruction and care from preop setting through postoperative period. One of the most important things for an optimal outcome is to have the patient marked or sited for stoma placement. Having a stoma in a visible location, free of abdominal irregularities is optimal. Marking of the site prior to surgery was introduced in the 1950s by Turnbull and Gill [7]. This became best practice and a study by Bass et al. demonstrated that patients marked and educated by a WOC nurse had fewer ostomy related challenges [8]. Since then many studies have duplicated that finding. Pittman et al. noted in a large sampling that less than 67% of patients were marked for stoma placement [9]. Another study by Pittman found 71% of complications were related to poor location and lack of siting [10].

The WOCN Society and ASCRS developed a position statement for stoma marking to be used as a guideline (http://c.ymcdn.com/sites/www.wocn.org/resource/resmgr/Publications/ASCRS_Stoma_Site_Marking_PS_.pdf) [11]. This can be especially helpful for training residents when there is no WOC nurse available. It states that with optimal location of a stoma there is a better post op experience including better pouch wear times, and therefore resumption of normal activities.

There are circumstances the necessitate using an alternate location other than the pre-determined site. The stoma may have to place it higher or lower due to tension or lack of blood supply; however this can mean the patient may encounter pouching challenges. It is hoped the alternate placement does not cause long-term problems.

Post Operative Ostomy Care

Optimally, within 24 h following anorectal surgery with resulting ostomy, the patient should begin to learn how to care for their new ileostomy or colostomy. The attending nurse should be familiar with the surgical procedure done and type of stoma constructed. Ideally, a WOC or ET nurse is available for teaching however if not, a nurse versed in ostomy care should be assigned to the patient with a new ostomy.

The primary aim of ostomy education is to assure the patient that by utilizing basic principles and care of the stoma and peristomal skin, they will be able to manage the ostomy with minimal problems. This education should include the following concepts:

Ensure healthy peristomal skin which facilitates the security and comfort of the pouch, correct fitting of pouch for security and prevention of peristomal skin irritation, resizing of stoma and pouch opening in first month, and how to manage skin irritation or erosion if this occurs. The patient should be informed there are some common challenges with evidence-based solutions [10]. For the person with an ostomy having a lot of emotional difficulty; there are resources for support and to help in learning how to live with an ostomy.

A transparent pouch should be used postoperatively because this facilitates observation of the stoma. The nurse should monitor the new stoma, which should be pink/red, moist and occasionally edematous. If the stoma darkens to maroon, or purple, the nurse should notify the surgeon of this sign of ischemia. The drainage from the stoma may be blood tinged on the first day, with very little or no flatus. Once peristaltic movement of the bowel returns, flatus will be noted in the pouch and the output will become greenish. The first time flatus is passed; the associated sound can be loud and alarm the patient who worries it will be noticeable and embarrassing. The nurse should assure the patient this will lessen in volume, and amount, and wearing clothes typically muffles the sound. With the commencement of fluids and diet the stomal output increases but initially it is liquidy in nature and should thicken quickly with solid food intake. The pouch (also called an appliance) is to be regularly emptied and output should be measured and recorded to ensure that fluid balance is maintained.

By the second postoperative day, teaching self-care should begin. Initially, the patient is taught to empty the pouch before learning how to

change or replace the pouch. The WOC nurse will advise and educate the patient on their choice of products. Choices will be dependent on the size, shape, position, and type of the stoma, which differs with each person. The patient should be shown how to change the pouch and should be observed at least once independently changing the pouch prior to discharge. Studies have suggested that ostomy patient education reduces the patient's in hospital length of stay and postoperative complications [10]. Once patients learn how to care for their ostomy, they feel more in control of the situation and more able to come to terms with the stoma. Maslow's hierarchy of needs, which show that if one first meets the patient's biological needs they can then move to self-actualization, identifies this [12]. If the stoma is temporary, patients do not tend to psychologically adapt, but accept that it is something they have to cope with for a limited period of time [12].

For those patients in whom the stoma is going to be permanent the psychological adaptation to their stoma and change in body image is vital for best outcomes. This adaption may take months and can only occur if and when the patient's biological needs are met. It is a nursing responsibility to ensure that information, both verbal and written, be provided. Additionally, patient support through contact with an ostomy organizations as previously stated in this chapter can provide practical help and advice regarding pouch changing. Involvement of the family, and their introduction to the concept of the stoma while the patient is in hospital, allows both patient and family to ask questions and discuss their feelings and anxieties. They should be allowed to verbalize concerns regarding possible difficulties in body image, daily activites and sexual adjustment. The nurse should provide resources such as the UOAA website which is a valuable resource. Also a review of needed supplies ensures that patients leave the hospital secure and that they know how to obtain supplies post discharge. Arranging follow-up ensures the patient continues to feel supported and it is in this environment that they can continue the adaptation to life with a stoma.

Patients who experience mechanical problems with their stoma such as leakage or sore skin complain of higher levels of anxiety and rejection or non-acceptance of the stoma [13]. Today's post op patients spend fewer days in the hospital with fewer opportunities for lessons and education regarding ostomy care. One must be sure the needed education is given verbally and ideally in writing as well.

The patient with a new ileostomy is at higher risk for dehydration, and should be educated on signs and symptoms as well as keeping a log of stoma output (for the first week). Close monitoring with post op phone calls or use of the newer medical APPS for post op monitoring, dehydration may be detected early enough and treated, therefore avoiding readmission. If needed, intravenous hydration can be ordered and administered by a home health nurse, thereby keeping the patient at home.

Stoma Complications

Any patient with an ostomy can experience stomal complications, however most occur in the first month. A 34% incidence of peristomal skin complications was reported in a nationwide audit but ranged as high as 63% [13]. Patients with loop ileostomies were found to have the most complications. The most common of these are chemical contact dermatitis, allergic dermatitis, fungal infections, folliculitis, and stomal retraction. These problems result in pain, higher usage of supplies, and adversely affect patient satisfaction [9]. It is so important to provide resources and help for this patient population especially during this early but critical postoperative period. The surgeon and their staff should have WOC/ET nurses they can refer their patients to post operatively.

One of the worst experiences a patient can have is to go to the emergency department (ED) for an ostomy skin problem. The ED is not equipped in personnel or supplies to help the ostomy patient. If the patient has no WOC/ET nurse/resource, they can call a manufacturer customer care team and often there is someone to

provide guidance by phone (see Appendix 32.1 for a list of resources).

Chemical contact dermatitis: is caused by skin exposure to feces and is the most common peristomal skin complication [14, 15]. This is often the result of a poor fitting pouches. The skin becomes reddened, itchy with burning sensation and can progress to skin erosion or ulcers and bleeding in a relatively short space of time if the problem is not rectified. Once the skin becomes eroded or ulcerated it is very difficult to attain dry skin to ensure a good pouch seal.

The first line of treatment is to confirm the stoma size and ensure that the opening in the pouch is correct; it should allow the stoma to pass through with ease but should not leave more than 1/16 to 1/8″ of peri-stomal skin exposed. Next, evaluate the stoma height and consider convexity if the stoma is flush or retracted. Once the best type of pouch is selected, drying the skin is necessary for successful adherence. There are several accessory items that help dry the denuded skin. Historically, stoma powder is most commonly used and is applied to any weeping areas to absorb excess moisture and promote pouch adherance. This alone may burn, so it is recommended to use a no sting or alcohol free barrier wipes or spray with optional layering or crusting of these two products. Once the skin is protected and dry enough, a successful pouch adhesion should heal the damaged skin within 24–48 h.

Fungal infections: can occur anytime but are most common in patients who have received perioperative antibiotic therapy. Candida albicans is the most common skin flora and accounts for up to 75% of these skin rashes [15]. This skin condition typically presents as erythema with a maculopapular rash along with satellite lesions. Subsequently this can cause the skin to be moist and itchy, thereby affecting pouch adhesion at times. Fungal infections must be treated with the application of antifungal powder and NOT with cream or ointment [15]. Miconazole 2% is most commonly used and easy to find at any drug store. Any other over the counter (OTC) antifungal powder is also acceptable and this does not delay treatment, as waiting on a prescription can. The pouch may be changed more frequently to facilitate the application of the powder to eradicate the fungal infection.

Stomal retraction: occurs for a number of reasons but most commonly from tension on the segment of bowel used to form the stoma and results in the stoma becoming flush with or below the surface of the skin [14, 15]. This causes problems with leakage and jeopardizes pouch security. It is compounded if the patients become distended due to ileus. With temporary loop stomas a rod or bridge is often placed under the loop of bowel for several days to support the bowel while the sutures heal and any distension resolves. Once the rod is removed, the loop stoma can still retract and this often occurs after the patient is discharged. This causes a leakage problem with an inability to form a good seal around the stoma. The use of convex products and adhesive rings or stoma paste/caulk for added security is the main stay of treatment.

Allergic dermatitis: is due to sensitivity to one or more of the ostomy products. In many cases it occurs quickly but it can develop at any time someone uses products on the skin. The skin becomes red and the patient will experience itching or burning of the skin. When observing the red peristomal skin, one must look at the shape of the reddened area, as this is the distinguishing factor typically and it will often correspond to a certain part of the pouch [16]. For example if the skin is red under the tape portion only, leaving clear healthy skin directly next to the stoma, an allergic response to a microporous tape border and not the adhesive wafer is likely. To identify the allergic agents the patient can be patch tested by placing small pieces of all products being used on a test area of skin [15, 16]. These patches are covered and left for up to 48 h and then checked for any reaction. The first line of treatment is to remove the products, which are causing the allergic response and change to products which patch testing has shown not to elicit this response. If the skin is extremely red and irritated, it may be necessary to use a topical steroid and antihistamine for a few days. A liquid steroid that is in a water base is recommended [15].

Folliculitis: is an inflammation due to injury or infection of the hair follicles, which can occur anywhere around the stoma. It can result from

poor technique when removing the pouch, or multidirectional shaving and subsequent secondary staph infection [15]. Patients should be observed removing the pouch and taught to remove the pouch with care, ensuring the skin is supported and not pulled. If the adhesive seems very aggressive on the skin, an adhesive remover can help lift the wafer with fewer traumas to the skin and follicles.

There are several other complications that can occur with a stoma and peristomal skin that will not be addressed in this chapter [17].

Diet Considerations

The patient requiring a stoma after anorectal surgery may be able to resume a regular diet, but some surgeons may order a low fiber diet as a temporary measure in the immediate postoperative period. After a few weeks, when stomal edema and excess gas has subsided, patients may resume their normal diet, introducing some of the high fiber foods one item at a time, in order to identify any food intolerance. Should abdominal cramping occur, that particular food should be discontinued and introduced at a later time.

Although rare, patients with ileostomies may have problems with food obstruction and this may result from eating very high fiber foods and not chewing properly. A large mass of high fiber food, if undigested, may cause mechanical obstruction. Some foods prone to cause blockage are: foods with skins, raw vegetables and certain fruits, Chinese vegetables, corn, coconuts, nuts, dried fruits, celery, mushrooms, pop corn, seeds and kernels [18].

Conclusion

Nurses with this specialty interest, motivation, clinical experience and knowledge offer individualized patient information and support for patients with anorectal disease. The continued development of specialist nurses in this field is essential if the development, progress and growth of this specialty is to continue and the range and quality of the support services offered to patients is to expand.

Anorectal disease is often stigmatized and embarrassing and often results in delayed treatment in addition to the correct surgical intervention. However, along with health education, knowledgeable nursing intervention, preparing for anorectal surgery and help in coping with their fears and anxieties all promote best outcomes. Despite the rapid increase in more complex surgical procedures, the expansion of the nurses' role should never result in loss of contact with the surgical patient before and after surgery. Current research studies have discovered that psychological and behavioral preparation can influence patient healing, and various ways of preparation have been found to significantly impact patient anxiety, pain, narcotic use, and patient satisfaction [9]. It is often the nurse in whom patients choose to confide sensitive information pertaining to their history and the nurse who carries out the education and follow-up of the patient. With the continued development and education of nurse specialists in this field, it should be possible, by health promotion to raise public awareness of anorectal disease. Patient support groups and material available through both social media and standard internet platforms can also be valuable educational adjuncts. However patients should be cautioned not to use these resources in isolation, but rather to discuss them with their respective nursing provider(s).

Appendix: Resources

United Ostomy Association of America
800-826-0826
www.ostomy.org
Coloplast Corporation
1601 West River Road
Minneapolis, MN 55411
800-533-0464
Full product line: SenSura, Assura, ColoKids, and full line of accessories.
ConvaTec
211 American Ave

Greensboro, NC 27409
800-422-8811
Full product line, Sur-Fit Natura, Active Life, Moldable Technology.

Cymed Ostomy Company
1440C Fourth Street
Berkeley, CA 94710
800-582-0707
Full product line including the MicroSkin Ostomy Pouching System

Hollister Incorporated
2000 Hollister Drive
Libertyville, IL 60048-3746
888-740-8999
Full product line: New Image, Premier, Adapt, Pouchkins

Marlen Manufacturing & Development Co.
5150 Richmond Road
Bedford, OH 44146-1331
216-292-7060
Full product line: Ultra Duet, Ultra, Skin Shield

Nu-Hope Laboratories, Inc.
P.O. Box 331150
Pacoima, CA 91333-1150
800-899-5017
Full line of pouches, Hernia belts, Non-adhesive systems

The Perma-Type Company
83 Northwest Drive
Plainville, CT 06062
860-747-9999 in CT; 800-243-4234 in other states
Reusable appliances for ileostomy, colostomy, urostomy

Schena Ostomy Technologies, Inc.
2313 Harrier Run
Naples, FL 34105
239-263-9957
EZ-Clean™ Ostomy Pouching System

Securi-T USA
12501 71st Court
Largo, FL 33773-3254
877-726-4400
Lower cost "Equivalent" products

Torbot Group, Inc.
1367 Elmwood Ave.
Cranston RI 02910
800-545-4254
Full product line, including customized appliances

References

1. American Nurses Association (ANA). Nursing's social policy statement: the essence of the profession. Silver Spring: Nursesbooks.org; 2010.
2. Hamric A, Hanson C, Tracy M, O'Grady E. Advanced practice nursing. 5th ed. St Louis: Elsevier; 2013. p. 12–21.
3. Roberts PL. Patient evaluation. In: Wexner SD, Beck DE, editors. Fundamentals of anorectal surgery. New York: McGraw Hill; 1992. p. 25–33.
4. Beck DE, Wexner SD. Anal neoplasms. In: Beck DE, Wexner SD, editors. Fundamentals of anorectal surgery. New York: McGraw Hill; 1996. p. 222–35.
5. Brumfeld VC, Kee CE, Johnson JY. Preoperative patient teaching in ambulatory surgery settings. AORN. 1996;64:941–52.
6. Phillips N. Perioperative nursing: Berry and Kohn's operating room technique. 12th ed. St. Louis: Elsevier; 2013. p. 65–84.
7. Doughty D. History of ostomy surgery. J Wound Ostomy Continence Nurs. 2008;35(1):34–8.
8. Bass E, Del Pino A, Tan A, et al. Does preoperative stoma marking and eduction by the enterostomal therapist affect outcomes? Dis Colon Rectum. 1997;40(4):440–2.
9. Pittman J, Rawl S, Schmidt C, et al. Demographic and clinical factors related to ostomy complications and quality of life in veterans with an ostomy. J Wound Ostomy Continence Nurs. 2008;35(5):493–503.
10. Pittman J. Characteristics of the patient with an ostomy. J Wound Ostomy Continence Nurs. 2011;38(3):271.
11. Wound, Ostomy and Continence Nurses Society 2014. WOCN Society and ASCRS position statement on preoperative stoma site marking for patients undergoing colostomy or ileostomy surgery. Mt. Laurel: NJ; 2014. http://c.ymcdn.com/sites/www.wocn.org/resource/resmgr/Publications/ASCRS_Stoma_Site_Marking_PS_.pdf.
12. Carmel JE Scardillo J. Rehabilitation issues and special ostomy patient needs. In: Wound ostomy and continence nurses society core curriculum: ostomy management. Philadelphia: Wolters Kluwer; 2016. p. 148–52.
13. Cottam J, Richards K, Hasted A, et al. Results of a nationwide prostpective audit of stoma com-

plications within 3 weeks of surgery. Color Dis. 2007;9(9):834–8.
14. Kann BR. Early stomal complications. Clin Colon Rectal Surg. 2008;21:23–30.
15. Salvadalena G. Peristomal skin conditions. In: Wound ostomy and continence nurses society core curriculum: ostomy management. Philadelphia: Wolters Kluwer; 2016. p. 176–80.
16. Evans EC, Gray M. What interventions are effective for the prevention and treatment of cutaneous candidiasis? J Wound Ostomy Continence Nurs. 2003;30(1):11–6.
17. Kwaitt M, Kawata M. Avoidance and management of stomal complications. Clin Colon Rectal Surg. 2013;26:112–21.
18. Orkin BA, Cataldo PA. Intestinal stomas. In: Wolf BG, Fleishman JW, Beck DE, et al., editors. The ASCRS textbook of colon and rectal surgery. New York: Springer; 2007. p. 622–30.

Index

D. E. Beck et al. (eds.), *Fundamentals of Anorectal Surgery*,
https://doi.org/10.1007/978-3-319-65966-4

U

V