Updates in Surgery

Achille Lucio Gaspari
Pierpaolo Sileri *Editors*

Pelvic Floor Disorders: Surgical Approach

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Achille Lucio Gaspari • Pierpaolo Sileri
Editors

Pelvic Floor Disorders: Surgical Approach

Foreword by
Giorgio De Toma

Springer

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Foreword

Pelvic floor pathology is one of the surgical fields in which multidisciplinary approach proves to be not only important but also indispensable. In the past 15 years, this issue has been thoroughly analyzed from an anatomical and pathophysiological point of view, and the aid of sophisticated diagnostic tools has led to a new interpretation of the pelvic floor pathology and to the development of increasingly advanced therapeutic techniques.

The pathology of the pelvic floor requires the expertise of three specific categories of professionals: colorectal surgeons, urologists and gynecologists with experience on functional aspects and pathophysiology of the disorder. Furthermore, the multidisciplinary team must include nursing staff dedicated to the psychological and behavioral support to patients.

The text is a complete and modern collection of the most advanced aspects of the functional anatomy of the pelvic floor. Of great importance is the diagnostic section that describes carefully the most advanced instrumental and radiological techniques. Moreover, of utmost relevance is the section that outlines open and minimally invasive procedures, with the aid of beautiful images, as well as techniques with perineal access. The book also includes an accurate analysis of complications and side effects, described technique after technique.

The volume is therefore exhaustive in every aspect and updated, thus representing a point of reference for this pathology.

Rome, September 2013 Giorgio De Toma

Preface

The idea for this book on pelvic floor disorders in general surgery arose from the need to offer an overwiew on clinical and available surgical approaches for pelvic organ prolapse. Since a solid, up-to-date, and complete undestanding of pelvic organ prolapse is mandatory for successful treatment, this volume provides a multidisciplinary description of its pathophysiology and diagnostic assesment. All the authors are part of an international group of experts in the field who deal with the pelvic organ prolapses on a daily basis, and continuously search for the ideal treatment. We all know that although there have been a large number of procedures described over recent decades, there is still a great need for improvement; thus, the authors' intention is to describe the different surgical techniques available, and possible complications arising from them, and also suggest treatment options, including an update on innovative prosthetic materials.

The book is divided into six parts. Concise text and many clear and didactic illustrations enrich every chapter. The first part provides a multidisciplinary view of the pelvic floor as a unit and discusses the prevalence of the disorders. The second part is focused mainly on anatomophysiological entities and diagnostic evaluation. The third details the large and often confusing spectrum of clinical syndromes, which can range from fecal incontinence to obstructed defecation. The fourth enhances our understanding of conservative and physiokinetic therapy. The last two parts address more technical areas, covering key points of surgical procedures as well as prevention and management of complications.

We believe that readers will find this collective and large contribution exciting in terms of new knowledge and innovation in a continuously developing topic, and we hope that it may serve as daily guide for best practice.

Rome, September 2013

Achille L. Gaspari
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Part I

Overview

The Multidisciplinary View of a Pelvic Floor Unit

1

Christopher Cunningham

1.1 Introduction

This chapter aims to highlight the importance of an integrated approach to pelvic floor (PF) practice. This facilitates adequate assessment of conditions across the three pelvic compartments, carefully selecting those patients who may benefit from surgery, optimizing conservative management preoperatively, and improving function postoperatively, as well as understanding and supporting the social, psychological and sexual impact of PF conditions. Creating a robust multidisciplinary team (MDT) offers advantages to both patients and healthcare providers, and is a defining feature of an established PF service.

1.2 Core Members of the MDT

The PF MDT needs to be inclusive. Surgical input should be provided by colorectal surgeons and appropriate specialists to cover urological and gynecological needs, and in many institutions this will be provided by a urogynecologist. However, a proportion of patients will be male or require specific expertise that can only be provided by a urologist with an interest in functional conditions. It is valuable to have more that one representative from each subspecialty but smaller services may be unable to achieve this. The MDT should have a clinical lead and administrative infrastructure to support audit

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and research. Core membership should contain PF physiologist and specialist nurses. This is the heart of the MDT through which patients are assessed and investigated, as well as introducing advice and conservative management at an early stage. The increasing use of neuromodulation (sacral nerve stimulation and posterior tibial nerve stimulation) demands highly trained individuals to motivate patients and optimize treatment. The PF nurse is ideally placed to deliver these treatments and explore the use of other approaches such as retrograde irrigation. Everyone involved in a PF practice is aware of the sensitive nature of the conditions and the potential relationship to psychological and sexual problems. Sexual abuse can be a significant etiological contributor to PF dysfunction and all members of the MDT need to be aware of opportunities to explore this; however, it is most often the PF nurse who is able to foster the close relationship and create the best opportunity to for this. Many relationships suffer the consequences of sexual problems as a result of PF dysfunction, particularly fear of leakage and pelvic pain during intercourse. Considerable support is needed to help women and their partners understand and cope with these difficulties. This can be provided by any member of the team with regular patient contact; however, it is often the specialist nurse who establishes rapport with patients to facilitate these discussions.

Good communication with obstetric and midwifery teams is important although they need not be core members of the MDT. This allows shared protocols for management of PF conditions early in the postpartum period, deciding who should be responsible for the management of acute pelvic floor and sphincter injuries and offering patients a seamless pathway of care to the colorectal service if problems persist. Clear guidelines and protocols are helpful in defining indications for caesarian section and vaginal delivery in patients with persisting PF problems either from previous obstetric injury or those with gastrointestinal conditions, e.g., previous or anticipated ileal pouch surgery in ulcerative colitis or polyposis.

A dietician with an understanding of PF abnormalities will support advice given through biofeedback and ensure that all members of the MDT present consistent and accurate advice to patients. Many patients with constipation and PF conditions have a background of “irritable bowel syndrome” in which dietetic input is invaluable. Dieticians also play an essential role in managing more challenging cases, e.g., those patients with eating disorders contributing to prolapse, constipation, and obstructed defecation.

PF complaints are more common in patients with functional gastrointestinal conditions such as irritable bowel syndrome, delayed transit, and gastroesophageal reflux disease; indeed, many patients with these diagnoses have underlying PF dysfunction such as obstructed defecation. Involvement of a gastroenterologist facilitates a holistic assessment, optimizing management of patients with combined pathologies.

Expert radiologist involvement provides reliable interpretation of defecating proctography and magnetic resonance imaging defecography, and provides training such that the entire clinical team can interpret these investigations in the context of the clinical presentation. Moreover, the whole radiology team plays an important part in getting the most out of these procedures. Patients regard proctography as one of the most embarrassing and potentially humiliating investigations; creating a relaxed, caring, and sensitive environment for these examinations is critical for reasons of patient compliance and comfort, and achieving high-quality radiology.

Finally, the PF MDT needs access to expertise in chronic pain management, rehabilitation, and psychological and psychiatric assessment and treatment. While this is only required on a formal basis in a minority of patients, discussion of these issues leads to awareness and education of the entire team in techniques of managing the complex problems that surround chronic PF conditions.

The MDT provides the engine room for a high-quality PF practice, demonstrating robust clinical governance and an evidence-based approach to practice and critical assessment by research and audit. Moreover, the concentration of expertise provides a fruitful environment for training and education.

1.3 Starting a PF MDT

The preceding description may set challenging standards for those embarking on a PF practice or those working in an environment where all facilities (e.g., anorectal physiology) are not available. It is useful for small, developing MDTs to be aligned with an established MDT in a “hub and spoke” arrangement. Most mature MDTs will welcome engagement with smaller affiliated units driven by an interest in improving access to high-quality PF services. Within the UK this has progressed to developing regional groups with regular meetings to discuss clinical and research matters around PF practice, generating guidelines and standards for clinical practice.

At a local level, it may be reasonable for the MDT to meet on a monthly basis to discuss interesting or challenging cases and particularly provide follow-up on previously discussed clinical problems and decisions. This is an excellent environment for the team to develop expertise collectively. An alternative strategy is to combine the MDT with a PF clinic. This allows effective delivery of MDT decisions directly to patients, and efficient assessment of patients by different specialties at the one clinic. The optimum way of developing this depends on local practice and commitments of specialists and supporting staff. However, the benefits of creating a definite identity for the PF MDT cannot be overstated. It provides a focal point for referrals, training, education, and research.

1.4 What are the Objectives of PF MDT?

1.4.1 Efficient Patient Pathways and Algorithms

The most obvious objective is to provide patients with the best experience of healthcare, avoiding unnecessary re-duplication of clinical assessment and investigations, and optimizing function with nonoperative approaches, and for those requiring surgery we should aim to offer procedures under a single anesthetic. This may require two disciplines operating together to offer patients sensible and appropriate surgical combinations and the best chance of improving outcome. This makes sense from a health economics view and is more convenient for patients; however, it needs a functioning and cooperative MDT structure, and resolution of these difficulties is often political rather than clinical.

Colorectal surgeons and urogynecologists will share many patients with related PF conditions and PF MDTs are often borne out of combined clinics to manage those patients with most severe conditions. Discussing patients in a common forum leads to an understanding of how the same pathology (e.g., rectocele) can be present with diverse symptoms (e.g., obstructed defecation or dyspareunia) for which the treatment may be the same or entirely different as determined by associated symptoms or signs, e.g., co-existing internal rectal prolapse. A multidisciplinary approach encourages clinicians to explore the impact of PF problems more widely and consider combined operative approaches that are perhaps more likely to benefit the patient with multiple symptoms.

1.4.2 Clinical Governance and Audit, and Protection from Litigation

It is important for professional and medico legal reasons that all conservative measures have been explored thoroughly before proceeding with surgical treatment. Many patients miserable with symptoms of PF pathology are looking for a “quick fix” and, although at times frustrating, it is important that we demonstrate that maximum conservative management has been undertaken and supported by the MDT. This offers patients the additional benefit of optimization before surgery and preparation and counseling for postoperative care and expectations. Managing expectations is an important aspect that is supported by the MDT as a whole, i.e., all members of the team understand treatments and provide consistent and noncontradictory advice. This means establishing what outcomes can be expected from surgery based on evidence available, and also exploring what options are available if surgery is not successful or the condition is aggravated by surgery or its complications. The patient who is seeking to improve quality of life must be aware of the chances that complications from PF surgery may impair quality of life; for example, urgency after stapled transanal resection or mesh infection or erosion after rectopexy. Patients should be encouraged to consider that surgery could make them worse.

It is valuable to maintain a database of patients, conditions, and treatment from the earliest stages of a pelvic floor practice. This is useful for internal audit and considering outcomes and complications against published standards. Treatments and particularly surgical intervention offered to improve quality of life should be demonstrably successful and the only way to record this is through patient-reported outcomes with validated PF function questionnaires. These need not be overly complex but some record of outcome and incidence of complications is imperative.

1.4.3 Training and Continuing Education

Concentrating expertise and developing a careful practice based on best evidence will create a rich environment for trainees from medical and paramedical disciplines to gain competence in the assessment and management of PF conditions. Over the last 5 years, PF practice has gained a new appreciation among trainees, not least because of the increased options available to treat these complex conditions and it is certain that the subspecialty is gaining credibility, through setting up regional, national, and international societies. Enthusiastic trainees are searching for organized PF clinics offering a modern approach to managing these complex cases, and which are able to offer the highest standards of care and training.

1.5 Conclusions

It is an exciting time in colorectal surgery and PF practice in particular. The last decade has seen a tremendous expansion in interest and therapeutic opportunities in PF conditions. Many women who were relegated to suffering in silence or resorting to a stoma are now improved with careful advanced conservative treatments and minimally invasive surgical procedures. The multidisciplinary approach to PF conditions has been at the heart of this revolution in management and is the foundation for the introduction of future novel approaches.

Suggested Reading

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2 Epidemiology and Prevalence of Pelvic Floor Disorders

Carolina Ilaria Ciangola, Ilaria Capuano, Federico Perrone, and Luana Franceschilli

2.1 Introduction

Pelvic floor disorders (PFDs) manifest with a variable spectrum of symptoms and can involve anterior, middle and posterior compartments. PFDs represent an important aspect of global healthcare, with about 28 million women affected by these diseases worldwide. This number is expected to reach 44 million in the next 40 years. In the literature, the incidence and prevalence of PFDs are often reported inconsistently, depending on the definitions used, the measures considered to assess the stages, the gender and age of the patient, and the severity of the pathology. The etiology of these disorders is multifactorial and it is important to identify the risk factors, because avoiding them or reducing exposure to them can change the natural history of PFDs, allowing physicians to make an earlier diagnosis and use more effective therapy.

2.2 Definitions, Costs, and Prevalence of Pelvic Floor Disorders

Pelvic floor disorders (PFDs) manifest with a variable spectrum of symptoms and can involve the anterior, middle, and posterior compartments of the pelvic floor. PFDs can manifest as:

- Urinary incontinence and sensory abnormalities of lower urinary tract
- Pelvic organ prolapse
- Anal incontinence
- Obstructed defecation
- Chronic pain syndromes related to the pelvic organs

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PFDs represent an important aspect of global healthcare, with an incidence of about 4 million visits per year to physicians in the USA (1% of total ambulatory visits). In 1997, costs of pelvic organ prolapsed (POP) surgery in the USA were US$1,012 million, including US$494 million for vaginal hysterectomy, US$279 million dollars for cystocele and rectocele repair, and US$135 million for abdominal hysterectomy. Moreover, costs for physician services and hospitalization increase the total expense. An indirect expense is represented by days absent from work due to illness [1].

The incidence of PFDs is increasing: 48,000 surgical procedures for urinary incontinence (UI) were performed in 1979, and over 100,000 were performed in 2004 [2]. For a woman aged 80 years, the lifetime risk of undergoing surgery for PFD is 11% [3]. Annually, in the USA, 80,000 surgical procedures are performed for UI, 220,000 for POP, and 3,500 for fecal incontinence. The following rates have been reported for age distribution of surgical treatment: 7, 24, 31, and 17 per 10,000 in reproductive, perimenopausal, postmenopausal, and elderly women, respectively [4].

It is thought that these numbers will increase, as the number of women expected to develop PFD increases in future decades. At present, the number of women affected by PFDs is about 28 million, and this number is expected to reach 44 million in the next 40 years. Moreover, the prevalence of PFD increases as the average age of the women increases; the percentage of PFD recurrence (currently 30%) also increases with age [5].

In the scientific literature, reports of the incidence and prevalence of PFD can be inconsistent, depending on the definitions used, the measures considered to assess the stages of PFD, the gender and age of the patient, and the severity of the pathology. Globally, we can assume that the prevalence of PFD may vary from 37% to 68% [6]. The National Health and Nutrition Examination Survey (NHANES) estimated that 24% of adult women experienced PFD symptoms. This prevalence increased with age: about 38% of women aged 60–79 years, and about 50% of women aged 80 years, were affected by PFD. In 2010, about 28 million people had a PFD in the USA.

2.3 Pelvic Floor Disorders

In order to increase our knowledge of the pathology of PFDs and their real impact on the global population, it is important to analyze the prevalence and incidence of each of the various manifestations of PFD.

2.3.1 Urinary Incontinence

The International Continence Society defined UI as “the complaint of any involuntary leakage of urine”. A review of 21 studies revealed a prevalence of 34% for any incontinence. Younger women are more affected by stress incontinence, while older women are affected by mixed and urge incontinence. Some studies have not found any relationship between ethnic origin and incidence of UI [7], while other studies on the USA population have found that 36% of Hispanic, 30% of white, 35% of black, and 19% of Asian American women experienced UI [8].

2.3.2 Pelvic Organ Prolapse

POP is defined as the complex of rectocele, cistocele and uterine prolapse. Based on a study conducted by Women's Health Initiative [9], the general prevalence of POP is thought to be 41%. Further distinguishing between the different clinical manifestations of POP, the prevalence of cystocele varies from 25% to 34%, that of rectocele from 13% to 19%, and that of uterine prolapse from 4% to 14%, considering any grade of prolapse.

2.3.3 Anal Incontinence

Anal incontinence (AI) is defined as involuntary passage of gas, mucus, or liquid or solid feces. In the literature, the reported prevalence of AI varies from 2% to 24%, depending on the different definitions used for AI in scientific papers. Age is a risk factor for AI and an increase in adds ratio of 1.20 has been demonstrated for an increase of 10 years in age. According to scientific data, ethnicity does not appear to be a relevant factor in AI [2].

2.3.4 Obstructed Defecation

Obstructed defecation (OD) is defined as a persistent, difficult, infrequent, and incomplete evacuation. The prevalence of OD is 2–30% in the general population. OD can be caused either by slow intestinal transit and functional abnormalities, such as dyssynergic contraction of the pelvic floor muscles, which are more frequent in younger women, or by structural abnormalities of the pelvic floor, such as rectal prolapse and rectocele, which are more frequent in older women. It is important to distinguish between various causes of OD, as they can be treated differently [10].

2.4 Risk Factors

The etiology of these PFDs is multifactorial. Multiple genes, clinical history, comorbidities, and environmental risk factors, such as drugs, diet, and lifestyle, and the association between them, contribute to the development of PFDs.

It is important to identify the risk factors because avoiding them or reducing exposure to them can change the natural history of PFDs, allowing clinicians to make an earlier diagnosis and use more effective therapy. It is possible to divide the risk factors into different categories:

- Predisposing factors: these are not modifiable
- Inciting factors: theoretically these can be modified, but often they cannot be avoided
- Promoting factors: these are easily modifiable and can influence the natural history of PFD
- Decompensating factors: these are extrinsic to the pelvic floor but can create decompensation and dysfunction of an otherwise compensated pelvic floor.

2.4.1 Predisposing Factors

These include genetic make-up, congenital factors, race, age, and anatomic, neurologic and muscular factors. Although specific genetic loci responsible for the development of these pathologies are unknown, pelvic floor dysfunctions are more likely to be present in some genetic syndromes, especially in collagen diseases such as Ehlers–Danlos and Marfan syndromes. Moreover, it has been demonstrated that women with POP have more type III collagen in their pelvic floor tissue [11]. Cases of neonatal prolapse have been described, sometimes in association with neural tube abnormalities such as spina bifida, but also in neurologically intact neonates, underlining the possible role of undernutrition in utero [12]. Some research publications have shown that there is a increased incidence of pelvic floor dysfunctions in white American women compared with African American women, who have a smaller posterior pelvic floor area [13], narrower pelvic inlet and outlet [14], and higher urethral closing pressure while contracting pelvic muscles [15], suggesting an important role of race and ethnicity in the development of these disorders. Some women with POP have been demonstrated to have denervation of levator ani and periurethral muscles and altered neuropeptide function [2]. Finally, aging seems to be a complex risk factor, as it allows other risk factors to act over a longer period of time and result in a PFD [16].

Female gender is also a predisposing risk factor, but men are also affected by pelvic organ disorders: the male to female ratio for rectocele is 1:10 and the prevalence reported in literature [17], although scant, varies from 4% to 17%. Rectocele in men is more often associated with aging and prostatectomy (40%), although precise criteria for diagnosis of male perineal prolapse are yet to be formulated.

2.4.2 Inciting Factors

Inciting factors for PFDs include childbirth, radiation, and pelvic surgery. Various studies have analyzed the role of pregnancy and modes of delivery in the development of PFDs. PFDs increase with the number of deliveries: 30% of women who have had three or more deliveries develop PFDs [7]. However, when considering the mode of delivery, vaginal parous women show a greater prevalence for PFDs compared with nulliparous and cesarean parous women. There is no difference in the incidence of PFDs between nulliparous and cesarean parous women, but when further distinguishing between gravid nulliparous (women who had a pregnancy but did not deliver an infant larger than 2 kg) and nulligravid nulliparous women, the former show a higher prevalence for PFDs and this indicates an important role for hormonal factors in the development of PFDs. Further distinguishing between cesarean deliveries with and without labor, there is a greater prevalence of PFDs in women who had a labor, underlining the importance of mechanical stress on the pelvic floor [18]. Studies analyzing the incidence of POP in nulliparous and parous sisters demonstrated a similar rate of prolapse between the two, indicating a strong familial predisposition [5]. It is important to remember that environmental factors such as childbirth should be considered together with genetic susceptibility, as prolapse often occurs many years after delivery; however, the majority of women who have delivered do not experience PFDs and some women who have not delivered develop PFDs [5].

2.4.3 Promoting Factors

Promoting factors include constipation, body mass index (BMI), increased waist circumference, smoking, comorbidities, occupational activities, medications, infections, and hormonal therapy. Chronic constipation is controversially associated with POP, although it seems to create injuries to sphincteric innervation. Of patients undergoing surgery for rectal prolapse, 80% experienced an improvement in defecatory function. A waist circumference of more than 88 cm is associated with an increased risk of developing POP, as there is an increase in mechanical stress on the pelvic floor [19]. Obesity causes an increase in intra-abdominal pressure and women with a BMI of greater than 25 have a 30–50% higher risk of developing a PFD. Moreover, women who have undergone bariatric surgery and then lost 18 or more BMI points improved their urinary incontinence symptoms [20]. Anorexia is another risk factor for PFDs: 81% of anorexic patients reported defecatory disorders that increased with the duration and severity of the eating disorder, probably because of prolonged attempts to defecate, use of laxatives, overzealous exercise, and increased intra-abdominal pressure from forced vomiting [21]. The association between anorexia nervosa and rectal prolapse may be much more common than previously recognized. The Epidemiology of Incontinence in the County Of Nord-Trondelag (EPICONT) study showed an association between heavy smoking (20 cigarettes/day) and incontinence, probably due to frequent coughing, which increases intra-abdominal pressure, and also due to an interaction between smoking and estrogens, which negatively affects collagen synthesis [22]. Among comorbidities, diabetes seems to contribute to the development of PFDs because of an alteration to the microcirculation in the pelvic floor: 20% of women affected by type 2 diabetes mellitus have an increased risk of PFDs. Women who work as laborers and in factories and those who are homemakers have an increased risk of developing PFDs. Menopausal hormone therapy and the oral contraceptive pill also increase the risk of developing PFDs [2]. Finally, an excessive consumption of coffee and tea can increase the incidence of urinary incontinence [2].

2.4.4 Decompensating Factors

Psychiatric comorbidities, such as altered mental status and dementia, can cause functional pelvic floor decompensation [2].

2.5 Conclusions

PFDs remain an underestimated problem, probably because they manifest with embarrassing symptoms in an older and comorbid population. Although PFDs are diseases with a very low morbidity and no mortality, they have a strong negative impact on the quality of life, and they are characterized by high cost of treatment. Also, the incidence of PFDs is predicted to increase in the coming years.

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Part II

Patient's Evaluation Criteria

Pelvic Floor Anatomy

3

Augusto Orlandi and Amedeo Ferlosio

3.1 Introduction

The maintenance of the correct integrity of the pelvic floor is fundamental for the physiology of this complex anatomical region, as it is involved in functions such as defecation, urination, sexual activities, especially in women, and in puerperium. In fact, the pelvic floor closes the pelvis and holds organs (uterus, rectum, urethra, bladder, and prostate) inside the body. Although there is good anatomical knowledge of the region, the neurological and biomechanical functions of the pelvic floor are not well understood and knowledge of these is continuously evolving. Consequently, correct assessment of pelvic floor anatomy is essential to understand the pathogenesis and surgical correction of pelvic disturbances.

For simplification, we have divided this chapter into the following three sections: bony pelvis, musculature, fasciae and aponevrosis, and somatic innervation.

3.2 The Bony Pelvis

The pelvis is divided into the major pelvis (part of abdominal cavity) and the minor or true pelvis [1]. The latter is frontally delimited by the pubic symphysis, and by the coccyx and sacrum at the back. The anatomical limits are considered to be a line from the promontory of the sacrum to the superior margin of the pubic symphysis (the superior strict of canal of partum in woman),

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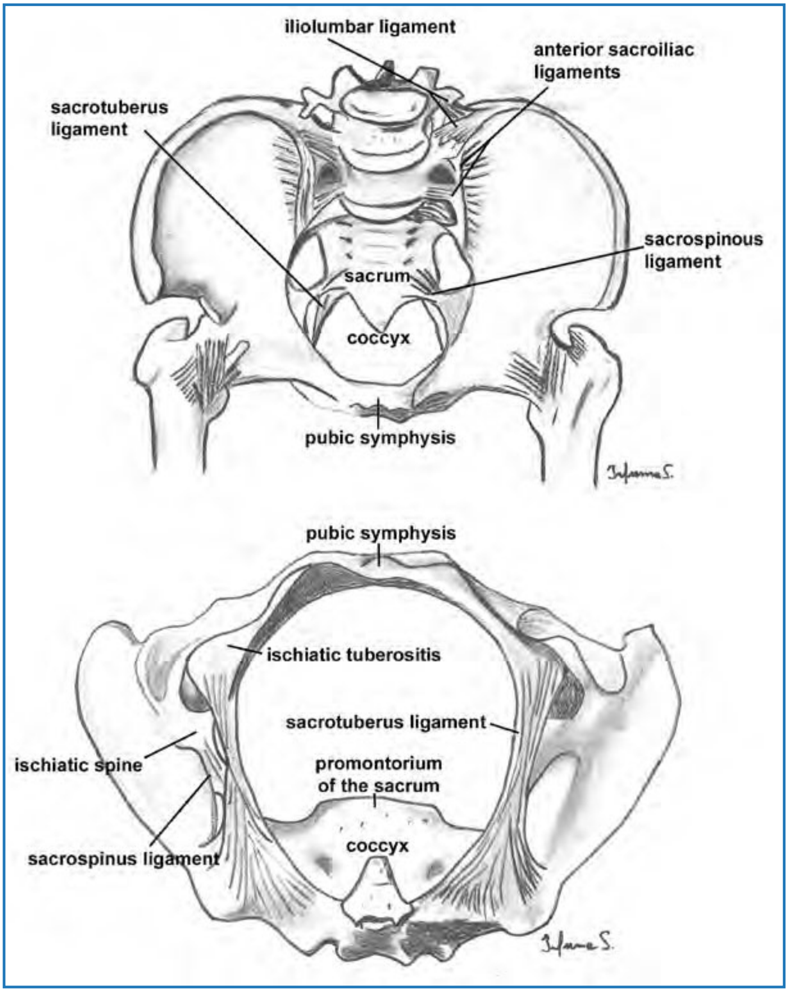

Fig. 3.1 The human bony pelvis seen from the front (*top*) and from below (*bottom*), showing the bones and main ligament structures of the pelvis supporting the pelvic floor

closed laterally by the spine of the ischium and the superior ramus of the pubis forward and seen from below from ischial tuberosity (Fig. 3.1, top and bottom).

The main ligamentous structures are the anterior and lateral sacrococcygeal ligaments, the sacrospinous ligament, the sacrotuberous ligament, and the arcuate pubic ligament [2].

3.3 The Musculature, Fasciae, and Aponevrosis

From a surgical point of view, when considering access to the pelvic floor

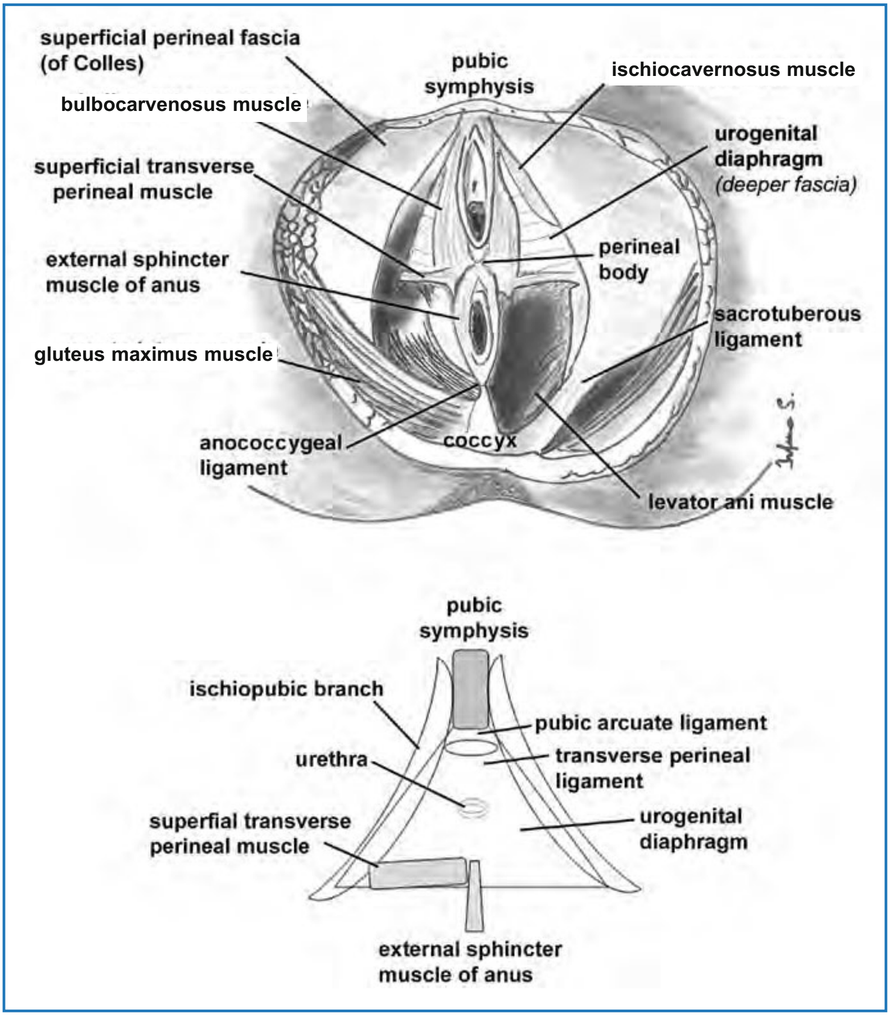

Fig. 3.2 Pelvic floor anatomy in women (*top*), and the urogenital diaphragm in men (*bottom*)

starting from the cutis in a gynecological position (Fig. 3.2, top), the perineal region can be divided in two parts: the superficial and deeper planes. The superficial plane coincides with the fascia of Cruveilhier, which continues with abdominal structures and adheres to the thigh, while the deeper plane coincides with the fascia of Colles [3].

The space between the two ischial tuberosities laterally and the pubic symphysis anteriorly is closed by the so-called urogenital diaphragm, which is composed mainly of the deep transverse perineal muscle and forms the anterior urogenital triangle (Figs. 3.1 and 3.2) together with external urethral sphincter, the urethrovaginalis (in woman) and compressor urethrae [4, 5]. This area is covered by the inferior and superficial fascia (Colles) of the urogenital diaphragm. The urogenital diaphragm is perforated, from front to back, in order to permit the passage of the urethra and, in woman, the vagina with its sphincter muscle. Immediately behind the pubic symphysis, the space between the arcuate pubic ligament and the fusion of the deep and superficial fascia of the urogenital diaphragm (the transverse perineal ligament) identifies a tight cleft where it crosses the deep dorsal vein of penis or glans clitoridis (Fig. 3.2, bottom).

The superficial and inferior fascias are fused posteriorly to envelop the superficial transverse perineal muscles, thus contributing to the composition of the perineal body (see below).

Inferiorly to the urogenital diaphragm, and more superficially with respect to the cutaneous plane, two muscles can be identified: the ischiocavernosus and the bulbocavernosus muscles (Fig. 3.2, top). The ischiocavernosus muscles originate from the pubic symphysis, lie parallel to the ischiopubic branches, and are attached to the ischiatic tuberosities. The bulbocavernosus muscles lie medially, and there is a marked difference in these muscles between the two sexes. In women, they surround the vagina between the pubic symphysis and perineal body. In men, they run parallel to each other, separated only from a median raphe.

In the urogenital diaphragm, the anal triangle can be identified [5] (Fig. 3.2, top). The anococcygeal ligament originates from the apex of the coccyx, and it is inserted into the perineal centrum, interrupted by the passage of anal canal with the external anal sphincter muscle (Fig. 3.2, top). The central ligament of perineum or perineal body is histologically composed of smooth and skeletal muscle, as well as collagen and elastic fibers [6]. The perineal body represents the fundamental structure maintaining the anatomical and functional integrity of the pelvic floor, and the point of insertion of the anal sphincter muscle, the transverse superficial perineal muscles (originating from ischiatic tuberosities), and the bulbocavernosus muscle (Fig. 3.2, top).

Once the urogenital diaphragm is removed, the pelvic diaphragm becomes visible. The latter is composed of the ischiococcygeous and levator ani muscles (Fig. 3.3). The ischiococcygeous muscle (or simply coccygeus) originates from the coccyx and sacrum and extends bilaterally extends towards the ischiatic spines and sacrospinous ligaments.

The levator ani muscle comprises the pubococcygeus, puborectalis and iliococcygeus muscles (Fig. 3.3) [7, 8]. Moreover, a thickening of the obturator internus, known as the arcus tendineus levator ani muscle, is stretched between the ischial spine to the superior pubic branch. From the arcus tendineus, the iliococcygeus originates, connecting to the coggyx posteriorly and to the perineal body medially, contributing to the creation of the anococcygeal ligament. Some authors divide the pubococcygeus into three regions called: the puboperineus, the pubovaginalis (in women), and the puboanalis [4]. The puboperineus is attached to the perineal body and contributes to its formation; the pubovaginalis and puboanalis muscle bundles fuse with those of the vagina and external anal sphincter, respectively.

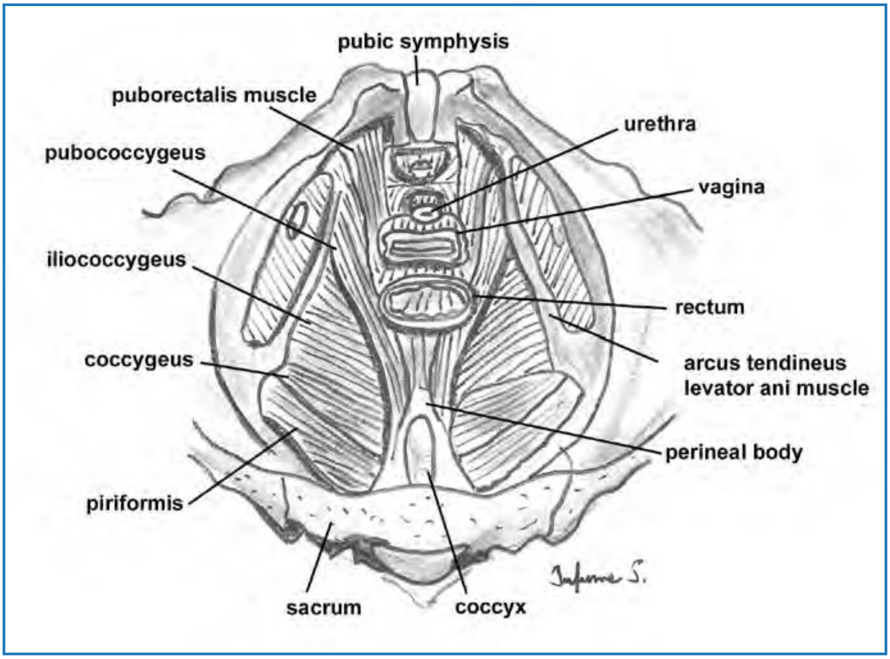

Fig. 3.3 Pelvic floor anatomy seen from cranial axis, showing the pelvic diaphragm and the relation between the muscles and the pelvic organs

The levator ani muscle is crossed by the urethra, vagina, and rectum through the urogenital hiatus. Indeed, the rectum is not considered to be part of the hiatus because the levator ani muscle attaches directly to the perineal body. Both the pubococcygeus and the puborectalis originate from the inferior pubic branch. The latter determines the closure of the urogenital hiatus since it surrounds the vagina and rectum, and terminates in the perineal body. Finally, the levator ani is covered by the superior and inferior fascia of the same name (i.e., superior and inferior fascia of the levator ani). In particular, all the connective tissue covering the pelvic diaphragm and viscera is called the endopelvic fascia [9], which attaches to the bony pelvis [10]. The endopelvic fascia has different names according to anatomical relationships: the pubocervical fascia (between the bladder and the vagina) and the rectovaginal fascia (between the vagina and rectum). Moreover, the parametrium and paracolpium are the tracts of the fascia extending from the cervix and vagina, respectively, to the pelvic walls [11]. Indeed, the term fascia is erroneous since microscopic study failed to determinate this [4].

Further support ligaments in the pelvic floor are the periurethral, paraurethral, and pubourethral ligaments, which help to maintain the structure of the urethra and bladder [9, 12].

3.4 Somatic Innervation

The bulbocavernosus, ischiocavernosus and superficial transverse perineal muscles are innervated by the perineal branches of the pudendal nerves [13]. Historically, the levator ani muscle has been assumed to be innervated by two nerves: the pudendal and the sacral nerves. More recently, the role of the pudendal nerve has been questioned. In fact, experimental studies have demonstrated that a nerve originating from S3, S4, and S5 innervates the levator ani and coccygeus, and it has been called levator ani nerve [4, 14]. It is probably correct that there are anastomotic branches between the pudendal and levator ani nerves [14]. Sometimes, the puborectalis receives a direct contribution from S5 [4]. From their sacral origins, the pudendal nerves exit from the pelvis across the great sciatic foramen, and enter again across the lesser sciatic foramen running in the so-called Alcock (or pudendal) canal [15]. At this level, posteriorly, the inferior rectal and perineal nerves, and the dorsal nerve of clitoridis (or penis in man), originate in succession from the pudendal nerve. The latter also provides the sensitive innervation of the external genitalia.

3.5 Conclusions

In conclusion, stability and correct anatomical function of the pelvic floor is maintained from the pelvic diaphragm caudally and the endopelvic fascia cranially. When the structures of pelvic diaphragm lose their integrity, as a result of traumatic or senile causes, there is only the endopelvic fascia to maintain the position of the organs. This fascia can rapidly lose its capacity to function and the organs may then prolapse.

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Imaging of Pelvic Floor Disorders

4

Valeria Fiaschetti, Valentina Funel, and Giovanni Simonetti

4.1 Introduction

Evacuation disorders, frequently found in elderly patients, are often caused by morphologic and functional abnormalities that are unlikely to be identified with static imaging techniques. The most common indications for "functional" imaging are constipation, incomplete evacuation or incontinence (often associated with rectal bleeding), mucous discharge, and perineal pain or discomfort [1].

Conventional defecography (CD) represents the gold standard examination for the identification and staging of morphological and functional disorders of the recto-anal region and pelvic floor in evacuation dysfunctions. Defecography evaluates in real time the morphology of rectum and anal canal in correlation with pelvic bone components both statically and dynamically, and it has assumed an important role in the diagnosis and management of these disorders [2].

Due to the recognition of the association of defecatory disorders with pelvic organ prolapse in women, the need to evaluate the pelvic floor as a unit has arisen. To meet this need, defecography has been extended to include not only evaluation of defecation disorders but also the rest of the pelvic floor by opacifying the small bowel, vagina, and the urinary bladder. The term dynamic cystocolpoenteroproctography (DCP) has been appropriately applied to this examination. Colpocystodefecography (CCD) combines vaginal opacification, voiding cystography, and defecography. Rectal emptying performed with DCP provides the maximum stress to the pelvic floor resulting in complete levator ani relaxation.

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In addition to diagnosing defecatory disorders, this method of examination demonstrates maximum pelvic organ descent and provides organ-specific quantification of organ prolapse, information that is only inferred by means of physical examination. It has been found to be of clinical value in patients with defecation disorders and the diagnosis of associated prolapse in other compartments, which are frequently unrecognized by taking history and because of the limitations of physical examination. The technique is also important for follow-up of patients who have undergone surgery of the pelvic region.

Other imaging techniques, such as anal manometry and electromyography, provide complementary functional information. Recently, magnetic resonance defecography (MRD) has been of increasing interest because of its accuracy in morphologic and functional assessment, as well as avoiding radiation exposure for the patient. Open-configuration magnetic resonance (MR) systems are required to perform the study with the patient sitting (providing natural conditions). Unfortunately, open-configuration MR systems are expensive and scarce. However, defecography can be performed in any hospital with a fluoroscopic room; a relatively short training time is required for the radiologist [3].

Fluoroscopic CCD has been proven to be better than physical examination in the detection and characterization of functional abnormalities of the anorectum and surrounding pelvic structures. Similarly MRD, performed either with an open-configuration or with a closed-configuration unit, appears to be an accurate imaging technique to assess clinically relevant pelvic floor abnormalities. Moreover, MRD negates the need to expose the patient to harmful ionizing radiation and allows excellent depiction of the surrounding soft tissues and support structures of the pelvic organs [4].

4.2 Cystocolpoenteroproctography Technique

4.2.1 Preparation

The patient fasts, beginning the evening before the procedure, and performs a rectal cleaning enema at home a few hours before going to the hospital. In the hospital, the patient receives 400 ml of an oral barium solution to obtain opacification of the pelvic loops of the small bowel at the time of examination (about 45 min later). It is important to obtain a complete clinical history of the patient. Defecography can be an embarrassing experience for the patient, and the radiologist must provide a clear explanation of the procedure in order to obtain complete collaboration.

4.2.2 Procedure

At the beginning of examination the patient is positioned on the left side, and about 300 mL of thick barium paste is injected into the rectum by means of a plastic syringe. When the subject reaches the stimulus to evacuate, the anal bulb is completely filled and injection can be interrupted. Barium paste is obtained by using barium sulfate powder for rectal use (enema) mixed with warm water or by mixing equal proportions of potato starch and barium solution with water. In both cases it is important that the barium paste has the consistency of normal stool or be a little more fluid to permit ease of injection into the rectum. These characteristics avoid the alteration of the diagnostic results.

Finally, in female patients, the vagina is opacified with either a commercially available barium sulfate paste for oral use or an echographic gel mixed with iodinated contrast medium. The opacification of the bladder is obtained with diluted uroangiographic contrast medium introduced by means of a bladder catheter that is removed immediately after filling.

The patient is seated on a radiolucent commode, which is upright on the end of a vertically oriented X-ray table. Deliberate efforts are made to ensure privacy. The patient is then asked to sit on the commode in right lateral projection. The examination is performed by filming the 3dynamics of defecation and urination step by step with short radioscopic sequences (1–3 images per second) and radiographs, the latter taken at rest, during squeezing and Valsalva effort. The patient must be instructed to empty the rectum and the bladder completely and without interruption: this process takes less than 30 s in physiologic conditions [2].

4.2.3 Parameters

The image analysis is aimed at the evaluation of the morphology of the pelvic organs and their position relative to the pelvic floor during the various dynamic phases.

The anorectal angle (ARA) represents the activity of the puborectalis muscle. Fibers of the puborectal muscle insert into the symphysis pubis and form a V-shaped sling around the posterior wall of the anorectal junction (ARJ). The ARA is measured from the longitudinal axis of the anal canal to a line along the posterior wall of the rectum or parallel to the longitudinal axis of the rectum.

At rest, the anal canal is almost completely closed, and the ARA is about 95–96° (physiological range, 65–100°), without noticeable differences between men and women. During maximal contraction, the angle becomes 15–20° sharper than at rest, while during straining and defecation it becomes 15–20° more obtuse.

The second important parameter to evaluate is the movement of the ARJ. The line drawn between the ischial tuberosities is called the bis-ischiatic line and can be used as a fixed bony landmark. Another fixed reference point is represented by the tip of the coccyx or recently by the pubococcygeal line (PCL), defining the pelvic floor base. The PCL is drawn from the inferior border of pubic symphisis to the last visible coccygeal joint.

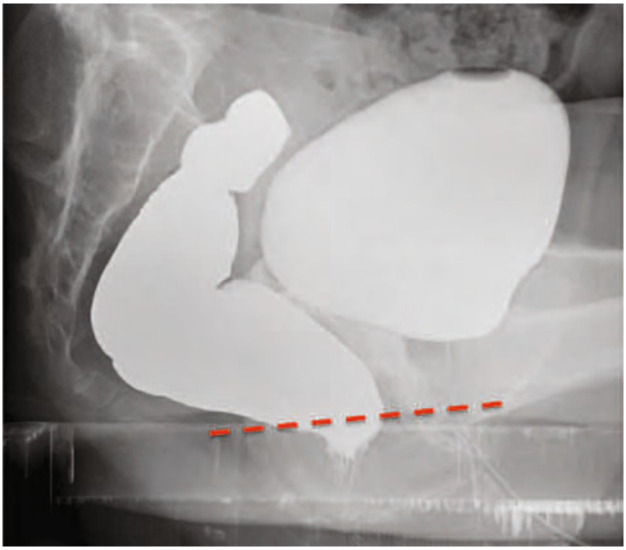

Fig. 4.1 Colpocystodefecography in the resting phase. The anorectal junction, the vaginal fornices, and the bladder neck lie over the pubococcygeal line (*dashed line*). The anorectal angle measures 93°

The craniocaudal migration of the ARJ indirectly represents the elevation and descent of the pelvic floor. The reproducibility and reliability of these parameters as usually measured have been confirmed, but their clinical significance is still controversial [5].

The posterior urethrovescical angle, measured between the inferoposterior wall of the bladder and the posterior wall of the urethra, is about 90–120°. An increase may indicate incontinence.

4.2.4 Normal Findings

In the resting phase, the anal canal is almost completely closed and the impression of puborectal sling is visible on the posterior wall of caudal rectum. In this condition, the angle between the anal canal and the rectum is 95–96° (Fig. 4.1).

During voluntary contraction of the pelvic floor, the ARA decreases to about 75°, and the ARJ migrates cranially. The puborectal impression becomes more evident because of the contraction of the levator ani, pulling the ARJ toward its insertion at the symphysis pubis.

When the patient is asked to strain, the converse is seen: the ARA increases with partial to complete loss of puborectal impression, and the pelvic floor descends. The degree of caudal migration, as measured in relation to the bony landmarks, is considered normal when it is less than 3.5 cm relative to the resting position.

During evacuation, the anal canal and the rectum migrate caudally. The ARA increases in relation to the relaxation of external and internal sphincters and puborectal muscle, respectively. Puborectalis sling impression on the rectum posterior wall disappears almost completely, and the anal canal reaches the widest diameter (it should open to a mean anteroposterior diameter of 1.5 cm).

During the late phases of evacuation, the rectal bulb funnels and its walls progressively collapse. A small amount of infolding of redundant anterior and posterior rectal walls is considered normal. The entire process lasts less than 30 s in physiologic conditions.

At the end of evacuation, the resting condition is reached when the anal sphincters close and levator ani restores its tone, pulling the ARJ cranially. The rectum is completely empty, and only minimal barium dye can be found [2].

4.3 Magnetic Resonance Defecography Technique

Pelvic floor anatomy is complex and DCP does not show the anatomical details that pelvic magnetic resonance imaging (MRI) provides. Technical advances, allowing acquisition of dynamic rapid MRI sequences, have been applied to pelvic floor imaging [6]. MRD, although still an experimental technique, may be a useful tool in preoperative planning of these disorders and may lead to a change in surgical therapy, reducing postoperative relapses especially in patients with multicompartmental disorders [7–9].

Concerns about the risks related to radiation, especially in women of childbearing age, and the spreading of pelvic floor MRI in addition to questions relating to the clinical significance of DCP findings have added to these controversies. Furthermore MRD allows the detection of incidental pathologic conditions, such as urethral and bladder diverticula, endometrial polyps, malignant lesions, fibroids, and adnexal lesions [10–12].

A potential disadvantage of MRD is its less physiologic nature if performed with the patient in the supine position, but sitting dedicated systems have been developed [13, 14]. In some studies, MRD has been performed in the orthostatic position also [15].

4.3.1 Preparation

The patient performs a rectal cleaning enema at home. The MRI protocol requires no oral or intravenous contrast agents, since the small bowel is inherently delineated. In some protocols, contrast material is not used to opacify the bladder and patients are requested not to void for 1–2 h prior to their examination.

4.3.2 Technique

Protocols vary by institution, with MRI studies performed with the patient in both supine and upright positions, either with closed or open magnets. Studies have been performed without contrast material, with vaginal and rectal markers, and with rectal, vaginal, urethral, and bladder contrast material.

In the majority of cases, a 1.5 T system is used and T2-weighted turbo spin echo and balanced fast field echo sequences are acquired, with the patient in the supine position. Pelvic or torso phased-array coils are centered low on pelvis to ensure visualization of prolapsed organs.

At the beginning of examination, the patient is positioned on the left side with flexed knees and the rectum is filled with 200 mL echographic gel; the vagina is also filled with an echographic gel suspension of 100 mL. Finally, the bladder is filled with 180 mL physiological solution via a 16 F double-way Foley catheter, which is removed soon after filling; otherwise the patient is asked not to void for 1–2 h before the examination.

With the patient at rest, static images of the entire pelvis are acquired in the axial, sagittal, and coronal planes using rapid half-Fourier T2-weighted sequences (HASTE, half-Fourier acquisition single-shot turbo spin echo) (recommended parameters: TR 3,000 ms; TE 90 ms; flip angle 90°; slice thickness 5 mm; FOV 250 × 250, matrix 448 × 345).

After the midline between the pubic symphysis and the coccyx is localized, dynamic images are acquired with a balanced sequence in the sagittal plane; a single stack of images is acquired continuously at rest, and during maximal contraction, straining, and defecation (recommended parameters: TR 2.7 ms; TE 1.35 ms; flip angle 45°; slice thickness 10 mm; FOV 300 × 300, matrix 160 × 160; dynamic scan time 0.432 s, dynamic images 100).

At our institution, MRD is also performed on a permanent open magnet with changeable position and static 0.25 T field. The magnet table is provided with a tilting mechanism going from 0° to 90° and pitched at 80° to allow a semi-orthostatic acquisition [15].

A surface lumbar spine DPA coil is used as the receiving coil, composed of a stiff base and a flexible anterior band with variable dimensions.

Before the examination, the rectum is filled with 200 mL mashed potato mixed with 1 mL paramagnetic contrast medium. The bladder is also filled with 180 mL physiological solution mixed with 3 mL contrast medium via a catheter, left in place during the entire study. Finally vagina is filled with an echographic gel suspension mixed with 0.5 mL paramagnetic contrast medium.

The three orthogonal image planes are acquired at rest using three-dimensional HYCE (hybrid contrast enhanced), a type of gradient echo (GE) balanced sequence (TR 10 ms; TE 5 ms; flip angle 90°; sections 20; section thickness 2.5 mm; FOV 280 × 280, matrix 200 ×160).

Static images are acquired in the sagittal plane at rest, during sphincter contraction and straining using a GE T1-weighted sequence (TR 35 ms; TE 10 ms; flip angle 90°; section 1; section thickness 5.5 mm; FOV 300 × 300, matrix 192×128).

Fig. 4.2 Magnetic resonance defecography performed on a 1.5 T magnet. T2-weighted turbo spin echo sequence acquired at rest in the sagittal plane. The anorectal junction, the vaginal fornices, and the bladder neck are located above the pubococcygeal line (*dashed line*). The anorectal angle measures 90°

Finally, the dynamic phase is performed during defecation using a GE T1-weighted sequence in the midsagittal plane (TR 30 ms; TE 6 ms; flip angle 90°; section 1; section thickness 5.5 mm; FOV 300 × 300, matrix 192×128; acquisition time 3 s/image).

The urinary study is performed after removing the bladder catheter.

4.3.3 Parameters

The interpretation of the images should begin in the sagittal plane by drawing the PCL, defining pelvic floor base, extending from the inferior border of pubic symphysis to the last visible coccygeal joint [13]. The distance between the PCL and the lowest recognizable part of pelvic organs (the bladder neck, vaginal fornices, and ARJ) should be measured at rest, during maximal sphyncterial contraction, and during straining and evacuation (Fig. 4.2).

Two other lines should be measured according to the HMO system: the H line, which represents the anteroposterior width of the levator hiatus and is drawn from the inferior aspect of the pubic symphysis to the ARJ; the M line, representing the vertical descent of the levator hiatus and is drawn perpendicular from the PCL to the ARJ; and the O component, which represents the organ prolapse [8].

The ARA and the posterior urethrovescical angle are measured similarly to conventional defecography examinations.

Fig. 4.3 Magnetic resonance defecography performed on a 1.5 T magnet. T2-weighted turbo spin echo sequence acquired at rest in the axial plane. The pelvic sling appears symmetric and hypointense

On the axial and coronal images, the puborectal and iliococcygeal muscles should be examined for thinning and tears. The pelvic sling appears relatively symmetric and is hypointense on T2-weighted images. Paravaginal fascial tears can be inferred from posterior displacement of the vaginal fornix. Lateral pubovesical ligaments can also be seen.

4.3.4 Normal Findings

In the upright position, the support to pelvic organs is primarily provided by the bony pelvis, while the pelvic floor muscles and the endopelvic fascia counteract intermittent increases in abdominal pressure. On axial images, the entire the levator ani should be of similar thickness and homogeneous low signal intensity. No tears should be identified. On coronal images, the iliococcygeal muscle should be intact and upwardly convex.

On axial images, the urethral cuff is located anteriorly with a bull's eye configuration; the vagina should have an H-shaped configuration, which indicates adequate lateral fascial support; the perineum is a diamond-shape structure, with the anorectum lying behind the transverse perineum (Fig. 4.3).

In healthy, continent patients, even with maximal downward pelvic strain, MR images demonstrate minimal descent of the pelvic organs (M line < 2 cm).

The ARA and the posterior urethrovescical angle can be measured in the saggital plane; normal values are similar to those cited for conventional defecography (see Section 4.2.4).

4.4 Pathological Findings

4.4.1 Intussusception and Rectal Prolapse

Rectal prolapse can be categorized as intrarectal, rectoanal, or external, depending on extension inside the viscus; and as simple or complete, depending on the involved wall layers.

The pathological condition called simple prolapse or procidentia occurs when the mucosal layer protrudes into the lumen. Complete prolapse or intussusception can be observed when all layers of the wall are involved and there is an invagination of the rectal wall into the rectal lumen or the anal canal.

Clinical manifestations frequently associated with rectal prolapse are outlet obstruction and persistent desire to defecate by blocking the rectal ampulla during evacuation, tenesmus, hematochezia, and incontinence. Symptoms are caused by the obstructive effect of the prolapsed wall on the propulsion of rectal contents and on sphincter irritation or weakness. This condition is frequently found in association with solitary ulcer syndrome [16].

4.4.1.1 Conventional Defecography

At the end of defecation, small infoldings of less than 3 mm thickness can be frequently observed without any clinical significance. Larger protrusions have also been observed in asymptomatic patients. Intussusception usually originates 6–8 cm above the anal canal at the level of the main rectal fold and can be either anterior, circumferential, or posterior in location.

Simple intrarectal prolapse is identified as a wall protrusion inside the rectal lumen more evident during straining and evacuation. Mucosal protrusions are almost exclusively found on the anterior rectal wall with a thickness less than 1 cm because of their simple mucosal composition.

In complete prolapse, all layers of the wall are involved. Dilation of the anal canal is evident during evacuation, and a circular infolding of the rectal wall invaginates into the lumen (Fig. 4.4). Descent can be so dramatic as to pass through the anus and prolapse externally, with associated incontinence.

The intussuscepting rectum pulls down the anterior peritoneal covering and can determine an enterocele, meaning a deep pouch anterior to the rectum that contains small bowel.

Evacuation can be blocked by the intrarectal prolapsed wall, which creates a plug obstructing the stool transit, causing barium paste to stagnate inside the viscus.

4.4.1.2 Magnetic Resonance Defecography

Intussusceptions can be difficult to detect on MRI: the sensitivity has been reported to be 70% relative to CD. However the soft tissue resolution may allow better differentiation between simple and complete prolapse. Diagnostic criteria are similar to CD.

An invagination of the rectal wall can be seen on the midsagittal plane (Fig. 4.5) as well as on the transaxial plane (“target sign”).

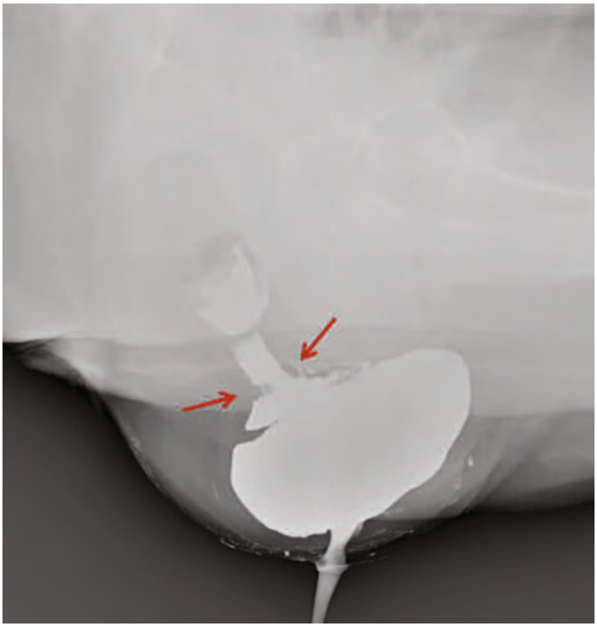

Fig. 4.4 Conventional proctography in the voiding phase. Circular infoldings of the rectal wall (*arrows*) can be seen in the middle part of the rectum. In addition, moderate anterior and posterior rectoceles are present

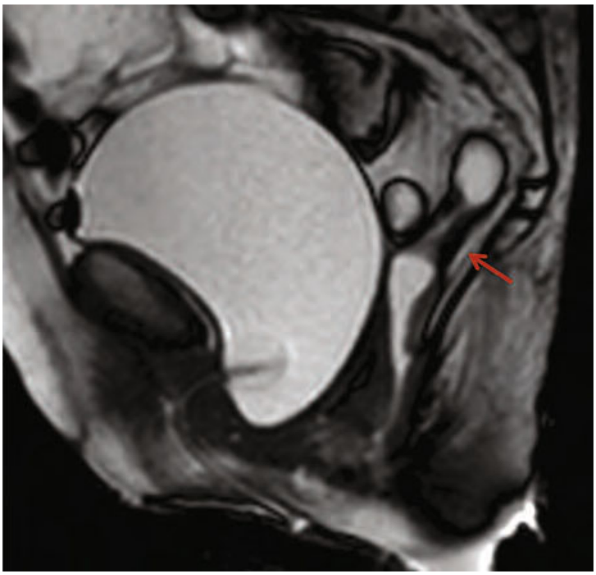

Fig. 4.5 Magnetic resonance defecography performed on a 1.5 T magnet. T2-weighted balanced fast field echo sequence acquired in the voiding phase. A complete internal rectal prolapse is visible (*arrow*), involving all the layers of the wall

Depending on the location, the intussusception is classified as intra-rectal (grade I), intra-anal (grade II), or external rectal prolapse (grade III).

4.4.2 Descending Perineum Syndrome

This syndrome represents a condition of pelvic floor muscle hypotonia and presents with difficult evacuation, incomplete emptying of the rectum, and/or incontinence. This condition is usually found in elderly women; risk factors are chronic constipation, neurologic dysfunction, perineal trauma, multiparity, and surgical procedures.

Abnormalities of the perineal body and levator ani musculature cause perineal descent, which is quantified by measuring the descent of the ARJ (the M line). Descent of the perineal body is measured by the width of the levator hiatus (the H line).

Caudal migration of the ARJ indirectly represents the perineal descent because this is caused by increased intra-abdominal pressure during straining associated with relaxation of the puborectalis and pelvic muscles. In this pathological condition, muscles of the perineum are hypotonic and overwhelmed by the caudal migration of abdominal organs, so that the descent of ARJ is abnormally pronounced.

This repeated stretching of pelvic floor chronically causes damage to the nervous structures, most notably the pudendal nerve, and determines dysfunction of continence and pain. Incontinence is frequently associated with this syndrome. If this process is chronic, a vicious cycle is established in which intense and prolonged strain is necessary to evacuate, leading to further stretching and weakening of the pelvic muscles. Descending perineum syndrome can be conservatively treated by means of suppositories to reduce straining during evacuation.

4.4.2.1 Conventional Defecography

The main radiographic feature is the caudal migration of the more than 3.5 cm during straining. The degree of descent is calculated from the resting position to the most caudal position during straining or evacuation in relation to the bony landmark. Similarly, the ARA is more than 130° at rest and increases to more than 155° during straining.

Recently, the PCL has become the main bony landmark and rectal descent is calculated perpendicular from that line to the ARJ. In normal conditions, the ARJ lies within 1 cm of the PCL. The rectal prolapse is considered mild if the ARJ lies between 1 and 3 cm under the PCL, moderate if it lies between 3 and 6 cm under the PCL, and severe if the ARJ descends more than 6 cm under the PCL (Fig. 4.6).

4.4.2.2 Magnetic Resonance Defecography

The descent of the ARJ is measured as in CD, and the ARA is also measured (Fig. 4.7).

Fig. 4.6 Colpocystodefecography during straining. A caudal migration of the bladder, the vagina, and the rectum can be appreciated as a descent of bladder neck, vaginal fornices, and anorectal junction below the pubococcygeal line (*dashed line*). The anorectal angle measures 137°

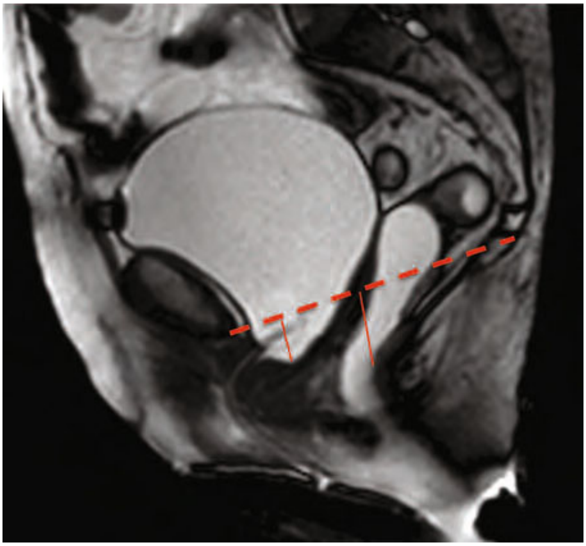

Fig. 4.7 Magnetic resonance defecography performed on a 1.5 T magnet. T2-weighted balanced fast field echo sequence acquired in the voiding phase. The bladder neck and the anorectal junction are located below the pubococcygeal line (*dashed line*). The anorectal angle measures 143°. A moderate anterior rectocele is also present

The MRI can provide additional information about the components of the levator ani muscle, i.e., the iliococcygeus muscle and the puborectalis muscle (Fig. 4.8). The normal thickness ranges from 3 mm (iliococcygeus) to 5–6 mm (puborectalis); little asymmetry is considered normal. In the absence of prolapse, the levator plate parallels the PCL.

Fig. 4.8 Magnetic resonance defecography performed on a 1.5 T magnet. T2-weighted turbo spin echo sequence acquired at rest in the axial plane. The pelvic sling appears enlarged and it shows heterogeneous signal intensity

4.4.3 Multicompartmental Syndrome

Classification of pelvic floor abnormalities has been topographic but distinctions are artificial in most cases. In fact abnormalities of the levator sling can determine defects in one or more compartment and they affect one other.

Evaluation of patients with pelvic floor complaints begins with a thorough history and physical examination, but the degree and the presence of pelvic organ defects are not always apparent on clinical examination.

A cystocele can be present, as a well as a vaginal vault prolapse or descending perineum syndrome. If two or three of these defects are associated, it is a case of bicompartmental or tricompartmental syndrome.

4.4.3.1 Conventional Defecography and Magnetic Resonance Defecography

Descent of pelvic organs is evaluated as described for descending perineum syndrome.

A comprehensive evaluation is considered essential in the preoperative setting in order to establish correct surgical planning and to avoid relapses due to unrecognized defects. MRI has the advantage of being able to evaluate all the compartments simultaneously, and it is achieving a primary role in the assessment of patients with pelvic floor weakness.

4.4.4 Rectocele

Rectocele is the most common cause of obstructed evacuation treated by surgery. It consists of an anterior bulge of the rectal wall. This condition is most commonly found in females because of laxity of the rectovaginal septum (congenital or caused by obstetric traumas or surgical procedures).

Pouches smaller than 2 cm are frequently found in asymptomatic females; these protrusions have no clinical significance and are not considered pathological. Pouches larger than 2 cm are significantly associated with evacuation disorders.

Excessive straining may also cause posterior bulges of the rectum because of hernias of the levator ani on posterolateral pelvic floor. Clinical manifestations are caused by incomplete emptying of the rectum; some patients apply digital rectal or vaginal maneuvers to complete evacuation.

4.4.4.1 Conventional Defecography

On defecography, an outpouching of the anterior or posterior rectal wall bulges and dislocates the opacified vaginal lumen during straining and evacuation. It is evaluated drawing a line parallel to the anterior or posterior wall of the anal canal and measuring the distance between this line and the widest point of the bulging.

There are three degrees of rectocele: a mild degree is < 2 cm in anteroposterior diameter (not clinically significant); a moderate degree is between 2 and 4 cm; and a severe degree is > 4 cm. A certain amount of radiopaque paste can be retained inside the pouch and persist at the end of defecation.

4.4.4.2 Magnetic Resonance Defecography

The measurement of the rectocele is obtained as described for CD (Fig. 4.9).

4.4.5 Dyskinetic Puborectalis Muscle Syndrome

Also known as spastic pelvic floor syndrome or anismus, this condition is caused by inappropriate contraction of the puborectalis muscle during evacuation instead of physiologic relaxation. Most cases are idiopathic, although focal pathological alterations such as fistulas, solitary ulcers, and thrombotic hemorrhoids can be associated with this syndrome. The etiology is unclear and includes abnormal muscle activity and physiological or cognitive factors.

Patients experience evacuation failure associated with incomplete emptying; evacuation time longer than 30 s is highly predictive of dyskinetic puborectalis muscle syndrome.

4.4.5.1 Conventional Defecography and Magnetic Resonance Defecography

This syndrome is characterized by a lack of pelvic floor descent during

Fig. 4.9 Magnetic resonance defecography performed on a 1.5 T magnet. T2-weighted balanced fast field echo sequence acquired in the voiding phase. A severe anterior rectocele is present (*arrow*)

straining and evacuation and paradoxical contraction of the levator ani: the levator plate bulges convexly when the patient is asked to strain.

Another less specific feature is an aberrantly deep impression of the puborectalis sling on the posterior rectal wall at rest; this is even more evident during squeezing. This sign is caused by the presence of a hypertrophic levator ani muscle, but its specificity is low; it can be also observed in asymptomatic subjects.

Measurement of the ARA changes shows no significant difference between symptomatic subjects and asymptomatic controls, and it is not a reliable parameter of this syndrome.

4.4.6 Enteroceles and Sigmoidoceles

Herniation of a peritoneal sac into the pouch of Douglas containing ileal loops or part of the sigmoid are respectively called enterocele and sigmoidocele. They are almost exclusively found in female subjects; pelvic surgical procedures are risk factors for this condition, especially gynecological procedures such as hysterectomy or urethropexy. Patients describe a sensation of pelvic oppression during evacuation and incomplete emptying of the rectum. These symptoms are usually not associated with obstructed defecation, and rectum emptying is complete at defecography.

Enterocele may be simple or complex, depending on the absence or presence of an associated vaginal vault prolapsed.

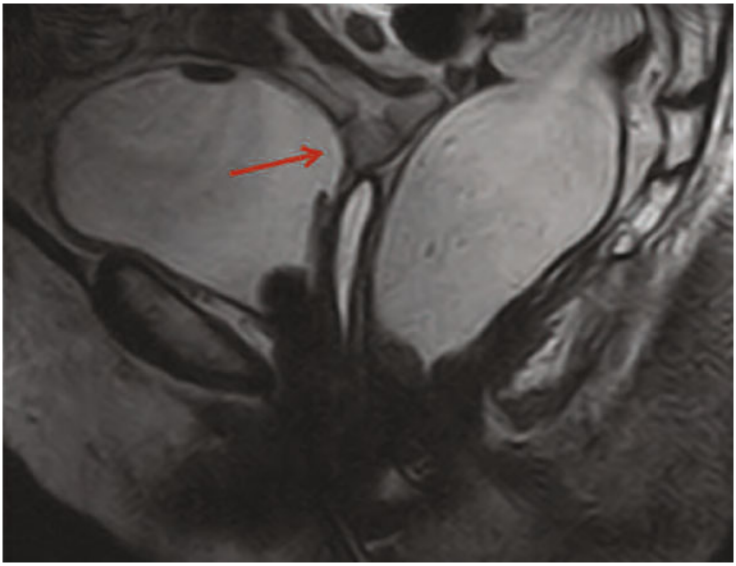

Fig. 4.10 Magnetic resonance defecography performed on a 0.25 T magnet. T1-weighted gradient echo sequence acquired at rest in the sagittal plane. Ileal loops are visible in the rectovaginal space (*arrow*)

4.4.6.1 Conventional Defecography

Good opacification of ileal loops is essential for identification of intestinal herniation into the rectovaginal space. Descent of barium-filled ileal loops is evident during evacuation in the space between the rectum and vagina that is widened.

Widening of this space is also an indirect sign of enterocele when opacification of ileal loops is not achieved. The presence of air between the rectum and opacified vaginal lumen can confirm this suspicion. These signs are evident during straining or evacuation (increased abdominal pressure). Occasionally enterocele becomes evident only when the rectum has been completely emptied and sufficient space is left for the small bowel loops to herniate. Protrusion of herniated viscera on the anterior rectal wall frequently causes an associated rectal prolapse.

4.4.6.2 Magnetic Resonance Defecography

The main limitations of defecography are related to the conventional technique: low-contrast resolution and bidimensional imaging. MRI has been shown to be superior to CCD, which fails to demonstrate up to 20% of enteroceles.

Descent of small bowel loops or sigmoid colon more than 2 cm into the rectovaginal space indicates tearing of the rectovaginal fascia. On axial images, loops of sigmoid or small bowel can be seen insinuated between the rectum and vagina. These findings may be seen on images obtained with the patient at rest, with a larger enterocele evident during straining (Fig. 4.10).

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Anorectal Physiology

5

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5.1 Introduction

Anorectal physiology deals with the defecatory function, which consists of the release of intestinal gas and feces through the anus. The control of the appropriate time and place of defecation is a complex mechanism of anal continence. In this chapter, the physiological mechanisms involved in the control of defecation and continence will be reviewed.

Anorectal physiology was poorly understood until the results of several new investigations were published, such as those on anorectal manometry, neurophysiology of pelvic floor muscles and pudendal nerves (electromyography, pudendal nerve terminal motor latency), and imaging techniques such as dynamic defecography, pelvic floor ultrasound, and defeco-magnetic resonance imaging.

The correct assessment of anorectal physiology has important clinical implications because any alteration of continence and defecation may result in incontinence and/or constipation causing severe impairment to the patient's quality of life.

5.2 Pathophysiology of Continence

5.2.1 Internal Anal Sphincter

The internal anal sphincter (IAS) represents a thickening of the circular muscle layer of the terminal rectum at the level of the anal canal; it extends about

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2 cm below the dentate line and is located between the anal mucosa and the longitudinal muscle of the rectum, separated by the intersphincteric space from the external anal sphincter (EAS). This muscle accounts for about 70% of the resting pressure and represents one of the most important factors for anal continence [1].

The IAS is involved in the rectoanal inhibitory reflex (RAIR) defined as "the transient decrease in resting anal pressure by ≥ 25% of basal pressure in response to rapid inflation of a rectal balloon with subsequent return to baseline" [2].This intramural reflex mediates relaxation of the IAS with specific duration and latency, followed by a gradual recovery of basal anal pressure as a response to rectal distension by the stool.

The RAIR is mediated by the enteric nervous system and does not require control by the peripheral or central nervous system, as demonstrated by its presence in spinal patients; nitrogen dioxide is the most common inhibitory mediator produced by the myenteric neurons [3]. Traumatic lesions of the IAS usually lead to soiling, and altered RAIR may be responsible for megarectum, such as that found in Hirschsprung disease [4].

5.2.2 External Anal Sphincter

The EAS is a voluntary striated muscle in which three components (deep, superficial, and subcutaneous) can be identified. These findings were described by Santorini, Von Holl, Milligan, Morgan, and Gorsch, but they became more accepted after the Shafik's 1975 paper in which three "U-shaped" loops (top, intermediate, and base) were identified, with separate and counterbalanced sphincter functions [5, 6]; however, modern imaging techniques have cast doubts on this theory.

The EAS, with its continuous tonic activity, contributes to resting anal tone and provides a strong increase in anal pressure during voluntary squeeze and during rapid increase of intrarectal or intra-abdominal pressure [7, 8].

5.2.3 Puborectalis Muscle

The puborectalis muscle, together with ileococcygeal and pubococcygeal, is a component of the levator ani muscle, which lies below and around pelvic organs. The tone of levator ani muscles contributes to continence, making the lumen of the pelvic organs a virtual space.

Many hypotheses have been proposed to explain the role of the puborectalis muscle in the control of continence. Parks and colleagues argued that continence is achieved by creating a "flap valve", whereby an increase of intra-abdominal pressure forces the anterior rectal wall down towards the upper third of anal canal, occluding it and preventing feces outflow [9]. Subsequent studies have shown that the "flap valve" is just a theoretical mechanism and it is mainly the simultaneous voluntary contraction of the EAS and puborectalis that prevents the escape of stool [10, 11].

One of the most distinctive features of the puborectalis muscle is the creation of an angle between the rectum and the anal canal, known as anorectal angle (ARA). It is open posteriorly due to the anatomic sling-shaped configuration of the puborectalis muscle that surrounds the anorectal junction and fits on pubic bone.

The ARA, which is easily measurable by defecography, is approximately 90–110° during the resting period, but it is a "dynamic angle" because it becomes more obtuse in pushing (during defecation) and more acute in squeezing (during retention of feces).

It has also been demonstrated that the erect position modifies the ARA without contraction of pelvic floor muscles, making the angle more acute (< 80°). On the other hand, the sitting position on the toilet causes opening of the ARA to more than the value recorded in voluntary pushing in Sim's position (121° vs. 113°).

These findings indicate that the erect position helps the maintenance of continence, whereas the sitting position on the toilet, probably due to the gravity and relaxation of pelvic muscles, allows defecation [12].

5.2.4 Rectal Compliance

The distal part of the colon, and particularly the rectum, works as "a reservoir" and has a great importance in anal continence. The rectum has the capacity of storing stools by adapting the tone of the muscular wall in order to reduce the pressure inside. This property, known as rectal compliance, is the ratio between rectal pressure and rectal volume ($\Delta v/\Delta p$) and its control is mediated by the sacral parasympathetic nerves.

The rectal wall also has mechanoreceptors inducing extrinsic and intrinsic reflexes, which play an important role in defecation.

5.2.5 Hemorrhoidal Cushions

Internal hemorrhoids are cushions of vascular tissue rich in arteriovenous anastomosis, elastic fibers, and collagen, and they seem to play a role in the maintenance of fine continence, contributing to 15–20% of the resting tone of the anal canal [1, 13].

In conclusion all these anatomical structures are involved in the maintenance of continence, but some are activated mainly during fecal urgency (EAS and puborectalis muscle), and others in the resting state (IAS, rectal compliance, hemorrhoidal cushions) [14].

5.2.6 Bowel Movement and Stool Characteristics

The occurrence of strong and coordinated contractions (mass movements) allows the migration of stool from distal colonic segments into the rectum. These contractions occur more frequently in the morning after awakening and after a meal (gastrocolic reflex). In contrast, colonic motility is reduced at night to avoid incontinence [15].

The volume and consistency of the feces are other important factors affecting anal continence. Leakage of gas or liquid stools is more difficult to control, while hard stools are difficult to expel even in the presence of damaged or poorly functioning anal sphincters.

5.2.7 Defecation

Sensory perception and physiological coordination of pelvic floor muscles are important components of defecation, which depends on both involuntary and voluntary mechanisms.

The site for the integration and control of defecation is located in the lumbosacral spinal cord and is modulated by higher centers (brainstem and cerebral cortex). Alterations of this brain–gut axis can lead to important dysfunctions: in fact the voluntary control of defecation is lost in patients who have a spinal cord injury with interrupted corticospinal connections [16].

At rest, the pressure in the rectum is lower than in the anal canal, but once the rectum has received the fecal mass from the distal colon, its intraluminal pressure increases and the rectal walls are stretched. The pressure becomes higher than pressure of the anal canal, and rectal distension activates the rectoanal inhibitory reflex causing the relaxation of the IAS so that the feces, according to the new pressure gradient, come down to the upper anal canal where the sensory receptors in the anal mucosa can discriminate between flatus and liquid or solid stools. This mechanism is called “sampling” and determines both the urgency of defecation and the reflected contraction of the EAS, which prevents the loss of stools.

When the conscious perception of the stimulus to defecate is realized, if the passage of stools must be prevented, a voluntary contraction of the EAS and puborectalis muscle forces the stool back into the high rectum. Here the feces are temporarily stored so that the urgency to defecate temporarily disappears and anal sphincters recover their basal tone.

In contrast, if the time and the place are appropriate, the subject sits on the toilet and by the Valsalva maneuver increases the abdominal pressure contracting the abdominal muscles. Simultaneously the EAS and puborectalis muscles voluntarily relax and the anorectal angle opens and the stool can be expelled through the anus. The “closing reflex” (transient contractions of the EAS and puborectalis muscle) after defecation closes the anal canal, restoring its basal tone [3].

5.2.8 Role of The Nervous System

Hormones, paracrine substances, enteric nervous system, autonomic (sympathetic and parasympathetic) nervous system, and cerebral cortex together regulate colorectal motility and sensitivity.

The enteric nervous system is composed of the myenteric plexus (Auerbach's plexus) and the submucosal plexus (Meissner's plexus), and it consists of a network of nervous fibers, ganglion cells (sensory and effectors neurons), and interneurons richly interconnected by reflex arcs located in the wall of the gastrointestinal tract and directed to innervate smooth muscle cells. The effector neurons of the myenteric plexus may be excitatory or inhibitory according to the substances released in contact with smooth muscle cells. Excitatory neurons release acetylcholine, substance P, and other tachykinins, while inhibitory neurons release vasoactive intestinal peptide and nitric oxide, which cause relaxation of smooth muscle cells [17]. As a result of this organization, the enteric nervous system acts like a semi-autonomous system: it is able to coordinate most of the activities, even in the absence of an extrinsic control.

Extrinsic innervation is provided by the sympathetic and parasympathetic nerves, which have only a modulatory function on the contractile activity.

Sympathetic innervation originates from postganglionic fibers of the hypogastric plexus and it has an inhibitory effect on the motor function, making connections with neurons of the enteric nervous system, which in turn sends fibers to smooth muscle cells, inhibiting the contraction.

On the other hand, parasympathetic fibers, which originate from the sacral plexus (S2–S4) and run into the pudendal nerve, send preganglionic fibers to neurons of the intramural plexus, which in turn sends fibers to smooth muscle cells, stimulating the contractile function.

Also important are the intrinsic reflexes located in the colon and rectal wall, as well as throughout the gastrointestinal tract; the colocolonic reflex is finely organized so that the stimulation of an intestinal segment causes contraction of the segments upstream and distension of segments downstream. The gastrocolic reflex acts to produce an increase in colonic motility and mass movements in response to the presence of food in the stomach.

Therefore, it is evident that continence and defecation are the effects of the integration of many functions involving the colon, anorectum, pelvic floor muscles, and nervous system.

5.3 Conclusions

The ability to retain stools, distinguish them from flatus, and allow defecation, is a complex process controlled by several anatomic factors including the pelvic floor musculature and the anorectum, with its complex innervation including the somatic, autonomic and enteric nervous systems.

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Pelvic Floor Ultrasonography

6

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6.1 Introduction

The pelvic floor is a complex, three-dimensional (3D) mechanical apparatus that has been artificially divided in three different regions: anterior, middle, and posterior compartments. However, urinary (urinary incontinence, voiding dysfuntion, cystocele), genital (uterine prolapse, vaginal vault prolapse, enterocele), and anorectal abnormalities (fecal incontinence, obstructed defecation, rectocele, intussusception, dyssynergia) are frequently associated in women with pelvic floor dysfunction [1]. Although patients may present with symptoms that involve only one compartment, 95% of patients have abnormalities in all three compartments [2]. As a consequence, the specialist (urologist, gynecologist, gastroenterologist, and colorectal surgeon) approaching the pelvic floor should not have vertical vision confined to their area of interest, but a transverse, multicompartmental vision, always taking into consideration that pelvic floor disorders rarely occur in isolation.

The diagnostic evaluation has a fundamental role in identifying all pelvic floor dysfunctions and providing adequate information for management, taking into consideration the consequences of therapy on adjacent organs and avoidance of sequential surgeries. The increasing availability of ultrasound equipment in the clinical setting, and the recent development of 3D and four-dimensional (4D) ultrasound, have renewed interest in using this modality to image the pelvic floor anatomy as a key to understanding dysfunction. Ultrasound has several important advantages over other imaging modalities (defecography, cystography, magnetic resonance), including the absence of

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ionizing radiation, relative ease of use, minimal discomfort, cost-effectiveness, relatively short time required, and wide availability. A “multicompartmental” ultrasonographic assessment, using a combination of different modalities (endovaginal sonography, endoanal ultrasound, and transperineal ultrasound), provides a comprehensive evaluation of this region [3]. The clinical relevance of this “integrated approach” is to reduce inappropriate surgical treatments and high rates of postoperative failures.

6.2 Ultrasonographic Techniques

6.2.1 Transperineal Ultrasonography

Transperineal ultrasonography (TPUS) is performed with the patient placed in the dorsal lithotomy position, with hips flexed and abducted, and a convex transducer positioned on the perineum between the mons pubis and the anal margin (perineal approach). Imaging is performed at rest, during maximal Valsalva maneuver and during pelvic floor muscle contraction [4]. Conventional convex transducers (with frequencies of 3–6 MHz and field of view of at least 70°) provide two-dimensional (2D) imaging of the pelvic floor. In the midsagittal plane, all anatomical structures (bladder, urethra, vaginal walls, anal canal, and rectum) between the posterior surface of the symphysis pubis and the posterior part of the levator ani are visualized (Fig. 6.1). Using 3D transabdominal probes developed for obstetric imaging (RAB 8-4, GE Healthcare Ultrasound, Milwaukee, Wis, USA; AVV 531, Hitachi Medical Systems, Tokyo, Japan; V 8-4, Philips Ultrasound, Bothell, Wash, USA; 3D 4–7 EK, Medison, Seoul, South Korea), 3D-TPUS and 4D-TPUS can be performed [5, 6]. These transducers combine an electronic curved array of 4–8 MHz with mechanical sector technology, allowing fast motorized sweeps through the field of view. An advantage of this technique, compared with the 2D mode, is the opportunity to obtain tomographic or multislice imaging in order to assess the entire puborectalis (PR) muscle and its attachment to the pubic rami (Fig. 6.2). It is also possible to measure the diameter and area of the levator hiatus, and to determine the degree of hiatal distension on Valsalva maneuver [7]. 4D imaging involves real-time acquisition of volume ultrasound data, which can then be visualized instantly in orthogonal planes or rendered volumes.

6.2.2 Endovaginal Ultrasonography

Endovaginal ultrasonography (EVUS) is performed with the patient placed in the same position as that adopted for TPUS. It may be performed with a high multifrequency (9–16 MHz), 360° rotational mechanical probe (type 2050, B-K Medical, Herlev, Denmark) or with a radial electronic probe (type AR 54

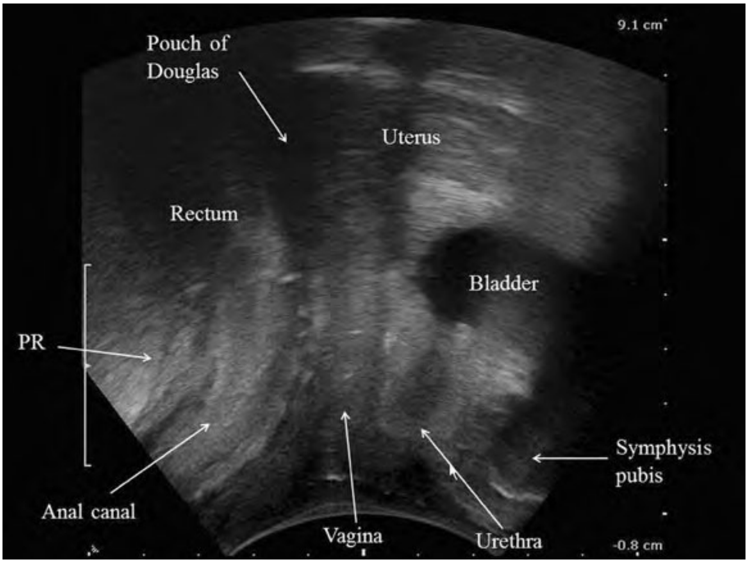

Fig. 6.1 Two-dimensional transperineal ultrasonography. Midsagittal view of normal female pelvic floor, including the symphysis pubis, the urethra and bladder, the vagina and uterus, the rectum, and the anal canal. Posterior to the anorectal junction, the puborectalis (*PR*) muscle is visualized as a hyperechogenic structure

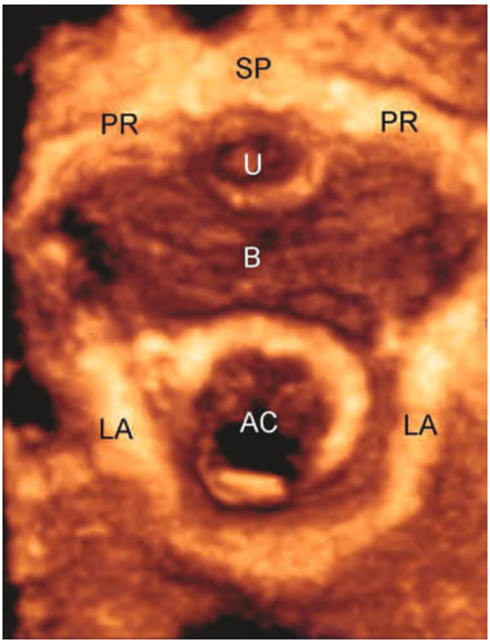

Fig. 6.2 Three-dimensional transperineal ultrasonography. Axial view of normal female pelvic floor, including the symphysis pubis (*SP*) and pubic rami (*PR*), the urethra (*U*) and bladder (*B*), the levator ani (*LA*), and the anal canal (*AC*)

AW, 5–10 MHz, Hitachi Medical Systems) [8]. The difference between these two transducers is that the 3D acquisition is free-hand with the electronic transducer, whereas the mechanical transducer has an internal automated motorized system that allows an acquisition of 300 aligned transaxial 2D images over a distance of 60 mm in 60 s, without any movement of the probe within the tissue. The set of 2D images is reconstructed instantaneously into a high-resolution 3D image for real-time manipulation and volume rendering. An advantage of 3D compared with the 2D mode is the opportunity to obtain sagittal, axial, coronal, and any desired oblique sectional image. The 3D image may be rotated, tilted, and sliced to allow the operator to vary infinitely the different section parameters, and to visualize and measure distance, area, angle, and volume in any plane. The 3D volume can also be archived for offline analysis on the ultrasonographic system or on a PC with the help of dedicated software [8].

6.2.3 Endoanal Ultrasonography

Endoanal ultrasonography (EAUS) is performed with the same probes adopted for EVUS [9]. During examination, the patient may be placed in a dorsal lithotomy, left lateral, or prone position. However, irrespective of patient position, the transducer should be rotated so that the anterior aspect of the anal canal is superior (12 o'clock position) on the screen, the right lateral aspect is to the left (9 o'clock), the left lateral aspect is to the right (3 o'clock), and the posterior aspect is inferior (6 o'clock). The recording of data should extend from the upper aspect of the PR muscle to the anal verge. The mechanical rotational transducer allows automatic 3D acquisition.

6.3 Ultrasonographic Anatomy

Evaluation of the complex anatomy and function of the pelvic floor may require more than one ultrasonographic modality. TPUS, EVUS, and EAUS may provide complementary information, and often multicompartmental scanning is needed to obtain a complete overview [3].

6.3.1 Pelvic Floor Structures

3D-EVUS performed with 360° field-of-view transducers provides a topographical overview of pelvic floor anatomy [8]. Four levels of assessment in the axial plane can be defined (Fig. 6.3). At the highest level (level I), the bladder base can be seen anteriorly and the inferior third of the rectum posteriorly. Level II corresponds to the bladder neck, the intramural region of the urethra, and the anorectal junction. Level III corresponds to the midurethra and

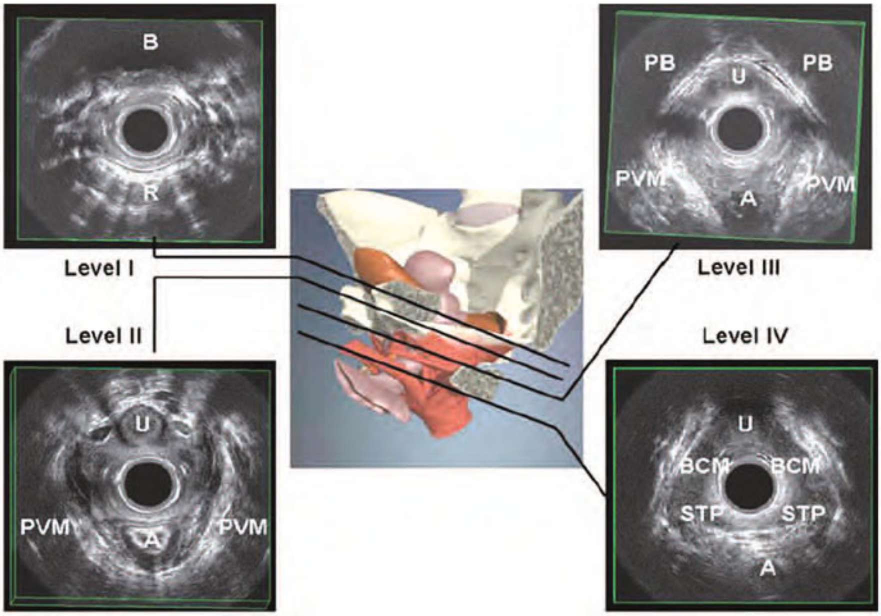

Fig. 6.3 Three-dimensional endovaginal ultrasonography. Four standard levels of assessment of the normal female pelvic floor: levels I–IV. *A,* anal canal; *B,* bladder; *BCM,* bulbocavernosus muscle; *PB,* pubic bone; *PVM,* pubovisceral muscle; *R,* rectum; *STP,* superficial transverse perinei muscle; *U,* urethra. (Reproduced from [10], with permission)

the upper third of the anal canal. At this level, the levator ani can be visualized as a multilayer hyperechoic sling coursing laterally to the vagina and posteriorly to the anal canal, and attaching to the inferior pubic rami anteriorly. Biometric indices of the levator hiatus can be measured [11]: (a) the anteroposterior diameter, from the inferior border of the symphysis pubis to the 6 o'clock inner margin of the levator ani; (b) the laterolateral diameter, measured at the widest part, perpendicular to the anteroposterior diameter; (c) and the area, calculated as the area within the levator ani inner perimeter enclosed by the inferior pubic rami and the inferior edge of the symphysis pubis. At the lowest level (level IV), the superficial perineal muscles (bulbospongiosus, ischiocavernosus, and superficial transverse perineal muscles), the perineal body, the distal urethra, and the middle and inferior thirds of the anal canal can be visualized. At this level, the anteroposterior diameter of the urogenital hiatus, corresponding to the symphysis pubis–perineal body distance, can be determined.

Pelvic organ descent is usually assessed with 2D-TPUS [6]. A midsagittal view, obtained with an acquisition angle of 70° or more, will include the symphysis pubis, the urethra and bladder, the vagina and uterus, the rectum, and the anal canal. Posterior to the anorectal junction, the PR muscle is visualized as a hyperechogenic structure (Fig. 6.1). 3D-TPUS provides the following additional information in the reconstructed axial plane [7] (Fig. 6.2): levator hiatus dimensions, determined in the plane of minimum anteroposterior dimensions; PR muscle dimensions, determined in the plane of maximum muscle thickness; qualitative assessment of the PR muscle and its insertion on the inferior pubic ramus. Biometric indices of the levator hiatus at rest determined in nulliparous women by Santoro et al. [11] using 3D-EVUS (anteroposterior diameter 4.84 cm, laterolateral diameter 3.28 cm, hiatal area 12 cm^2) were comparable to the results reported by Dietz et al. [7] using 3D-TPUS (anteroposterior diameter 4.52 cm, laterolateral diameter 3.75 cm, hiatal area 11.25 cm^2). The main advantage of external (transperineal) over internal (endovaginal) sonographic imaging of the levator ani is that maneuvers such as Valsalva and pelvic floor muscle contraction allow its functional assessment. Ballooning of the hiatus, i.e., excessive distensibility of the levator ani, is defined as an increase in hiatal area to > 25 cm^2 on Valsalva maneuver, and its visualization generally requires full development of pelvic organ prolapse (POP) [12]. Quantitative assessment of muscle trauma is greatly facilitated by tomographic ultrasound [13].

6.3.2 Anterior Compartment

Assessment of the anterior compartment is performed with 2D-TPUS [4] (Fig. 6.1). Measurements in the midsagittal plane, performed with the patient at rest or during functional maneuvers, include [14]: bladder wall thickness or detrusor wall thickness (normal value, up to 5 mm); postvoid residual bladder volume; bladder–symphysis distance, measured between the bladder neck and the lower margin of the symphysis pubis (this measurement enables assessment of the position and mobility of the bladder neck, using the difference between values obtained at rest and on Valsalva; there is no definition of 'normal' for bladder neck descent, although a cut-off of 25 mm has been proposed to define hypermobility); urethral length, measured from the bladder neck to the external urethral orifice; retrovesical angle, the angle between the posterior wall of the bladder and the longitudinal axis of the urethra (normal value, 90–120°); proximal urethral rotation (change in angle between proximal urethra and central symphyseal axis) on Valsalva; and descent of the most inferior aspect of a cystocele relative to the symphysis pubis.

6.3.3 Central Compartment

Assessment of the central compartment is performed with 2D-TPUS [4] (Fig. 6.1). In the midsagittal section, an unusually low cervix is isoechoic, its distal margin evident as a specular line, and it often causes acoustic shadowing. In the same section, it is possible to visualize the corpus uteri and determine whether it is enlarged, retroverted, or anteverted. Dynamic 2D-TPUS allows evaluation

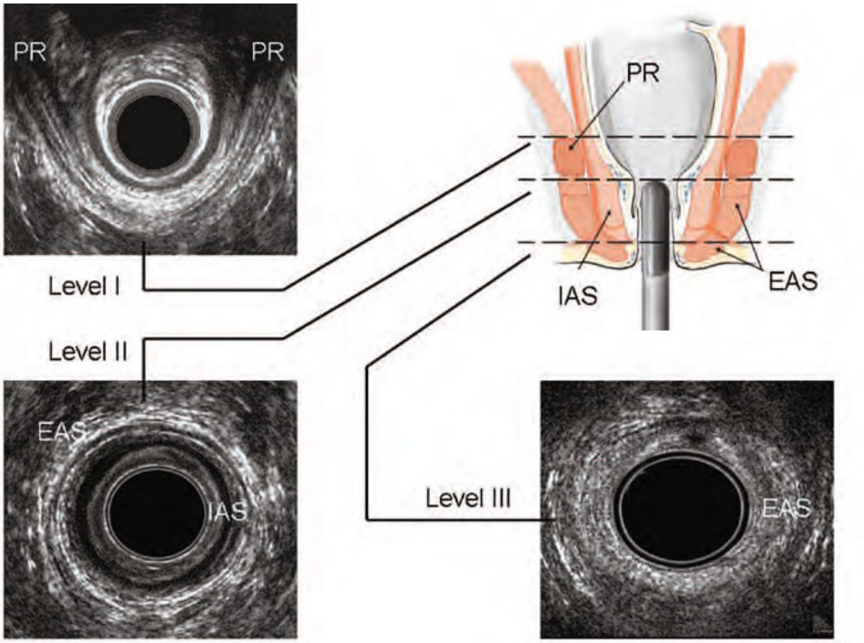

Fig. 6.4 Three-dimensional endoanal ultrasonography. Three standard levels of assessment of the normal anal canal: levels I–III. *EAS,* external anal sphincter; *IAS,* internal anal sphincter; *PR,* puborectalis muscle. (Reproduced from [10], with permission)

of uterine descent that may result in compression of the rectal ampulla, explaining symptoms of obstructed defecation. Imaging of vault descent is more difficult, because the vaginal wall is often obscured by a descending rectocele or enterocele.

6.3.4 Posterior Compartment

The anal canal is generally imaged by 3D-EAUS [9]. This method is firmly established as one of the cornerstones of a colorectal diagnostic work-up [15]. With EAUS, the anal canal is divided into three levels of assessment in the axial plane (Fig. 6.4). (1) The upper level corresponds to the hyperechoic sling of the PR muscle and the concentric hypoechoic ring of the internal anal sphincter (IAS). In males, the deep part of the external anal sphincter (EAS) is also identified at this level. (2) In the middle level, the complete ring of the superficial EAS (concentric band of mixed echogenicity), the conjoined longitudinal layer, the complete ring of the IAS and the transverse perinei muscles are visualized. (3) The lower level corresponds to the subcutaneous part of the EAS. 3D-EAUS is useful in assessing the anatomical characteristics of the anal canal [9]. The muscles of the lower and upper parts of the anal canal are different. At its upper end, the PR muscle anchors the sphincter complex to the pubic rami. Anteriorly, the circular fibers of the deep part of the EAS are not recognizable in females, whereas in males the EAS is symmetrical at all levels of the anal canal. The IAS is not completely symmetrical, either in thickness or at its distal end. It can be traced superiorly into the circular muscle of the rectum, extending from the anorectal junction to approximately 1 cm below the dentate line. In the intersphincteric space, the smooth longitudinal muscle conjoins with striated muscle fibers from the levator ani, particularly the puboanalis, and a large fibroelastic element derived from the endopelvic fascia to form the conjoined longitudinal layer.

6.4 Clinical Applications

6.4.1 Urinary Incontinence

Urinary incontinence has been defined by the International Urogynecology Association and the International Continence Society as 'involuntary loss of urine' [16]. This condition is exceptionally common, with more than 40% of women over the age of 40 years estimated to experience it. The most common types are: stress urinary incontinence (SUI), defined as involuntary loss of urine during increased abdominal pressure, thought to be due to a poorly functioning urethral sphincter muscle (intrinsic sphincter deficiency) or to hypermobility of the bladder neck or urethra; and urge urinary incontinence (UUI), defined as involuntary urinary leakage accompanied or immediately preceded by urgency, due to detrusor overactivity [16]. Ultrasonography can provide essential information in the management of SUI [5]. Tunn et al. [17] recommended measurement of the retrovesical angle with TPUS in patients with SUI. For quantitative evaluation of urethral mobility, Valsalva maneuver is preferable to the cough test. In patients with SUI or UUI, funneling of the internal urethral meatus may be observed on Valsalva and sometimes even at rest. Marked funneling has been shown to be associated with poor urethral closure pressures. TPUS allows comprehensive evaluation of many abnormalities of the female urethra, such as urethral diverticula, abscesses, tumors, and other urethral and paraurethral lesions [5].

Ultrasonography also allows evaluation of tapes used in anti-incontinence surgery, whose improper positioning or dislodgement may be associated with failed surgery (Fig. 6.5). Dietz et al. [18] performed 3D-TPUS to assess the effectiveness of suburethral slings (tension-free vaginal tape, intravaginal slingplasty, and suprapubic arch sling system). All three tapes were visualized by ultrasound and showed comparable short-term clinical and anatomical outcomes. Ultrasound is particularly useful in the assessment of postoperative voiding dysfunction. The minimum gap between implant and symphysis pubis on maximal Valsalva maneuver seems to be the single most useful parameter in the postoperative evaluation of suburethral tapes, as it is associated negatively

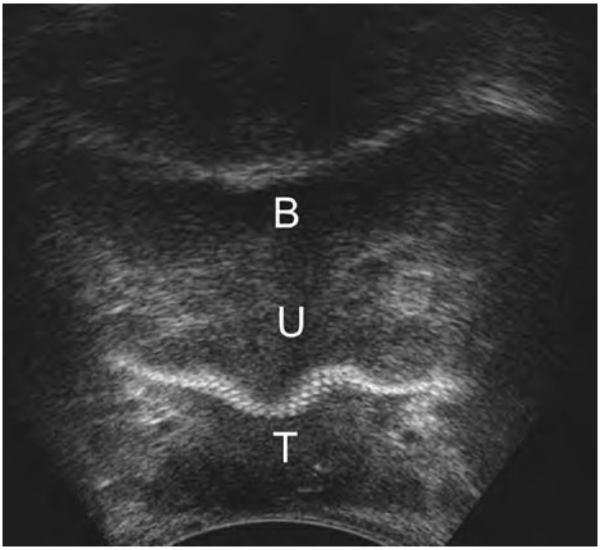

Fig. 6.5 Two-dimensional transperineal ultrasonography. Midurethra (*U*) tape (*T*). *B*, bladder

with voiding dysfunction and positively with both SUI and UUI. Occasionally, sonographic findings will suggest tape perforation (partial or complete), with the implant found within the rhabdosphincter muscle, or even crossing the urethral lumen. At times it is necessary to divide an obstructive tape, and ultrasound can help in locating the tape, as well as in confirming tape division postoperatively.

6.4.2 Fecal Incontinence

Fecal incontinence (FI) is defined as the involuntary loss of feces (liquid or solid stool), and anal incontinence is defined as the involuntary loss of flatus or feces [16]. Intact musculature, including the PR muscle, IAS, and EAS, is a prerequisite for fecal control, as is a functioning nerve supply to these muscles. Other factors contributing to continence include stool consistency, rectal sensitivity and capacity, and anorectal angle. Any impairment of one or more of these factors may result in FI. Anal sphincter defects and pudendal nerve damage occurring during vaginal delivery are by far the most common causes of FI, consequently making this problem more prevalent in women than men. In patients with FI, it is fundamental to establish the underlying pathophysiology in order to choose the appropriate therapy (e.g., dietary adjustments, medication, biofeedback, sphincter repair, artificial bowel sphincter, graciloplasty, sacral nerve stimulation, and injection of bulking agents) [19]. EAUS has become the gold standard for morphological assessment of the anal canal [15]. It can differentiate between incontinent patients with intact anal sphincters and those with sphincter lesions (defects, scarring, thinning, thickening, and atrophy) [9]. Tears

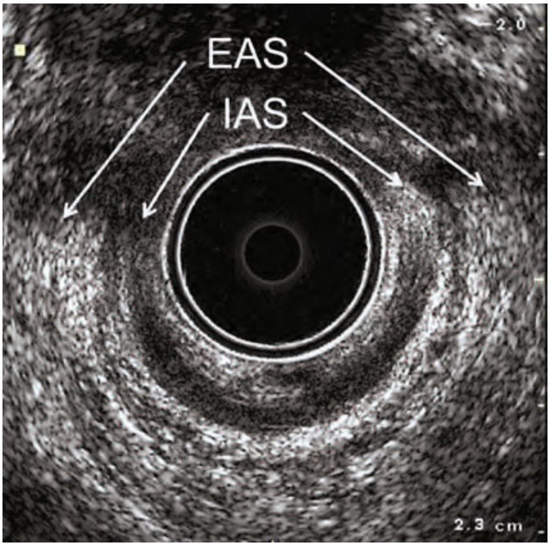

Fig. 6.6 Three-dimensional endoanal ultrasonography. Combined anterior damage of the external (*EAS*) and internal anal sphincters (*IAS*) from the 10 o'clock to the 2 o'clock position

are identified by interruption of the circumferential fibrillar echo texture (Fig. 6.6). Scarring is characterized by loss of normal architecture, with an area of amorphous texture that usually has low reflectivity. Two scoring systems have been proposed to define the severity of anal sphincter damage. Starck et al. [20] introduced a specific score, with 0 indicating no defect and 16 corresponding to a defect >180° involving the whole length and depth of both sphincters. Noderval et al. [21] described a simplified system for analyzing defects: the maximal score of 7 denotes defects in both the EAS and the IAS exceeding 90° in the axial plane and involving more than half of the length of each sphincter. The presence of a sphincter defect, however, does not necessarily mean that it is the cause of the FI, as many people have sphincter lesions without having symptoms of incontinence. On the other hand, patients with FI and an apparently intact sphincter may have muscle degeneration, atrophy, or pudendal neuropathy. Ultrasonography also allows evaluation of anti-incontinence surgery (sphincter repair, graciloplasty, bulking agent injection) [3].

6.4.3 Levator Ani Injuries

Levator avulsion is the disconnection of the muscle from its insertion on the inferior pubic ramus and the pelvic sidewall, whereas tears may occur in any part of the muscle. Avulsion is a common consequence of overstretching of the levator ani during the second stage of labor and occurs in 10–36% of women at the time of their first delivery [21]. 3D-EVUS and 3D-TPUS may be utilized to document major levator trauma [3, 12, 13] (Fig. 6.7). Defects are usually visualized most clearly on maximal pelvic floor muscle contraction.

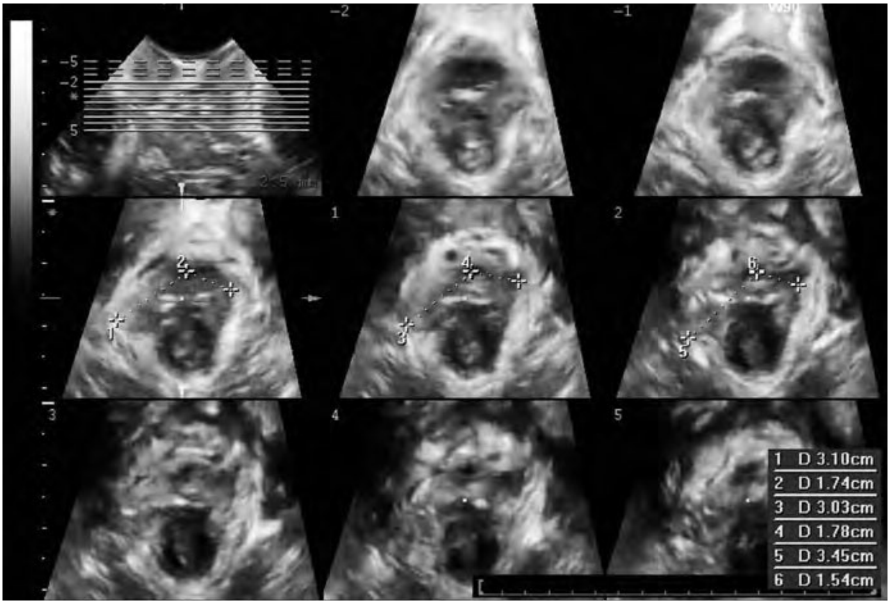

Fig. 6.7 Three-dimensional transperineal ultrasonography. Tomographic ultrasound, showing a right-side levator ani avulsion. (Reproduced from [10], with permission)

Tomographic ultrasound imaging is particularly useful [13]. The functional and anatomical consequences of levator ani avulsion are considerable, with a reduction in muscle strength of about one-third and marked alteration of anatomy. The main effect of avulsion is probably due to enlargement of the levator hiatus, but avulsion may also be a marker for other forms of trauma, such as damage to connective supporting structures (uterosacral ligaments and endopelvic and pubocervical fascia), which are currently difficult to detect by imaging [22]. An enlarged levator hiatus, whether congenital or due to irreversible overdistension or avulsion injury, may result in excessive loading of ligamentous and fascial structures, which may, over time, lead to connective tissue failure and the development of prolapse [22]. Patients with, compared with those without, a levator ani defect are 2.3 times more likely to have a significant cystocele, and four times as likely to have uterine prolapse. It seems that, compared with any of the other components of the levator ani, trauma to the PR component is most significant in affecting both the size of the hiatus and the symptoms and signs of prolapse.

6.4.4 Anterior Compartment Prolapse

Anterior compartment prolapse, or ‘cystocele’, is common in women and may cause symptoms such as pelvic heaviness, the sensation of a lump, and

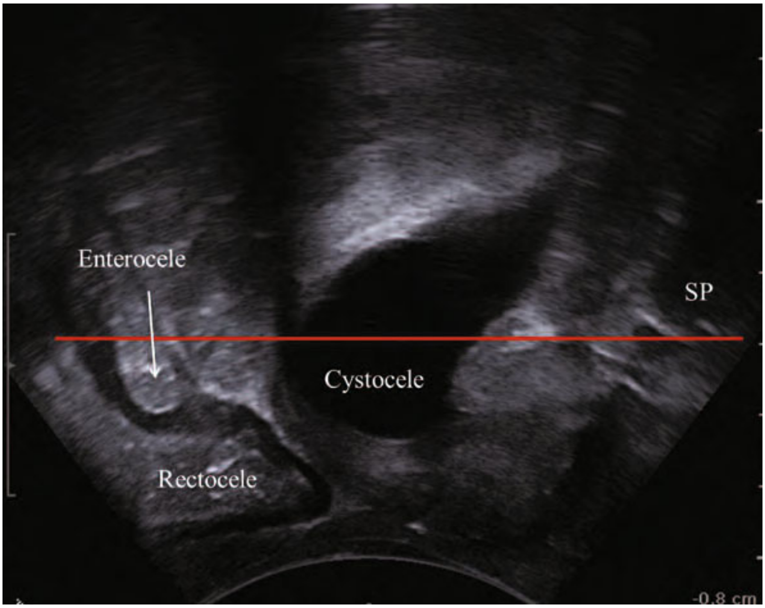

Fig. 6.8 Two-dimensional transperineal ultrasonography. Midsagittal view of multicompartmental prolapse, appearing as displacement of the pelvic organs below the referral line (*red line*, horizontal to the inferior margin of the symphysis pubis *SP*)

voiding difficulty. Cystocele frequently coexists with other disorders involving the central and the posterior compartments, such as uterine prolapse, rectocele, and enterocele [16]. Dynamic 2D-TPUS demonstrates downwards displacement of the urethra and the presence of cystocele in the midsagittal plane during maximal Valsalva maneuver [23] (Fig. 6.8). There are two basic types of cystocele: cystourethrocele, in which both bladder base and urethra form one smooth surface, and ultrasound shows an open retrovesical angle over 140° and isolated cystocele, in which the retrovesical angle remains intact and the lowermost point of the bladder is clearly below the bladder neck. Cystourethrocele is associated with SUI, while isolated cystocele is associated with symptoms of prolapse and with voiding dysfunction. Comparative studies have shown good correlation between TPUS and radiological methods [24].

Ultrasonography also allows evaluation of mesh implants for anterior compartment prolapse [3]. This is particularly useful considering that complications such as support failure, mesh erosion, and chronic pain are not uncommon. Polypropylene meshes are less visible on X-ray and magnetic resonance imaging, but highly echogenic. Sonographic imaging can determine the position, extent, and mobility of implants, helping with the assessment of surgical techniques and determination of functional outcome. Mesh may be visualized in the anterior vaginal wall, dorsal to the trigone and posterior bladder wall.

3D-TPUS has demonstrated that often the implanted mesh is nowhere near as wide as it is supposed to be, and this finding has been interpreted as evidence of mesh shrinkage, ‘contraction’, or ‘retraction’. A more likely explanation is that the mesh did not remain flat but folded up on itself, either during the implantation process or immediately after closure. Surgical technique seems to play a role, since fixation of mesh to underlying tissues results in a flatter, more even appearance. Moreover, ultrasonography may uncover complications such as dislodgement of anchoring arms [3].

6.4.5 Middle Compartment Prolapse

Uterine prolapse is defined as downwards displacement of the uterus beyond the halfway point of the vagina. Vaginal vault prolapse refers to descent of the vaginal apex in a patient who has had a hysterectomy, and is commonly associated with enterocele or sigmoidocele. Continued descent of the apex of the vagina may result in complete eversion of the vagina [16]. These conditions are usually obvious clinically, but dynamic 2D-TPUS can demonstrate the effect of the descending uterus on the bladder neck, urethra, or anorectum, explaining symptoms of voiding dysfunction or obstructed defecation [23].

6.4.6 Posterior Compartment Prolapse

Posterior compartment prolapse includes rectocele, rectal intussusception, rectal prolapse, enterocele, and perineal descent [16]. Symptoms that can be related to these disorders include obstructed defecation, such as incomplete evacuation, straining at stool and vaginal digitation [16]. Several modalities have been employed to identify and quantify posterior compartment prolapses. To date, defecography has been the gold standard for evaluation of this condition. However, dynamic TPUS has been shown to demonstrate rectocele, enterocele, and rectal intussusception with images comparable with those of defecography [6]. Rectocele is measured as the maximal depth of the protrusion beyond the expected margin of the normal anterior rectal wall (Fig. 6.8). On radiological imaging, a depth of < 2 cm is considered within normal limits; rectocele should be considered moderate if the depth is 2–4 cm, and large if it is > 4 cm. On sonographic imaging, a herniation of a depth of over 10 mm has been considered diagnostic [6]. Rectal intussusception may be detected as an invagination of the rectal wall into the rectal lumen during maximal Valsalva maneuver. The intussusception may also be observed to enter the anal canal or be exteriorized beyond the anal canal [6]. Enterocele is diagnosed ultrasonographically as a herniation of bowel loops into the vagina (Fig. 6.8). It can be graded as: small, when the most distal part descends into the upper third of the vagina; moderate, when it descends into the middle third of the vagina; or large, when it descends into the lower third of the vagina [6].

Enterocele may also coexist with rectocele. A comparative clinical study found poor agreement between defecation proctography and TPUS in the measurement of quantitative parameters. However, when ultrasound imaging revealed a rectocele or rectal intussusception, there was high likelihood of this diagnosis being confirmed on proctography [6]. Other studies have shown better agreement between sonographic and radiological assessment. Steensma et al. [25] reported good agreement between 3D-TPUS and defecography for detecting enterocele. On the other hand, other studies have suggested that defecography overdiagnoses these abnormalities. Perniola et al. [26] suggested that ultrasonography should not replace defecography in clinical practice, but that it should be performed as an initial examination or screening method in patients with defecatory disorders.

A new ultrasonographic technique (echodefecography, EDF) to evaluate posterior compartment prolapses has been developed by Murad-Regadas et al. [27, 28]. This is a 3D dynamic anorectal ultrasonographic modality performed with the same 360° rotating transducer used for EAUS. The standardization of the technique, parameters, and values of EDF makes the method reproducible [28]. EDF was shown to correlate well with conventional defecography and was validated in a prospective multicenter study [28]. Following rectal enema, patients are examined in the left lateral position. Images are acquired by four automatic scans and analyzed in the axial, sagittal, and, if necessary, in the oblique plane. Scan 1 (at rest position without gel): the transducer is positioned at 5.0–6.0 cm from the anal margin. It is performed to visualize the anatomic integrity of the anal sphincter musculature and to evaluate the position of the PR and EAS at rest. The angle formed between a line traced along the internal border of the EAS/PR (1.5 cm) and a line traced perpendicular to the axis of the anal canal is measured. Scan 2 (at rest–straining–at rest without gel): the transducer is positioned at 6.0 cm from the anal verge. The patient is requested to rest for the first 15 s, strain maximally for 20 s, then relax again, with the transducer following the movement. The purpose of the scan is to evaluate the movement of the PR and EAS during straining, identifying normal relaxation, nonrelaxation or paradoxical contraction (anismus). The resulting EAS/PR positions (represented by the angle size) are compared between scans 1 and 2. Normal relaxation is recorded if the angle increases by a minimum of 1°, whereas paradoxical contraction (anismus) is recorded if the angle decreases by a minimum of 1°. Nonrelaxation is recorded if the angle changes less than 1° (Figs. 6.9 and 6.10); Scan 3: the transducer is positioned proximally to the PR (anorectal junction). The scan starts with the patient at rest (3.0 s), followed by maximum straining with the transducer in fixed position (the transducer does not follow the descending muscles of the pelvic floor). When the PR becomes visible distally, the scan is stopped. Perineal descent is quantified by measuring the distance between the position of the proximal border of the PR at rest and the point to which it has been displaced by maximum straining (PR descent). Straining time is directly proportional to the distance of perineal descent. Even with patients in the lateral position, the

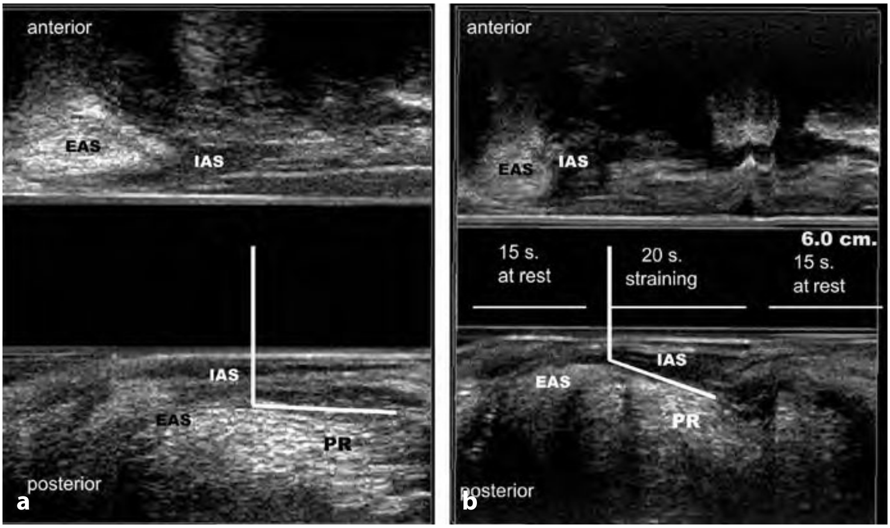

Fig. 6.9 Three-dimensional echodefecography. Sagittal plane: **a** angle measured at rest position (*lines*), **b** increased angle (normal relaxation) during straining (*lines*). *EAS*, external anal sphincter; *IAS*, internal anal sphincter; *PR*, puborectalis muscle

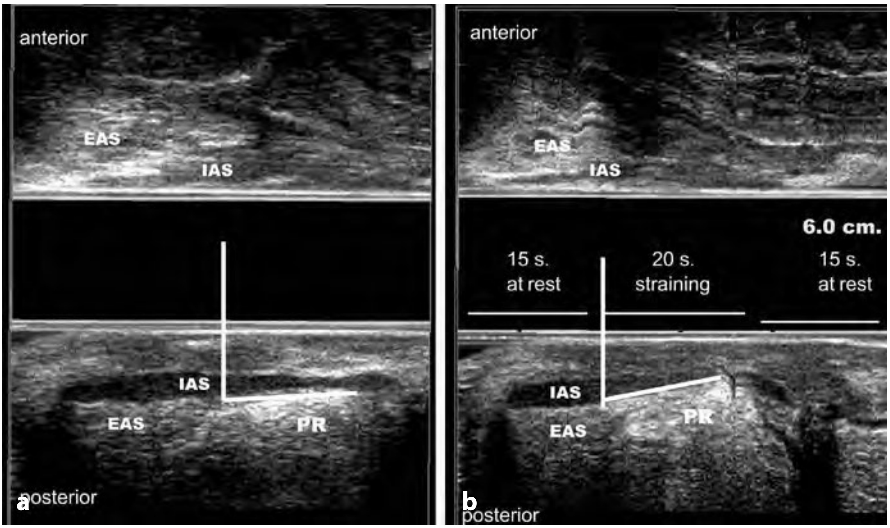

Fig. 6.10 Three-dimensional echodefecography. Sagittal plane: **a** angle measured at rest position (*lines*), **b** decreased angle (anismus) during straining (*lines*). *EAS*, external anal sphincter; *IAS*, internal anal sphincter; *PR*, puborectalis muscle

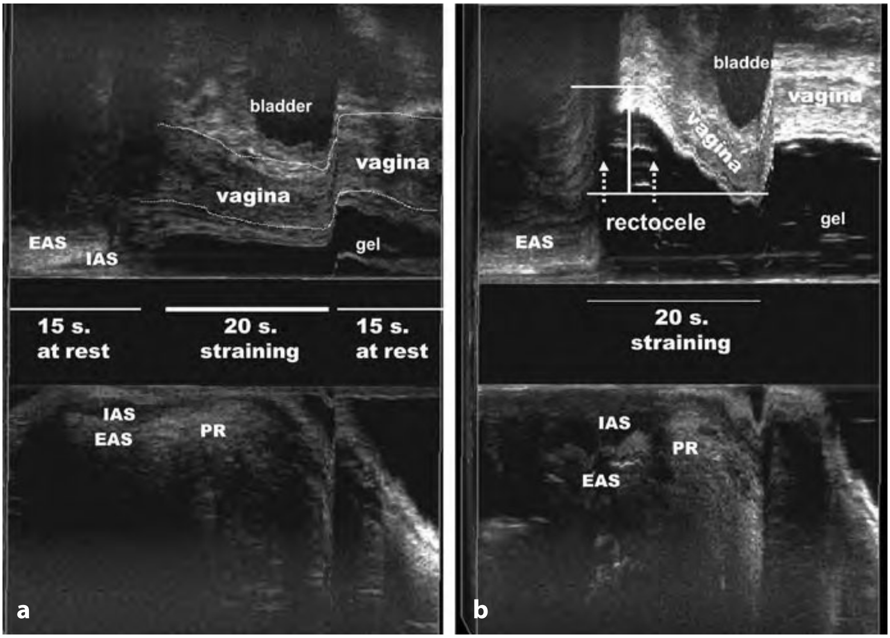

Fig. 6.11 Three-dimensional echodefecography using gel into the rectum. Sagittal plane: **a** patient without rectocele, **b** grade III rectocele (*arrows*). *EAS*, external anal sphincter; *IAS* internal anal sphincter; *PR,* puborectalis muscle

displacement of the PR is easily visualized and quantified. On EDF, normal perineal descent during straining is defined as a difference in PR position of ≤ 2.5 cm and perineal descent > 2.5 cm. The normal range values were established by comparing EDF with defecography [29]. Scan 4: following injection of 120–180 mL ultrasound gel into the rectal ampulla, the transducer is positioned at 7.0 cm from the anal verge. The scanning sequence is the same as in scan 2 (at rest for 15 s, strain maximally for 20 s, then relax again, with the transducer following the movement). The purpose of the scan is to visualize and quantify all anatomical structures and functional changes associated with voiding (rectocele, intussusception, grade II or III sigmoidocele/enterocele). In normal patients, the posterior vaginal wall displaces the lower rectum and upper anal canal inferiorly and posteriorly, but maintains a straight horizontal position during defecatory effort. If rectocele is identified, it is classified as grade I (< 6.0 mm), grade II (6.0–13.0 mm), or grade III (> 13.0 mm) (Fig. 6.11). Measurements are calculated by first drawing two parallel horizontal lines along the posterior vaginal wall, with one line placed in the initial straining position, and the other line drawn at the point of maximal straining. The distance between the two vaginal wall positions determines the size of the rectocele. Intussusception is clearly identified by observing the rectal wall layers protruding through the rectal lumen. No classification is used to quantify

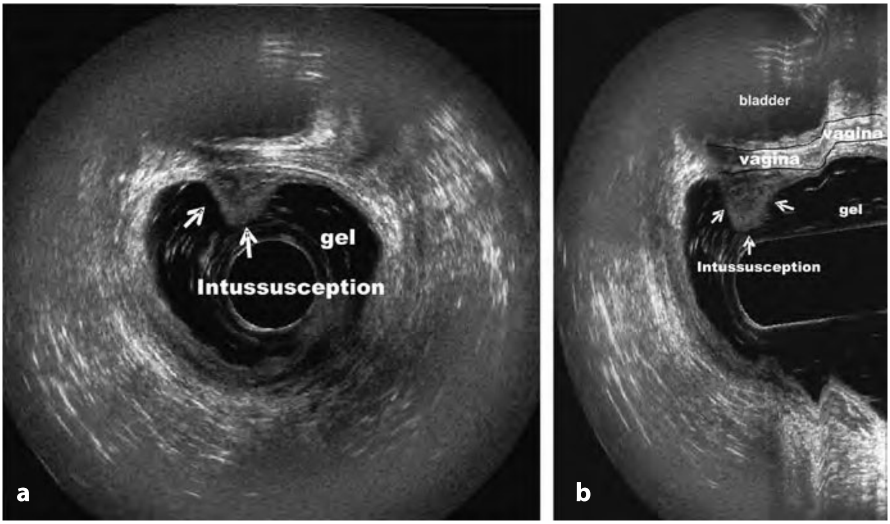

Fig. 6.12 Three-dimensional echodefecography using gel into the rectum. **a** Axial plane: anterior intussusception (*arrows*), **b** Sagittal with coronal plane: without rectocele and anterior intussusceptions (*arrows*)

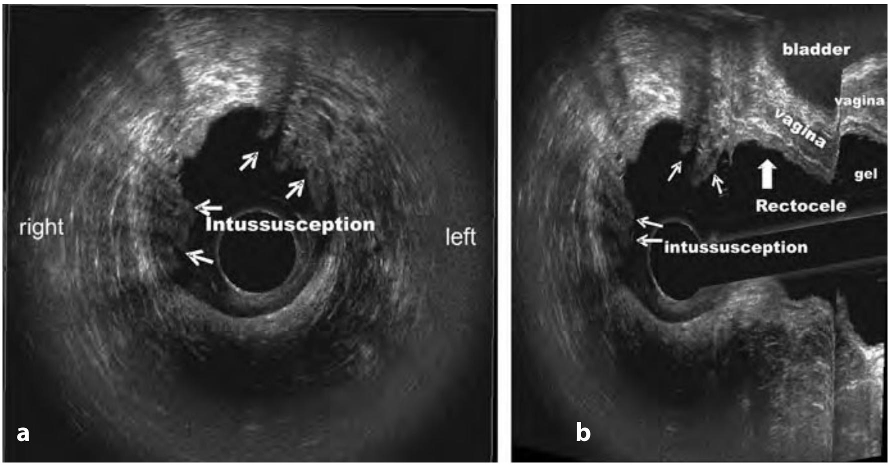

Fig. 6.13 Three-dimensional echodefecography using gel into the rectum. **a** Axial plane: anterior and right-side intussusceptions (*arrows*). **b** Sagittal with coronal plane: grade II rectocele and anterior and right side intussusceptions (*arrows*)

intussusceptions (Figs. 6.12 and 6.13). Grade II or III sigmoidocele/enterocele is recognized when the bowel is positioned below the pubococcygeal line (on the projection of the lower rectum and upper anal canal).

6.4.6 Pelvic Floor Dyssynergia

Pelvic floor dyssynergia, also known as anismus, spastic pelvic floor syndrome, or paradoxical PR syndrome, is a phenomenon characterized by a lack of normal relaxation of the PR muscle during defecation [30]. However, an involuntary (reflex) contraction of the levator ani is common, especially in young nulliparae, and it is thought to be part of a generalized defensive reflex, implying that false-positive findings in asymptomatic women may well be common in stressful clinical settings. Dyssynergia is associated with symptoms of obstructed defecation and incomplete emptying. The diagnosis of dyssynergia may be suggested by tests of anorectal physiology (electromyography and manometry); however, proctography and dynamic magentic resonance defecography have an important diagnostic role [30]. Various radiological abnormalities have been described, including prominent puborectal impression and acute anorectal angulation during straining and defecation. Dynamic TPUS may also have a role in documenting pelvic floor dyssynergia [3]. During Valsalva maneuver, the anorectal angle becomes narrower, the levator hiatus is shortened in the anteroposterior dimension, and the PR muscle thickens as a result of contraction. This sonographic finding may help to choose biofeedback therapy and in evaluating the results after treatment.

6.5 Discussion

The ultrasonographic multimodalities (EVUS, EAUS, TPUS, and EDF) integrated approach to the pelvic floor provides an accurate anatomical assessment of patients with UI, FI, and POP [3]. Division into anterior, middle, and posterior compartments has led to fragmentation of assessment: the anterior compartment containing the urethra and bladder has been the realm of the urologist and urogynecologist, who use TPUS as their modality of choice for scanning; the middle compartment containing the uterus and reproductive organs has been the domain of gynecologists, who use mainly EVUS for assessment; and the posterior compartment containing the small and large bowels and the anorectum belonged to the colorectal surgeons, who prefer EAUS and EDF [16]. This artificial division of the pelvis fails to recognize the close anatomical relationship of these compartments. Dysfunction of one of the compartments influences the structure and function of another. For this reason imaging should evolve from assessment involving a single compartment, with the inherent limitations, to an "integrated approach" for multicompartmental evaluation [3].

Combining different modalities has the potential to complement the advantages, overcome the limitations of each of these tools, and substantially improve the clinical management of pelvic floor disorders (PFDs). Care of women with PFDs begins with an understanding of the unique musculofascial system that supports the pelvic organs. The principles underlying reconstructive surgery are either restoration of normal anatomy and thereby a presumed return to normal function, or creation of compensatory anatomical mechanisms [1]. To date, decisions have been based on clinical assessment, which has a limited role in evaluating the morphological changes leading to PFD. Obstructed defecation, FI, UI, and voiding dysfunction are frequently concurrent issues in patients with POP, suggesting a more widespread PFD affecting both support and sphincter function, and requiring more specific investigation. Moreover, it is often unclear as to whether, or to what degree, given symptoms are related to the degree of prolapse [1]. It is, therefore, important to make an accurate preoperative assessment, yet there is controversy concerning the role of diagnostic testing in selecting treatment for PFD. Several studies have looked specifically at the clinical utility of imaging investigations, with varying results [31, 32]. The greatest utility of ultrasonography in patients with POP is to identify not just the clinical manifestation (cystocele, uterine prolapse, rectocele, or enterocele) but the underlying anatomical and functional abnormalities of the pelvic floor muscles and connective tissues. Levator ani damage, avulsion defects, abnormal levator ani contractility, pathologically enlarged levator hiatus (ballooning), and anal sphincter lesions may be diagnosed on TPUS, EVUS, and EAUS [3]. Ultrasonography also has the advantage of enabling evaluation of function of the pelvic floor with various dynamic maneuvers. Perniola et al. [26] suggested that ultrasonography should be performed as an initial examination in patients with defecatory disorders. Positive findings on ultrasound may avoid more invasive tests, whereas negative findings require confirmation by defecation proctography. In patients with UI, ultrasonography can provide useful information on the anatomy and function of the lower urinary tract. Urethral mobility, urethral vascularity, funneling of the internal urethral meatus, bladder neck descent, and bladder wall thickness may be evaluated on TPUS [4, 5]. In addition, ultrasonography allows evaluation of anti-incontinence procedures and helps in understanding their failure. In patients with FI, EAUS has been recommended by the International Urogynecological Association/International Continence Society joint report as the gold standard investigation to identify anal sphincter injury [16].

In conclusion, the goal of pelvic surgery is to relieve patient symptoms and to restore anatomy and function whenever possible. There is no doubt that the additional knowledge gained from multicompartmental ultrasonography of the pelvic floor, with a systematic "integrated" approach, will improve our chances of actually reaching this goal. Imaging findings are already leading to either modification or a choice of specific operative procedures, and current research is being directed toward the impact of imaging on patient outcomes, in both the short and the long term.

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Functional Assessment of Anorectal Function

7

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7.1 Introduction

Disorders of the posterior compartment of the pelvic floor are essentially represented by disorders of defecation, fecal incontinence, and constipation. Their functional assessment includes the evaluation of their severity, their impact on quality of life (QoL), and their etiology, by means of medical history, and clinical and instrumental examinations of the perineum and the anorectum.

7.2 Anorectal Function: Definitions

Fecal incontinence (FI) is defined as the loss of control of the passage of gas and/or stools through the anus (passive incontinence) or the inability to defer the call to defecate to a socially acceptable time and place, resulting in the release of gas, liquid, or solid stool (urge incontinence) [1].

Constipation is defined as infrequent defecation, difficult defecation, or both [2]. Two main mechanisms have been hypothesized as causes of constipation: slow transit in the colon and difficulty in expelling feces. Slow transit can be primary (idiopathic) or secondary, which is the result of low fiber intake, use of drugs such as opioids, or endocrine, metabolic, neurological, or behavioral disorders. Obstructed defecation syndrome can result from functional disorders (pelvic floor muscle dyssynergia, rectal hyposensitivity, and hypomotility) or from anatomical abnormalities during defecation (rectocele, intussusception, mucosa prolapse, descending perineum).

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7.3 Clinical Features

In patients with FI or constipation, the duration, the nature of the leakage, and the impact on QoL, and also the presence of other conditions such as diabetes mellitus, spinal cord injury, pelvic radiation, vaginal deliveries, and co-existing urinary incontinence should be assessed. The medical history of the patient should be taken to try to establish the most likely cause of FI and constipation. Previous conservative, pharmacological, and surgical therapies should be investigated.

7.4 Scoring Systems

Assessment of the severity of FI and constipation can help to evaluate the effects of therapy and it is essential in the choice of treatment.

One of the oldest scoring sytems for FI was designed by Pescatori et al., who assigned different scores according to the type (flatus/mucus, liquid stool, or solid stools), and frequency of FI [3].

Jorge and Wexner [4], from the Cleveland Clinic, Florida, described the most commonly used score, which introduced alteration of lifestyle items, and Vaizey et al. [5], from St Mark's Hospital, London, UK, further modified this score by adding the evaluation of urgency. Another well-designed score was proposed by Wong: the American Medical System (AMS) score [6], which assigns a score to any clinical severe condition of the problem and considers the impact on the QoL.

The specific impact of FI on QoL can be assessed by the Fecal Incontinence Quality of Life Scale (FIQL), which was designed and validated by Rockwood and colleagues [7]. It is composed of 29 items, comprising four areas: lifestyle, coping/behavior, depression/self-perception, and embarrassment, which are used to evaluate each aspect of the disorder. The use of other generic scores of QoL, such the SF-36 score, is now discouraged because of their low sensitivity for this clinical condition.

Several scoring systems have been developed to quantify the severity of constipation. The most widely adopted for chronic constipation is the Cleveland Clinic Constipation Score by Agachan and colleagues [8]. It is easy to understand and administer and therefore is well accepted, although it has never been formally validated. It consists of eight items scored from 0 to 4, with a maximum score of 30; however, one of the items, "duration of symptoms", cannot be modified by therapy. Recently the Constipation Severity Instrument (CSI) [9] was developed, and includes 78 items that can identify and quantify different types of constipation (irritable bowel syndrome, slow transit, and obstructed defecation).

The first specifically designed score for obstructed defecation syndrome was published and prospectively validated in 2008. It consists of seven items scored from 0 to 4, with a maximum score of 27 [10].

7.5 Clinical Examination

A thorough physical examination is essential to assess the general state of the patient (body mass index, dexterity, and mobility), abdominal masses, bladder distention, and surgical scars. Examination of the perineum and external genitalia is of great importance in determining the presence of vaginal prolapse, prolapsed hemorrhoids, dermatitis, skin excoriations, perianal greases, or gaping anus. A digital rectal examination allows evaluation of the resting sphincter tone, the length of the anal canal, the strength of the puborectalis sling, the acuteness of the anorectal angle, the strength of the anal sphincter squeeze, and the presence of rectocele and impacted stools. The sensitivity of the perianal skin and the integrity of the anocutaneous reflex can be assessed rubbing a cotton bud on each quadrant of perineal skin, while the presence of descending perineum or rectal prolapse can be demonstrated by asking the patient to attempt defecation. A simple device (the perineometer) was designed at St Mark’s Hospital to quantify the perineal descensus with a clinical evaluation instead of an X-ray examination, but the device has not produced commercially.

A clinical examination in patients with obstructed defecation should also include an anoscopy, which can demonstrate a mucosal intussusception while the patient is pushing.

7.6 Balloon Expulsion Test

This easy and practical test gives qualitative information reagarding the ability of a patient to retain or expel feces, which might be related to FI or constipation caused by pelvic floor dyssynergia. The test lasts a few minutes and consists of the introduction of an inflatable balloon into the rectum, with the patient being asked to expel it while the operator uses moderate traction to remove the balloon. Patients with pelvic floor dyssynergia have difficulty in performing this maneuver because of anismus or the opposing contraction of the anal sphincters, while those with FI cannot retain the balloon during the external traction by the operator because of the damaged anal sphincters.

An attempt to quantify the outcome of this test was produced by Dodi (Fig. 7.1), who designed a solid sphere connected to an external digital dynamometer. Using this device, the resistance offered by the anal sphincter to the removal of the sphere from the rectum is measured in dynes.

7.7 Anorectal Manometry and Sensory Tests

Anorectal manometry consists of the measurement of pressure in the anal canal and the rectal ampulla, and it is useful as a diagnostic tool in patients with FI and outlet obstruction due to pelvic floor dyssynergy, to help understand the pathophysiology of the patients’ symptoms. The measurement of the

Fig. 7.1 Solid sphere expulsion test device

pressures in the anorectal tract can be performed using various techniques that differ in the type of probe used (water–perfused probe, solid-state probe, microtransducer probe) and the mode of detection.

The pressure detectors can be placed longitudinally, helically, or radially on the probe. At the end of the probe there is a latex balloon placed in the rectum, which is inflated with air or water, mimicking the presence of feces in the rectum. This allows the patient to evoke the rectoanal inhibitor reflex, to determine the compliance and sensitivity of the rectum.

Water-perfused probes are connected to a low-compliance water infusion system, and to a water-filled pressure transducer, linked to a digital multichannel recorder. The pressure is converted to mmHg.

Solid-state probes are directly connected to a pressure transducer, linked to multichannel recorder. This method is more practical, fast, and reliable than water-perfused systems, but more expensive; the pressure is expressed in mmHg.

The rectum must be prepared with a hypertonic phosphate enema (130 cm^3) 2 h before the manometry examination, and the patient is placed in a left lateral decubitus position, with legs bent at 90° and superimposed on the trunk (Sims' position). The probe is positioned with all solid state sensors or open-tips in the rectal ampulla and retracted with a rapid pull-through technique using an automatic retractor or with a stationary pull-through technique, in which the probe is stopped for 20 s every 5 mm, allowing to the operator to obtain the pressure profile of the anal canal. In the assessment of voluntary functions, the sensors should be placed all along the anal canal. In the study of reflexes, anorectal sensitivity and compliance, the probe is positioned with the end of the balloon 8–10 cm from the anal margin.

The parameters that are usually considered to have clinical utility are described in the following sections [11].

7.7.1 Resting Anal Pressure

This is mainly influenced by the tone of the internal anal sphincter (IAS). High anal pressure has been observed in patients with anal fissures or anal pain. Pressure reduction, occurring as lone symptom, is usually present in patients with incontinence, but measurements have low specificity and sensitivity.

7.7.2 Squeezing Anal Pressure

This is expressed in peak size and duration, and is produced by the contraction of external anal sphincter (EAS), with possible contributions by the accessory muscles of the perineum (puborectalis and gluteus). A decrease in peak pressure is caused by a weak EAS and may be myogenic (usually iatrogenic or obstetric) or neurogenic. A decrease in duration of squeeze (< 45 s) may indicate pudendal nerve damage.

7.7.3 Rectoanal Inhibitory Reflex

The distention of the rectum elicits an intrinsic reflex (i.e., via the myoenteric plexus) that produces a relaxation of the IAS. This reflex can be elicited by inflating a rectal balloon with 20–40 mL of air. Absence of the reflex is pathognomonic of Hirschsprung's disease, and is also found in patients after low rectal resection and coloanal anastomosis, when it can disappear.

7.7.4 Cough Reflex

An intra-abdominal pressure increment induces a reflex contraction of the EAS. This parameter is particularly useful in cases of damage of the EAS, resulting in muscular weakness. It can be used to evaluate possible damage to the sacral reflex arc. In patients with lesion of the sacral reflex arc, the contraction of EAS has a lower peak size and duration; in subjects with spinal cord injury above the sacral level, the cough reflex is preserved.

7.7.5 Canal Pressure in Response to Defecatory Attempts

This maneuver determines an inhibition of the EAS. The failure to inhibit the tone of EAS or even its paradoxical contraction is typical of pelvic floor dyssynergia.

7.7.6 Compliance of the Rectum and Sensory Thresholds in Response to Balloon Distention

Rectal compliance is expressed by the pressure/volume ratio during continuous rectal distention obtained by using an inflatable low-compliance balloon. It is influenced by the size of the rectum, the tone of the rectal wall muscles, the elastic properties of the rectum, the integrity of parasympathetic innervations, and the mobility of the pelvic organs, which may limit rectal distention. A normal range of value has never been determined; in our laboratory a normal range is said to be between 2 and 15.

During progressive rectal distention, the sensitivity of the rectal ampulla can be evaluated by asking the patient about his first sensation of rectal distention (threshold of rectal sensitivity), his desire to defecate (threshold of the stimulus to defecate), and pain or impending desire to defecate (maximum tolerable volume). Some authors consider that the sensitive threshold measurement is a suitable test for the identification of patients with rectal hyposensitivity in cases of constipation. In contrast, hypersensitivity can be present in cases of fecal urge incontinence.

7.7.7 Vector Anal Manometry

A more sophisticated application of anal manometry is vector anal manometry, which shows the pressure profile in the anal canal in three dimensions. The methodology requires dedicated software, with automatic retraction of a microtip probe. Vector anal manometry can best assess the asymmetry of the anal pressure in cases of anal sphincter damages, in both resting and squeezing states [12].

7.8 Electromyography

Electromyography (EMG) of the anal sphincter is a neurophysiological examination used to identify the presence and the characteristics of myoelectric activity in the anal sphincters and levator ani. This investigation has lost its importance in the functional assessment of anorectal function because mapping the anal sphincters (IAS and EAS) by EMG, which is aimed at identifying sphincter injury (scar), is now performed by endoanal ultrasound, and because the diagnosis of acute or chronic denervation or re-innervation potentials indicating a pudendal neuropathy have been found to have no prognostic implications. EMG can be performed by three different types of electrode: concentric needle electrode, single fiber electrode, or surface electrode. In routine diagnosis, needle electrodes are used (these are more accurate than surface electrodes).

The standard technique applied with a concentric needle electrode consists of introducing the electrode into each quadrant of the EAS. Introducing the electrode at a greater depth enables study of the puborectalis muscle. Use of an intramuscular needle can identify the electrical activity of the membrane potential in the muscle fibers.

EMG enables measurement of motor unit action potentials, both at rest and during voluntary and reflex activity. This provides qualitative and quantitative assessment of muscle fiber innervation, and also highlights states of acute or chronic denervation, total or partial re-innervation, as well as providing an assessment of the functional capacity of the motor unit.

During voluntary contraction there is an increase in the number of motor unit action potentials; however, during straining there is inhibition of the pathway.

Anal EMG is currently less utilized than in the past; in fact it has been replaced by anal endosonography in patients with incontinence. On the other hand, anal EMG can still be useful for identifying a primary or secondary myogenic disease or motor neuron disease in incontinent patients.

Fibrillation potentials and high-frequency spontaneous discharges indicate denervation, as in cases of cauda equine syndrome or pudendal nerve injury. This investigation is now obsolete.

7.9 Pudendal Nerve Terminal Motor Latency

The neurophysiological study of the pelvic floor is completed with determination of pudendal nerve terminal motor latency (PNTML), which is easily performed by the 'St Mark's Hospital' electrode [13]. This is mounted on the finger of the examiner's glove, and is used to measure the conduction time (terminal motor latency) of the distal part of the pudendal innervation of the EAS, on each side of its circumference (right and left). Electrical stimulation is applied by the tip of the electrode directly on to the pudendal nerve, which is identified in the ischial spine. The EAS contraction induced by the stimulus is recorded by the zone located at the base of the finger, and the latency time from the stimulus to the start of the contraction is calculated, with normal values at approximately 2 ± 0.2 ms.

PNTML is used as a complementary technique in patients with FI, chronic pelvic pain, and rectal prolapse.

7.10 Motor-evoked Potentials

Motor-evoked potentials are produced by an electric current discharged through a conducting coil, with the production of a magnetic flux, which stimulates the neural tissue. The stimulation of the lumbosacral nerve and the measurement of the conduction time through the cauda equina are used to diagnose sacral motor radiculopathy. Tantiphlachiva and colleagues [14] demonstrated that translumbar and transacral motor-evoked potentials could be used to assess anorectal neuropathy in patients with FI.

7.11 Transanal Endosonography

An ultrasound examination of the rectum by a 360° rotating three-dimensional probe is currently the best technique for investigating the integrity of the anal sphincters, the rectal wall, and the puborectalis muscles in patients with FI. The procedure is fast, safe, and painless, with high reliability [15].

7.12 Dynamic Transperineal Ultrasound

This new noninvasive, no-risk procedure is gaining wide acceptance among radiologists and coloproctologists involved in the functional evaluation of the pelvic floor, but it is still rarely used, probably because of the great amount of operator experience that is required.

Sagittal and transverse transperineal ultrasound imaging has been shown to be able to define the infra-elevator viscera, soft tissues, and margins of the puborectalis muscle. Dynamic measurements are also possible of the extent of puborectalis shortening, the anorectal angle, and the movement of the anorectal junction during straining, but, most interestingly this ultrasound technique can also identify the presence of rectoceles, and calculate the posterior urethrovesical angle, and the movement of the urethra–bladder junction [16]. Transverse images of the anal sphincter are comparable with those obtained using endoanal ultrasonography, and sagittal images can be used for measuring puborectalis contraction and anorectal angle; results of these measurements have been shown to be equivalent to those obtained during defecography. Rectoceles, enteroceles, and rectoanal intussusception can be clearly identified and measured during the dynamic part of the examination, although the rectum cannot be emptied and defecation completed.

7.13 Dynamic Defecography

Dynamic defecography, or evacuation proctography, is an X-ray examination that shows the dynamic changes of the rectum and anal canal during defecation of an artificial radiopaque stool. This test is used to evaluate disorders of the lower bowel that are not evident by colonoscopy or sigmoidoscopy, and to confirm and quantify a diagnosis of rectal intussusception, rectal prolapse, rectocele, dyssynergia, or anismus. Used in association with a bladder X-ray contrast agent, this investigation can help in the evaluation of a cystocele and urinary incontinence/retention in women. The oral administration of 50 mL barium sulfate solution about 1 h before the defecography procedure can be used to help recognize an enterocele in women. Alternatively, the contrast medium (usually about 250–350 mL barium sulfate solution mixed with some gelling agents) is introduced through the anus and vagina, and the patient is then invited to evacuate the artificial stools while sitting on a radiotransparent commode. The examination is digitally recorded on a DVD.

A static proctogram usually precedes the dynamic evaluation of the rectal emptying in order to evaluate the width and changes of the anorectal angle, changes in puborectalis length, and descent of the pelvic floor.

7.14 Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a very good method for evaluating the EAS and its abnormalities. Dynamic MRI defecography [17] produces better delineation of the pelvic anatomy and the surrounding organs, compared with traditional defecography; however, the position of the patient during the attempt to defecate is unnatural (standing-like position) and this may prevent full evaluation of the defecatory function. Open MRI can partially overcome this drawback, but its availability is still very limited. Furthermore, the current cost of the procedure prevents widespread use of this procedure.

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Part III

Clinical Syndromes

Fecal Incontinence

8

Carlo Ratto, Angelo Parello, Lorenza Donisi, Francesco Litta, Veronica De Simone, and Giuseppe Zaccone

8.1 Introduction

Fecal incontinence (FI) is a frequently occcurring, distressing condition that has a devastating impact on the lives of patients. However, patients are typically embarrassed and reluctant to acknowledge this disability, so they do not seek a cure and remain socially isolated. The exact incidence of FI is not known, because of the reluctance of patients to seek help from their physicians. Most epidemiological studies suggest a prevalence of as high as 2% of the general population; however, when patient interviews ask specific questions about FI, the rate is usually significantly higher. Women seem to be at higher risk of FI, mostly because of obstetric damage to anal sphincters; however, during the last decade there has been increasing interest in types of FI with nontraumatic causes, as these have been shown to occur in significant numbers. Older subjects are at a very high risk of FI, especially those that present with disabilities or are institutionalized. Young patients are also often affected. This results in a significant economic impact for society because of the direct and indirect costs, and also for intangible reasons. Since FI can be the result of various pathophysiological conditions, and a variety of risk factors can cause a wide range of ways in which patients develop the inability to control the passage of feces, an accurate diagnostic work-up of each patient is fundamental. Although not fully accepted, a multimodal diagnosis, using a multiparametric evaluation, seems to allow a better understanding of FI pathophysiology and address the optimal treatment. Optimal treatment is the most important challenging aspect of FI management. Indeed, there is currently a

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wide range of therapeutic options available, including conservative, rehabilitative, and surgical procedures. The aim of surgery might be correction of a defect, or improvement of a dysfunction in continence control when the sphincter complex is intact, or replacement of a largely fragmented or non-functioning sphincter. Making the correct choice is pivotal to the successful management of this condition. Although a number of reports are available regarding results of different surgical procedures, there is a lack of evidence from randomized controlled studies, making the choice of procedure very difficult.

8.2 Diagnostic Work-up

Anal continence is maintained by the activity of complex anatomic and physiologic structures (anal sphincters, pelvic floor musculature, rectal curvatures, transverse rectal folds, rectal reservoir, and rectal sensation). It is also dependent on numerous other factors, such as stool consistency, the mental faculties and mobility of the patient, available facilities, and social convenience. Only if there is effective coordinated integration of these factors can defecation proceed normally. FI is the result of disruption of one or a few of these different entities: it can have a multifactorial pathogenesis, and in many cases it is not secondary to a sphincter tear. The disruption can lie in alterations that are intrinsic to the anorectal neuromuscular structures of continence control, or extrinsic to them, also involving extrapelvic control mechanisms. The primary aim of an effective therapeutic approach is the improvement, or better still the resolution, of this distressing condition. Different forms of therapy are currently available, so physicians have to select the most appropriate treatment for each patient. Consequently, the diagnostic work-up is fundamental in order to assess the functional condition of every part involved in the continence mechanism, and identify the presumed cause(s) of incontinence. Several specific tests have been designed that are instrumental in FI diagnosis; these are available in a clinical setting for investigational purposes. However, there is disagreement among clinicians on the choice and timing of diagnostic procedures.

8.2.1 Clinical Assessment

Investigation of the patient's history is of utmost importance. It is important to ascertain the characteristics of normal defecation (occurring without incontinence). Then, efforts should be made to identify the symptoms of pathogenic significance and define the type of FI (urge incontinence, passive incontinence, fecal soiling, or seepage). Thereafter, timing, duration, and frequency of FI, type of stool lost, use of pads, rectoanal sensation during normal defecation and FI episodes, and influence on health status and quality of life are all fundamental features to be ascertained. They should be related to possible events in the patient's history, including metabolic and neurological diseases, obstetric and pelvic surgery, neurosurgery, pelvic trauma, chronic inflammatory bowel disease, pelvic irradiation, psychiatric conditions, and physical and sexual abuse.

An interview with the patient could be used effectively in the physical examination of the patient. Exploration or a digital maneuver should be performed in order to determine physical alterations of the anus, perineum, and pelvis, and elicit specific reflexes.

The symptoms and signs of the patient should be considered in order to classify the grade of FI, in order to evaluate the severity, and also for future assessment of the effectiveness of therapeutic approaches; a number of scales have been proposed for FI grades. Finally, the patient's quality of life must be considered in both the evaluation of FI severity and the assessment of treatment; numerous criteria have also been proposed for this parameter.

8.2.2 Physiological Investigations

The primary aims of the tests used for FI patients are to better elucidate the pathophysiology and to address the treatment. The assessment must address both the function (mostly provided by anorectal manometry and rectal sensation investigation, and anorectal electrophysiology) and the structure (obtained by endoanal ultrasound and/or magnetic resonance) of all components, both pelvic and extrapelvic, involved in continence mechanisms. As a result of the multifactorial nature of FI, no single test is sufficient on its own, and a combination of investigations is needed. When FI occurs with diarrhea, other possible causes should be explored by use of endoscopy and stool tests. When a clinical examination suggests that FI could be secondary to metabolic or neurological causes, or neurosurgical causes, trauma, bowel inflammation or irradiation, or psychiatric reasons, specific investigations should be carried out.

Diagnostic assessment should be used to plan the treatment. In fact, anorectal testing can add to diagnostic information in 19–98% of patients, influence the management plan in 75–84% of patients, and alter the management plan in 10–19% of patients, when compared with a clinical assessment alone.

8.2.2.1 Anorectal Manometry and Rectal Sensations

Anorectal manometry and rectal sensation tests are usually performed at the same time, and include the evaluation of rectoanal reflexes and rectal compliance. Although they are the most frequently used diagnostic procedures in proctology, particularly in FI patients, they are carried out using a variety of techniques because of wide technical variations concerning computer software, probes (water perfused or solid state; unichannel or multichannel; difference in number, location, and shape of openings; difference in location and balloon material), acquisition modality of pressures (by pull-through or stationary), and sensations (by inflation using either air or water, or using a barostat); because of these technical differences it is not possible to precisely define either a standard examination or normal values.

In incontinent patients, both resting and squeeze pressures should be calculated; the investigator should be very careful to evaluate not only the numeric value (i.e., mean or median) but also consider the pressure profiles, giving information on asymmetry in the anal canal (due to a limited lesion of the internal or external anal sphincter), or decreased external anal sphincter endurance to muscle fatigue during prolonged squeeze. Based on a multichannel acquisition of resting pressure profile, it is usually possible to visualize a "vector manometry". On the other hand, in a number of incontinent patients, resting and/or squeeze pressures can be normal, and related to a nontraumatic pathophysiology of their incontinence. Although the rectoanal inhibitory reflex is routinely evoked, its role in pathophysiological assessment of FI is not well established. Other reflexes (i.e., coughing) should be elicited to investigate possible spinal cord lesions. Rectal sensations are very important parameters that should be investigated in FI patients (threshold and urge sensations, and maximum tolerated volume).

8.2.2.2 Endoanal Ultrasound

Endoanal ultrasound (EAUS) is used to investigate the anal canal and rectum with specifically designed ultrasound probes and software. The most useful probes are those that include radial probes with a full 360° field of view, and a frequency range between 5 and 16 MHz. During the examination, the probe is inserted into the anal canal, reaching the puborectalis sling showing the "U"-shaped aspect. From this level, a manual or mechanical pull-through examination is performed to evaluate the distinct layers and structures of the anal canal: submucosa, internal anal sphincter, longitudinal sphincter, external anal sphincter, puborectalis, anococcygeal ligament, puboanalis muscle, and perineal body. More recently, the EAUS technique has been developed to obtain a three-dimensional imaging (3D-EAUS), obtained from numerous axial, rapidly acquired, two-dimensional (2D) slices. With 3D-EAUS, the operator is able to navigate inside the 3D structure to observe the anal canal not only in axial views, but also longitudinal and oblique views. A sphincter lesion appears as a hypoechoic area involving a circumferential segment of the internal anal sphincter, external anal sphincter, or both. Then, EAUS is particularly useful in differentiating FI patients with and without sphincter tears.

8.2.2.3 Anorectal Electrophysiology

Anorectal electrophysiology (AREP) includes tests that are used on patients who have already been investigated with history and physical assessment and other procedures (mainly ARM and ultrasound), in whom pelvic muscular and/or nervous functions seem to be altered. Electrophysiological studies are usually carried out with a neuromyograph system equipped with software dedicated to anorectal physiology, and cables and electrodes to evaluate electrical muscle activity and nerve functionality.

The purpose of electromyography (EMG) is to investigate the electrical activity of the EAS and the other striated pelvic floor muscles, at rest and during squeezing and straining. Muscle denervation or reinervation can be found in incontinent patients.

Threshold mucosal sensation can be evaluated with electrostimulation not only in the rectum (as with anorectal manometry), but also in the anal canal, using a bipolar ring electrode. Pudendal nerve terminal motor latency is measured with a disposable St Mark's pudendal electrode, allowing the evaluation of the integrity of the pelvic floor. The evoked potentials can be obtained by stimulation of the cortex or sacral roots in order to assess the central and peripheral motor (motor-evoked potentials) and somatosensory (somatosensory-evoked potentials) pathways.

8.2.2.4 Defecography and Magnetic Resonance

Defecography is able to assess pelvic floor physiology, recording motion at rest, and when squeezing, straining, and coughing. The anorectal angle should be calculated. Perineal descent can be found frequently in incontinent patients. Moreover, rectorectal intussusception, rectocele, enterocele, or sigmoidocele can also be diagnosed; pelvic muscle dyssynergia also needs to be adequately evaluated because it can cause continence disturbances.

Magnetic resonance (MR) imaging of anal sphincters has been evaluated using phased-array coils or an endoanal coil; controversy exists about preference between the two types. More recently, it has been suggested that MR defecography be included in the diagnostic work-up of FI patients in order to detect previously missed functional alterations of anterior, middle, or posterior pelvic compartments.

8.3 Treatment

Criteria for selection of patients for treatment of FI are of central importance. These criteria should take in account not only the possible impact of a certain therapy on FI pathophysiology in a particular patient (resulting from the investigations), but also the psychological aspects caused by FI and those that might possibly be related to future treatment.

8.3.1 Medical Therapy

There is little evidence published regarding medical therapy for FI; therefore it is the subject of debate and treatment is often pragmatic. It includes diet and drugs, supportive measures, rehabilitation, and biofeedback. These treatments are usually chosen either for "elective" reasons or for patients who cannot be treated by a surgical approach. Poor clinical condition of a patient, limiting anesthesia and/or surgery, could be a valid criterion for a nonoperative approach, while a patient's age might also be relatively limiting. Psychological problems or psychiatric disturbances should suggest avoiding very complex surgical procedures requiring the patient's compliance. Specific bowel diseases (chronic inflammatory diseases, irritable bowel syndrome), with uncontrolled symptoms, should contraindicate a major surgical approach. The choice of treatment for life-threatening clinical conditions (evolving diseases, chronic diseases, not radically treated neoplasms) should consider the patient's life expectancy and the possible benefits in quality of life.

An "elective" indication for medical therapy should include minor FI without physiologic or morphologic alterations; in cases with minor abnormalities, a medical approach could be considered as a first-line intervention. Individuals with continence dysfunctions related to altered quality of feces (i.e., diarrhea) should expect to have benefits from conservative treatment; the patient should be encouraged to improve perianal hygiene, use carefully absorbent cotton diapers and tampons, and reduce intake of or avoid foods inducing loose stools and increasing gastrointestinal transit and gas production (milk derivates, legumes, excess fiber). Diarrhea should be fully investigated and, consequently, treated with medication when appropriate. Specific drug treatment should be initiated in cases of chronic bowel diseases. Also the pathophysiology of the soiling should be fully elucidated in order to inform the choice between operative and nonoperative treatment.

Pelvic floor rehabilitation, including biofeedback, kinesitherapy, sensory retraining, and electrostimulation, is frequently regarded as a first-line treatment for FI. However, disagreement exists about indications for rehabilitative techniques.

8.3.2 Surgical Treatments

Until recently, in cases of intractable poor FI, the criteria for selecting patients for surgical treatment were sphincter lesions or pudendal neuropathy with perineal descent and altered anorectal angle. In the former condition, a sphincteroplasty was indicated in cases of a limited lesion without alteration of pudendal nerve terminal motor latency, while a sphincter replacement operation (dynamic graciloplasty, artificial sphincter, or gluteoplasty) was indicated for presence of a wide lesion, plurifragmented sphincters, or failure of previous sphincteroplasty. In the latter condition, a postanal repair was indicated. In 1995, sacral nerve stimulation was introduced into the wide range of treatments available for FI, and this resulted in a significant change in the selection criteria. Recently, there has been renewed interest in bulking agents, and a new implantable system, based on a self-explandable prosthesis (Gatekeeper), has been introduced.

8.3.2.1 Sphincteroplasty

Patients with sphincter lesions caused by an obstetric trauma (third-degree and fourth-degree tears) have undergone elective sphincteroplasty. Edge-to-edge approximation or an overlapping of external anal sphincter can be used in this technique. Immediate repair, at the time of delivery, or delayed for a period of 24 h has been suggested to produce the best results. However, sphincteroplasty is frequently performed a few decades after childbirth, when the patient present clinically with FI. In order to improve the long-term results of sphincteroplasty alone, which can sometimes be of limited success, this operation can been performed within a total pelvic floor repair or with anterior levatorplasty.

8.3.2.2 Postanal Repair

Patients with neuropathic FI, associated with perineal descent and without sphincter lesions seem, theoretically, to present with the best indications for postanal repair. However, considering the limited long-term effectiveness of this treatment, these patients could be more effectively treated by other procedures. Indeed, indications for postanal repair have been significantly reduced over time. It has been advocated as a part of a total pelvic floor repair in conjunction with anterior levatorplasty.

8.3.2.3 Dynamic Graciloplasty, Artificial Bowel Sphincter, and Gluteoplasty

These procedures must be regarded as major sphincter replacement operations, used only for patients with very severe FI caused by a large sphincter lesion (more than half of the sphincter circumference) or fragmented sphincters not amenable to either sphincteroplasty or other surgical approaches (i.e., sacral nerve stimulation, SNS). It can also be indicated in cases in which previous sphincteroplasty has failed (and there is no indication to repeat it), and the patient is not suitable for SNS. Moreover, if severe FI is a consequence of neuropathy or anorectal malformation, one of these operations could be performed (specifically, in cases of neuropathy, when SNS has failed). The only major contraindications to sphincter replacement procedures are very poor chronic bowel diseases causing intractable defecation dysfunctions (severe diarrhea, as well as severe constipation) and coexistence of rectal prolapse, intussusception, rectocele, or enterocele.

Although the indications for dynamic graciloplasty, artificial bowel sphincter, and gluteoplasty overlap, there are various differences between the procedures related to the surgeon's preference and expertise, techniques and materials used, and evaluation of perioperative morbidity and long-term results.

8.3.2.4 Sacral Nerve Stimulation

SNS now plays a central role in the algorithm of FI management. Even though it has been only recently applied clinically to anorectal dysfunctions, the use of this approach has rapidly expanded and the number of acceptable indications has increased. Initial applications concerned patients with dysfunctions of unlesioned striated anal muscles, then those with a prevalent neurogenic etiology. Thereafter, since there has been progress in clinical use and understanding mechanisms of action, SNS has been expanded to other indications including idiopathic sphincter degeneration, iatrogenic internal sphincter damage, partial spinal cord injury, scleroderma, limited lesions of internal or external anal sphincters, rectal prolapse repair, and low anterior resection of the rectum.

8.3.2.5 Injectable and Implantable Agents

This treatment approach is regarded as attractive because it is not invasive. However, only very accurate patient selection can produce positive effects on FI using bulking agents. Usually, patients with either a limited internal sphincter lesion or a weak anus without tears are indicated for this type of treatment. Moreover, individuals who cannot be considered for other major surgical approaches because of their general poor clinical condition could be suitable for the injection of bulking agents. The increasing variety of agents proposed and used to create a bulking effect, with different methods of injection (through the anal mucosa, or transsphincteric), different placement sites (submucosal or intersphincteric), and different check procedures (digital examination or EAUS), has not produced comparable criteria for selecting the most appropriate approach.

More recently, another procedure has been deveopled for the implantation of a specifically designed prosthesis: the Gatekeeper System. The prosthesis is small, thin, and solid when implanted, becoming larger and soft in contact with organic liquids when inserted into the anal canal, within 24–48 h after implantation. The procedure provides for the implantation of 4–6 prostheses for each patient, in the intersphincteric space, using a dedicated delivery device. The prostheses are visible on sonography, and this makes it possible to follow and control the position of the prostheses sonographically during follow-up. The main characteristic shown by the Gatekeeper prostheses is the stability of their position in the sites of the implant over time, because they are not biodegradable.

8.4 Treatment Evaluation

A variety of factors can affect the evaluation of the effectiveness of a certain therapy for FI. Identification of factors reflecting the impact of the treatment and methods for measuring the improvement obtained are of crucial importance. These should be derived from well-controlled studies with a sufficiently large number of patients that have been selected using strict criteria. However, the results of published reports are frequently affected by non-standardized patient selection. Also, the criteria used to define the response to the therapy are not standardized. This could depend on what is taken to be the end point of the particular treatment: improvement of symptoms (i.e., reduction of FI episodes, improved control of solid versus liquid stools versus gas, ability to postpone defecation), or improvement of patient's quality of life, or improvement of multifactorial aspects (i.e., improvement of scores), or normalization of physiology parameters (i.e., manometric, electrophysiologic, ultrasonographic, etc.).

It is debatable whether a relative improvement of at least 50% for FI could be considered a good response; in fact, for a patient treated for very severe FI, reduction of 50% in the number of FI episodes (for instance, from ten down to five episodes per week) is probably not enough to significantly improve the patient's poor quality of life and lifestyle (e.g, need to wear pads, staying close to a bathroom, confined to staying at home, etc.). Moreover, even if perfect control of solid stools has been regained after treatment, incontinence to liquids or gas remains very detrimental to the quality of life of the patient. Because there is disagreement on the clinical parameters to define a response to treatment, the data available in reports should be evaluated carefully and critically.

In addition to this, the scoring systems used for FI measurement are not the same as those used in quality-of-life questionnaires. They are often too vague and subjective. A patient's "satisfaction" would be probably the most comprehensive parameter to reflect success of the therapy, but it is difficult to quantify. Moreover, each scoring system and questionnaire needs to be validated according to specific social, cultural, and environmental factors.

Physiological parameters are used to demonstrate the objective impact of a treatment. However, conflicting data are frequently obtained when a single parameter is considered, because of the multifactorial origin of FI. Moreover, the outcome of a particular treatment can vary in different subgroups of patients, as each group could have particular physiological features.

Suggested Reading

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Obstructed Defecation Syndrome

9

Kim J. Gorissen and Martijn P. Gosselink

9.1 Introduction

Obstructed defecation syndrome (ODS) is a term used to describe the whole complex of mechanical and functional disorders leading to difficult or inadequate rectal emptying. ODS or anorectal outlet obstruction is typically seen in middle-aged, multiparous women. Prevalence ranges from 3.4% in the general population up to 23% in middle-aged women [1, 2]. ODS and slow-transit constipation (STC) are two subgroups of constipation, as defined in the Rome III criteria for functional bowel disorders [3]. Strictly speaking, ODS is confined solely to the evacuation disorder and differs from STC because in patients with isolated ODS the fecal stream reaches the rectum without delay. However in around 30% of patients both conditions occur simultaneously [4] and their strong association leads to a suspicion of interaction. Differentiation between both subtypes of constipation requires a specialized pelvic floor work-up because treatment approaches are different.

9.2 Symptoms

Patients with ODS typically report straining, incomplete emptying, need for manual support of the perineum, vaginal/rectal "digitation", and pain. Prolonged and repeat visits to the toilet may develop in substantial daily rituals with severe impact on quality of life. Dependence on laxative and/or

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enema use is common. In contrast, patients with isolated STC report the absence of urge or call to stool. Their main complaint is abdominal heaviness and bloating.

Patients with ODS and/or STC are not uncommonly also troubled by varying degrees of fecal incontinence. Postdefecatory soiling might be caused by residual stool trapped in the anal canal or rectocele. Both overflow-diarrhea and excessive laxative use can aggravate existing borderline incontinence. Clinical scoring tools such as the Cleveland Clinic Constipation Score [5] and, more specific for ODS, the Altomare Obstructed Defecation Scoring tool, are essential to assess severity of initial symptoms and audit treatment outcomes [6].

9.3 Etiology

Defecation is a complex process composed of several essential factors. After propulsion into the rectum, bowel content is sensed and sampled by the anorectal mucosa. Afferent signals are processed in the cerebral cortex under the influence of environmental stimuli. If regarded safe and appropriate, the internal and external sphincter, together with the pelvic floor muscles, are allowed to relax. Relaxation of the puborectal sling leads to alteration of the angulation of the rectum, and rectal motility needs to expel the contents in the right vector towards the anal canal. Problems can occur on all levels of this process.

9.3.1 Anorectal Hyposensitivity

Decreased perception of the rectum has been described in about one-third of patients with ODS [7]. The tonic response of the rectum to evoked urge to defecate seems to be absent or significantly blunted in ODS patients with or without STC [8]. The most likely cause is impairment of afferent sensory pathways due to pelvic nerve injury such as during childbirth, pelvic surgery (hysterectomy), or excessive perineal descent and prolapse.

9.3.2 Relaxation of Sphincter and Pelvic Floor Muscles

Several terms (anismus, dyssynergia, spastic pelvic floor, and puborectalis syndrome) are used to reflect the inability to relax the pelvic floor muscles in order to open the anal canal and facilitate defecation. This might be related to subconscious cortical inhibition, as it is more common after sexual abuse. The currently popular “safe toilet syndrome” is a more subtle variant of anismus, demonstrating the influence of various psychological components [9].

9.3.3 Anatomical/Mechanical Obstruction

Rectocele is a result of weakening of the rectovaginal septum, leading to "herniation" into the posterior vagina. The bulging at straining, together with the entrapment of stool in the rectocele, prohibits efficient evacuation. Isolated rectocele can occur, but often they are a sign of overall pelvic weakness. The complex of rectocele, rectal intussusception, enterocele and anterior compartment prolapse is known as 'descending perineal syndrome'.

In enteroceles, small bowel or sigmoid (sigmoidocele) becomes trapped between the vagina and rectum in a deepened pouch of Douglas. The role of enterocele in ODS is debatable, as two studies found no influence of adequate enterocele repair on symptoms of ODS [10, 11].

External rectal prolapse can be accompanied by symptoms of ODS, but fecal incontinence is often more pronounced. Bowel mucosa and pudendal nerves can be damaged as a result of stretch. Recurrent or persistent full-thickness prolapse dilates the sphincters and anal canal. Repetitive stimulation of the rectoanal inhibitory reflex can result in insensitivity to the reflex. In addition to this, the intussusceptum occludes the lumen of the rectum causing mechanical obstruction. Internal prolapse or intussusception seems to be the precursor of external prolapse, and is increasingly recognized as a cause of ODS [12]. Early studies demonstrating internal intussusception in asymptomatic volunteers [13] have been contradicted by others [14] showing that high-grade full-thickness intussusception is confined to symptomatic patients. The good results of laparoscopic ventral rectopexy in both external and internal intussusception, where anatomical correction is achieved without resection of the hyposensitive mucosa, argues in favor of the important role of prolapse in ODS.

9.4 Investigations

9.4.1 Anamnesis

Anamnesis should identify patients who are mainly worried about underlying (malignant) pathology and are satisfied by reassurance only, instead of further treatment. A subgroup of patients has unrealistic views of "normal" bowel patterns. A common, but easily negated, misbelief seems to be that if defecation fails to occur for a few days, toxins arise that "poison the body".

9.4.2 Physical Examination

Inability to relax, and especially paradoxical contractions on straining, can raise suspicion of anismus, although digital examination alone gives a high rate of false-positives results [15]. Perineal descent and rectocele have to be assessed. Sometimes internal prolapse can be felt touching the fingertip on straining.

9.4.3 Flexible Sigmoidoscopy/Colonoscopy

Flexible sigmoidoscopy/colonoscopy should be used with a low threshold to exclude anorectal malignancies and strictures.

9.4.4 Colon Transit Studies

Colon transit studies are an easy, safe, and inexpensive way to diagnose whole-gut slow-transit constipation where the radiopaque markers are found mainly proximal in the descending and transverse colon. Left-sided retention can sometimes be seen in obstructed defecation.

9.4.5 Defecating Proctography

Defecating proctography gives very valuable functional dynamic information. Inability to void any contrast can be indicative of anismus, but the clinician has to be aware that embarrassment can mimic the disorder and lead to a high rate of false-positive results. Defecating proctography is the preferred tool in assessing anatomical causes of obstruction such as enterocele, rectocele, and intussusception, although incomplete emptying can lead to underdiagnosis of the latter. An examination under anesthetic is used to diagnose these initially missed prolapses.

9.4.6 Anorectal Physiology

Anorectal physiology with rectal balloon distension is used to examine rectal sensory perception and rectal wall contractility, sensory threshold volume, urge to defecate volume, and maximum tolerable volume. Paradoxical contractions or pelvic dyssynergia can be detected. The rectal anal inhibitory reflex is absent in congenital Hirschsprung's disease and systemic sclerosis.

9.4.7 Endoanal Ultrasound

A thickened internal sphincter can be seen in anismus, rectal intussusceptions, and solitary ulcer of the rectum syndrome. Congenital myopathy/hypertrophy of the internal anal sphincter is a rare cause of ODS. Diagnosis is made by observation of inclusion bodies on biopsy specimens. Successful treatment with nitrates, calcium-channel blockers, and strip myectomy has been reported [16]. A balloon expulsion test is mandatory when considering colectomy.

9.5 Treatment

9.5.1 Lifestyle Modification

Physical activity has shown to accelerate colonic transit time [17]. The effect of increased fluid intake and “timed toilet training” are not supported by any trials. However, providing information on different coping techniques in “pelvic floor educational programs” seems logical [18].

9.5.2 Medication

Bulking or fiber laxatives are first line treatment, but they have to be ingested with sufficient water. Soluble fibers can lead to gas formation and bloating through fermentation. Osmotic laxatives, such as macrogol, are supported by level I evidence. Stimulative laxatives are generally used as rescue medication, as doubt of dependence and rebound constipation limits their use on a daily basis. Prucalopride is a high-affinity 5-hydroxytryptamine 4 receptor agonist that has been proven to be effective in severe constipation [19].

9.5.3 Biofeedback

Biofeedback is laborious and time consuming, and requires a highly dedicated therapist as well as a strongly motivated patient. Several randomized controlled trials proved its benefit mainly in pelvic floor dyssynergia [20]. Its use in the presence of anatomical problems such as intussusception seems to be far less helpful.

9.5.4 Retrograde Colonic Irrigation

Retrograde colonic irrigation is simple, noninvasive, and safe. High success rates have been reported by several groups, especially when patients are guided by dedicated nurses [21, 22]. Normal water is used and provides a mechanic washout, but also triggers colon mass movement. Addition of polyethylene glycol, glycine, bisacodyl, and glyceryl trinitrate solutions can enhance colonic emptying even further.

Antegrade colonic irrigation, for example by a Malone stoma, should in theory be even more effective, as the flow of water and bowel contents is in the same direction as the bowel motor complexes. However this technique is invasive, possibly less effective in adults [23, 24], and often requires revisions of the appendicostomy because of stenosis or rectraction.

9.5.5 Botulinum Toxin

Botulinum toxin is very effective in the treatment of anismus, especially if underlying (internal) prolapse is excluded [15].

9.5.6 Surgery

Many different surgical procedures have been developed since colectomy and colostomy were the only options. Most surgery is focused on restoration of anatomical abnormalities.

Primary repair of an isolated rectocele can be performed by transperineal, endoanal, or transvaginal repair. The only randomized trial performed to date showed no benefit [25] apart from a possible lower recurrence rate for transvaginal repair. Rectal repair might be associated with (transitory) fecal incontinence due to stretch of the sphincter, and transvaginal correction might cause more dyspareunia.

Stapled transanal rectal resection procedures for ODS seem to be quite successful, with long-term improvement of around 50% in ODS scores [26]. Success seems to be related to the combination of removal of the insensitive part of the rectum and anatomical correction of the rectocele/intussusception.

Postoperative (transient) urgency is often reported, and major complications such as bleeding, anastomotic dehiscence, rectovaginal fistulas, and stenosis illustrate the need for specialized surgical care.

Rectopexy previously had a negative image, as posterior mobilization with division of the lateral ligaments caused worsening of constipation. With modern nerve-sparing laparoscopic ventral rectopexy, significant improvement of over 50% in the short-term and mid-term has been reported [27, 28]. Prosthetic mesh repair compared with repair by biodegradable meshes might lower recurrence rates of intussusception and rectocele, but long-term follow-up is scarce. Mesh erosion is a severe, but relatively uncommon, complication (< 2%), especially when compared with transvaginally placed meshes.

Sometimes correction of anatomical abnormalities as a treatment on its own does not lead to restoration of normal function. In these cases, hyposensitivity/mobility might be the key.

Sacral nerve stimulation (SNS) can elicit pancolonic pressure waves [29]. Long-term effects of SNS in ODS/constipation varies and SNS might be more effective in adolescent females [30]. Alterations of SNS settings, like suprasensory stimulation, might be helpful in improving success rates [31].

9.6 Summary

Although often coexisting in the same patient, ODS and STC are different entities.

Whether ODS is caused primarily by sensory dysfunction or by anatomical/mechanical obstruction is not clear yet, although there seems to be an increasing awareness of the role of internal prolapse in ODS.

Treatment should be directed to the disorders found at full pelvic floor work-up.

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Solitary Rectal Ulcer Syndrome and Obstructed Defecation: Common Pathology

10

Niels A. T. Wijffels and William Chambers

10.1 Introduction

Solitary rectal ulcer syndrome (SRUS) is a condition combining disturbances to bowel function and ulcer-related symptoms such as the passage of blood and mucus rectally. Ulceration is not always present but the main feature of the condition is erythema or ulceration of the anterior rectal wall [1]. It was first described by Cruveilhier in 1829 [2]; however, it was not until 1969 that Madigan and Morson [3] proposed the clinicopathological features accepted today. It is an uncommon condition with an annual incidence of 1 in 100,000 to 3.6 in 100,000. It affects young adults, occurring most commonly in the third decade in men and in the fourth decade in women [4], with a slightly higher rate of occurrence in women [5]. As a result of the low incidence/prevalence of SRUS, good-quality articles on etiology and therapy are scarce or even lacking. It is associated with other pelvic floor disorders with overlapping symptomatology. Although a variety of both conservative and surgical therapies have been described, a lack of consensus regarding the exact underlying etiology remains.

10.2 Etiology

Physiological and histological studies have illustrated a spectrum of findings suggesting a possible variety of causes [6–9]. Most authors describe at least internal or external rectal prolapse and a simultaneous opposing force on the rectal mucosa; the downward force of defecation countered by upward force from the pelvic floor generates the trauma required for the formation of SRUS.

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The forces may lead to mucosal ischemia and subsequent ulceration. In addition, the prolapsed mucosa may be traumatized against the closed anal canal.

While the presence of rectal prolapse, external or internal, is clearly understood, the nature of the opposing upward physiological force is unclear. Some authors suggest another, contributing factor to explain the ischemia hypothesis: an opposing upward physiological force. Anismus or paradoxical puborectalis contraction may cause an obstruction during defecation that necessitates excessive straining to evacuate stool. Increased activity in the external anal sphincter during evacuation, together with high voiding pressures, has been measured [10]. However, it can be questioned whether these findings reflect a true anismus. A reflex secondary to the accompanying pain sensation during the act of defecation, as seen in fissura ani, might be an alternative explanation.

10.3 Pathological Features

Though usually single, SRUS is occasionally multiple. The ulcers are usually situated on the anterior rectal wall. The microscopic histological features include thickening of the mucosa and distortion of the underlying glands. The lamina propria is edematous and may contain an abundance of fibroblasts. There is thickening of the muscularis mucosae and extension of its fibers upward through the glandular crypts. Often, there is erosion of surface epithelium. This is accompanied by a fibrinous exudate and engorged vessels in the superficial lamina propria, but perhaps, surprisingly, no significant inflammatory cell infiltrate [1].

Chiang et al [11] summarized the histological findings of 158 patients: 56% showed an ulcerated pattern, 24% a polypoid pattern, and 20% a flat lesion (also called erythematous lesions). Glandular crypt abnormalities were seen in 91% of patients, fibromuscular obliteration of the lamina propria in 98%, hypertrophied and splayed muscularis mucosae upwards into the lamina propria in 96%, inflammatory cells and granulation tissue infiltration in the lamina propria in 75%, mucosal capillary abnormalities in 48%, hemosiderin deposition in the lamina propria in 53%, surface erosion with fully mature and normal epithelium in 56%, and misplaced glands in the submucosa in 7%.

10.4 Clinical Features

Classically, the symptoms of SRUS are said to be rectal bleeding, passage of mucus, pain or tenesmus, and excessive straining [2]. Chiang et al [11] reported bleeding in 91% of patients, mucous discharge in 77%, rectal pain in 61%, excessive straining in 63%, tenesmus in 64%, digitations in 29%, incontinence in 38%, constipation in 47%, and diarrhea in 18%. Up to 26% of patients can be asymptomatic [1]. Patients often present long after the onset of symptoms. The mean reported duration of symptoms before diagnosis ranges from 3.5 to 5.3 years [1, 12, 13].

10.5 Diagnosis

Diagnosis is made on sigmoidoscopy. Typically the rectal ulcer is small with a white sloughy base and a hyperemic rim of mucosa, often located anteriorly [14]. Lesions may be multiple (in 30% of patients) [3]. The ulcerated lesion (present in 57% of patients) is not always present, and polypoid lesions (25% of patients) or erythema of the mucosa (18% of patients) are seen instead [12].

An endoanal ultrasound can be considered, especially if fecal incontinence is present, to rule out sphincter injury. In patients with a rectal prolapse, a typical asymmetric thickening of the internal anal sphincter can be seen. If a symmetrical thickening of the internal anal sphincter is seen and patients present with obstructed defecation, a rare condition called hereditary myopathy of the internal anal sphincter can be diagnosed by biopsy of the internal anal sphincter followed by pathological investigation with electron microscopy [15].

Anorectal physiology testing yields variable results in patients with SRUS. The tests neither make the diagnosis nor predict the response of the patient to therapy. The most consistent finding with anorectal physiology is that of relatively high maximum resting pressures, excessive perineal descent, and pudendal neuropathy [16].

Patients with a rectal ulcer deserve a full diagnostic work-up to exclude other causes for excessive straining, even when a relapse prolapse has been shown on defecography (or magnetic resonance [MR] defecography).

Defecography is the gold standard to diagnose occult or internal rectal prolapse. The Oxford rectal prolapse grading system is very useful to determine the severity of prolapse (Fig. 10.1, Table 10.1). Simultaneous existence of a rectocele and enterocoele will also be demonstrated on defecography. Although anismus can also be shown on defecography, it has been suggested that defecography is likely to overdiagnose anismus [17]. MR defecography has been shown to be feasible and reveal the same anatomic entities as compared to normal defecography. The (lying) position of examined patient is not physiologic though and because defecating feels unnatural in a lying position it might under diagnose the degree of rectal prolaps(which is best diagnosed with a complete evacuation of stool/contrast).

A colonic transit study or colonic transit scintigraphy can show or exclude slow transit constipation. For its practical advantages, Arhan's method [18] is recommended: 10 markers or pellets are ingested on 6 consecutive days (60 markers in total) and an X-ray of the abdomen is performed on the seventh day. The number of markers is counted and this number is multiplied by 2.4 h to give the colonic transit time. Differentiation between right-sided (suggestive of true or primary slow transit constipation) and left-sided (suggestive of secondary slow transit constipation caused by outlet obstruction) slow transit constipation is possible. A colonic transit of more than 50 h is considered abnormal.

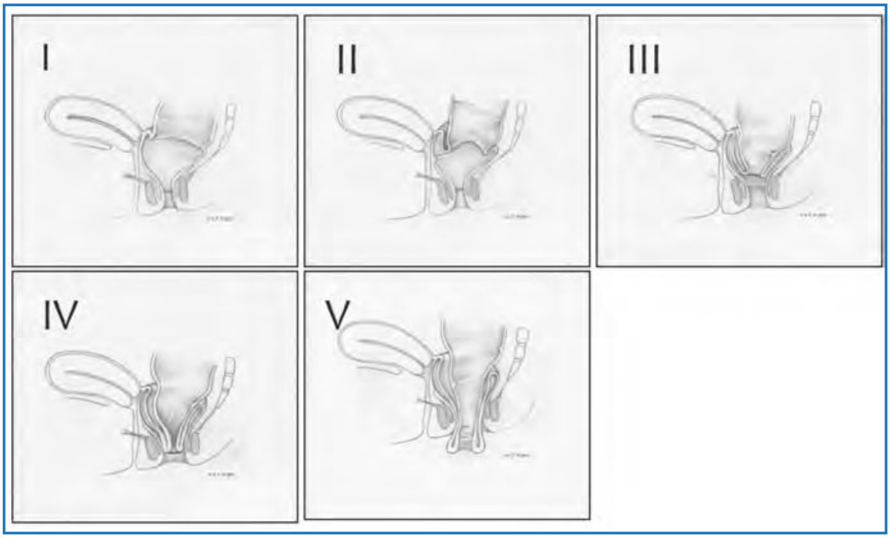

Fig. 10.1 Oxford rectal prolapse grade: a radiologic grading system (visual appearance)

Table 10.1 Oxford rectal prolapse grade: a radiologic grading system (types and characteristics)

Type of rectal prolapse	Grade of rectal prolapse	Radiological characteristics of rectal prolapse
Internal rectal prolapse		
Rectorectal intussusception	I (high rectal)	Descends no lower than proximal limit of the rectocele
	II (low rectal)	Descends into the level of the rectocele, but not onto sphincter/anal canal
Rectoanal intussusception	III (high anal)	Descends into sphincter/anal canal
	IV (low anal)	Descends into sphincter/anal canal
External rectal prolapse	V (overt rectal prolapse)	Protrudes from anus

10.6 Treatment

Many different treatment strategies have been published. Since SRUS seems to be a symptom caused by other pelvic floor disorders rather than being a pathology by itself, treatment should be focused on the underlying disorders. To treat the solitary rectal ulcer is to treat the (predominant) underlying disorder causing the ulceration. It is mandatory that conservative measurements are comprehensively explored before surgical procedures are offered to the patient.

10.7 Conservative Management

10.7.1 Dietary Fiber

When using dietary fiber, the response rate varies from 19% to 70%, with rectal prolapse patients seeming to benefit least from the use of bulking agents alone [19]. Most investigators have combined the use of additional dietary fiber with behavioral modification to reduce straining. Combination therapy was used successfully for symptom control in 14 of 21 patients.

10.7.2 Topical Agents

Local agents may contribute to healing of the mucosa but they do not address the underlying defecatory disorder and/or anatomy. Topical steroids and sulphasalazine enemas have not been shown to be effective. In contrast, a small study has demonstrated that sucralfate enemas (2 g twice daily for 3–6 weeks) have produced symptomatic improvement and even macroscopic healing on sigmoidoscopy, but the histological changes have persisted [20].

The application of human fibrin glue has also been shown to stimulate fibroblast and vascular proliferation leading to tissue regeneration and mucosal healing. In a small study, all six subjects treated with topical fibrin, increased dietary fiber, and behavioral correction of straining had ulcer healing at 14 days. The healing remained at the 1-year follow-up. In the group of control subjects, treated with fiber and correction of straining alone, none had achieved ulcer healing by 14 days, yet half demonstrated healing at 1 year [21].

10.7.3 Biofeedback

Malouf et al. [22] showed short-term benefit from using biofeedback in 8 of 12 patients, but longer-term benefit in only half this number. Jarrett et al. [23] showed that biofeedback led to a significant rise in mucosal blood flow and postulated that this showed improved extrinsic autonomic nerve activity. Binnie et al. [24] demonstrated a higher recurrence rate in 14 patients treated with surgery (posterior rectopexy) alone compared with a group of 17 who were treated with surgery and biofeedback, either before or immediately after surgery.

10.8 Surgery

The surgical options that have been used for SRUS include perineal treatments (local excision, Delorme's procedure, stapled transanal rectal resection [STARR]) and abdominal rectopexies of various kinds, almost always posterior, and sometimes combined with resection. Anterior resection and stoma formation have also been used.

10.8.1 STARR

Boccasanta et al. [25] reported the results of STARR in patients who had all received biofeedback and remained refractory to treatment. While ulcer healing was reported as occurring in 100% in this series, 20% of patients remained symptomatic to some degree.

10.8.2 Posterior Rectopexy

Success with posterior rectopexy ranges from 50% to 100% (median 70%). It should be noted that all published series report posterior rectopexy, involving posterior rectal mobilization and rectal denervation. Posterior rectopexy does not support the anterior rectal wall, the usual origin an internal prolapsed. Sitzler et al. [26] described results of SRUS at St Mark's Hospital, Harrow, London in which 81 patients underwent surgical treatment over a 10-year period and 66 were followed up for at least 12 months. Forty-nine patients underwent posterior rectopexy, nine underwent Delorme's procedure, two underwent anterior resection, and four patients a primary stoma. Rectopexy succeeded in 27/49 patients (55%); the procedure failed in 22 patients, and of the 19 underwent further surgery including rectal resection and colostomy formation. Eventually, 14 of these patients required permanent colostomy. For the nine patients treated initially with Delorme's procedure there were four failures at a median follow-up of 38 months. Two of these patients ultimately required a stoma. Seven patients underwent an anterior resection as their initial treatment or as second-line therapy for SRUS, and four of these eventually required a colostomy. Anterior resection was not a successful salvage procedure. The overall stoma rate for the treatment of SRUS in this large series was 30%. Posterior rectopexy resulted in a satisfactory long-term outcome in only 55–60% of patients. The poor outcome after surgery was related to two main factors: incontinence and incomplete evacuation, probably due to rectal denervation associated with posterior rectal dissection.

10.8.3 Ventral Rectopexy

When ventral rectopexy is employed, the success rate is improved [27, 28]. Ventral mesh rectopexy supports the anterior rectum where intussusception originates, without disturbing the autonomic innervation of the rectum, as happens with posterior rectopexy. However, the number of series detailing the use of this novel treatment for SRUS is limited and further studies are needed to confirm the promising early results.

10.9 Summary

A proportion of patients with SRUS respond to conservative measures such as advice to stop straining, and stool modification with bulking agents and stool softeners. For those who do not respond the main choice is between biofeedback and surgery.

It can be argued that any structural abnormality should be corrected before defecatory re-education commences, but it is reasonable to try biofeedback before surgery. Rectopexy should be a laparoscopic ventral rectopexy rather than a posterior rectopexy.

Perineal procedures such as Delorme's procedure may result in ulcer healing, but they are also likely to lead to poor function and recurrence. The STARR procedure may be suitable for those in whom an abdominal approach is likely to be difficult.

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Chronic Anorectal Pain: Pathophysiological Aspects, Diagnosis, and Treatment

11

Heman M. Joshi and Oliver M. Jones

11.1 Introduction

Chronic anorectal pain is a syndrome made up of a complex interaction between neurological, musculoskeletal, and endocrine systems that is further affected by behavioral and psychological factors [1]. The ambiguity of the pathophysiology related to this pain has created several synonyms, but chronic idiopathic perineal pain is an umbrella term used to describe the subgroups of patients who present with chronic anorectal pain [2, 3].

Chronic proctalgia is a term traditionally used for the most common pain syndromes termed proctalgia fugax, levator ani syndrome, and coccygodynia, although the Rome III criteria use only levator ani syndrome and proctalgia fugax in its classification [3]. These syndromes will overlap and pose a diagnostic and therapeutic challenge as they tend to represent variations of the same disorder, and pelvic diagnostic investigations to detect such structural or anatomical pathology are nugatory [4–6].

Pudendal neuralgia is the term used to describe pain secondary to injury to the pudendal nerve, while pudendal pain syndrome refers to pain when there is no obvious injury to the nerve.

11.2 Anatomy

Without a thorough understanding of the anatomy and physiology of the pelvic floor it is impossible to understand the pathology of chronic anorectal pain. The pelvic floor is a biomechanical composite of muscles, ligaments, and fascia that

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creates an opening in the pelvis for the pelvic organs to pass into the perineum. The predominant muscle in the pelvic floor is the levator ani, which is composed of four parts: puborectalis, pubococcygeus, ileococcygeus, and coccygyeus. These muscles confer support to the pelvic organs and are essential to functions such as continence, defacation, micturition, delivery, and sexual function [7]. The levator ani and sphincteric muscles are situated in a state of continuous tonic activity, relaxed only during bowel and bladder motility.

The pudendal nerve arises from the S2, S3, and S4 nerve roots. It passes through the greater sciatic notch before wrapping round the ischial spine/sacrospinous ligament before re-entering the pelvis through the lesser sciatic notch below the levator ani. At this point, it lies within a fascial condensation on the medial aspect of obturator internus called Alcock's canal. It passes below the pubic symphysis before dividing into three branches: the inferior anorectal nerve, the superficial perineal nerve, and the deep perineal nerve. This anatomy is covered in more detail in Chapter 3.

11.3 Proctalgia Fugax

Thaysen introduced the term proctalgia fugax in the 1950s. It is characterized by sudden, short (less than 30 min), intense pain that is anal in distribution (90%) [8]. In most patients, it occurs less than five times per year. It tends to occur at night (30%) and is self-limiting, affecting 8–18% [9, 10] of the population aged 30–60 years and its prevalence shows similar sex predilection [11]. Unlike levator ani syndrome, patients are asymptomatic during examination and no characteristic clinical findings can be found to support the diagnosis.

11.4 Chronic Idiopathic Anal Pain or Levator Ani Syndrome

Smith used the term levator spasm syndrome associated with perineal pain, and Todd reported symptoms of a dull, pressure sensation or a foreign body feeling [12]. The pain is exacerbated by sitting and lasts for hours to days. The prevalence in the general population is 6–7% between the ages of 30 and 60 years with a female predilection [13]. There is an association with previous pelvic surgery/injury and psychological stress/anxiety. Clinically there is tenderness on palpation of the levator ani muscles [14].

11.5 Coccygodynia

Simpson described the relation between coccyx injury and coccygodynia over 150 years ago. Thiele used the term coccygodynia to relate the levator spasm with anal pain [15]. It refers to severe rectal, perineal, and sacrococcygeal pain, mainly in women (5:1). The key to diagnosis is manipulation of the coccyx, which will trigger the pain and thus differentiate it from levator spasm syndrome.

11.6 Pudendal Neuralgia

Pudendal neuralgia is typically perceived in the perineum from anus to clitoris. Classically, it is a burning pain, worse with sitting, and many patients remain standing [16]. Those with unilateral pain often favor sitting on one buttock. On clinical examination, pain may be elicited by pressure over the path of the pudendal nerve either by rectal or by vaginal examination.

11.7 Etiology

Advanced or high-grade internal rectal prolapse appears to be very commonly associated with chronic idiopathic perineal pain, particularly when symptoms of obstructed defecation are present. Neil and Swash [17] commented on the high prevalence of pelvic floor laxity in patients suffering from chronic rectal pain and the real significance of internal prolapse only began to be addressed seriously much later in the 1990s and 2000s [18]. Chronic anorectal pain is a common symptom in patients with advanced posterior compartment prolapse presenting with defecatory dysfunction. About 50% of such patients will complain of pain at least some of the time. This pain often responds to antiprolapse surgery [19, 20].

Many patients with pudendal neuralgia will have a clear history of injury. This may be from previous surgery including a neuropraxia related to positioning during hip surgery, or from transvaginal or transobturator tapes and sacrocolpopexy. Other causes include obstetric trauma and rarer infiltrative causes including tumors. More chronic causes include chronic constipation and straining bringing about a stretch of the nerves, prolonged sitting and exercise (especially cycling).

11.8 Other Pathologies and Tests for their Exclusion

It is crucial to exclude the more simple causes of organic pain. These include the proctological conditions, most commonly anorectal sepsis, abscess, or thrombosed hemorrhoids. Intraluminal pathology (typically anal or rectal cancer) can be excluded by endoscopy, while extraluminal/presacral pathology may be delineated by magnetic resonance imaging scanning.

11.9 Investigations

Anorectal physiology and ultrasound (see Chapters 6 and 7) should be standard work-up investigations. Simple benign proctology can be excluded with ultrasound. A thick, hypertensive (more than 5 mm) internal anal sphincter on physiology and ultrasound is indicative of a rare inherited internal sphincter myopathy and should be confirmed by biopsy and demonstration of inclusion bodies on electron microscopy. A hypotensive, thickened (anterior, upper anal canal) internal sphincter suggests high-grade (anal) internal rectal prolapse (rectoanal intussusception). Why this causes pain is not fully understood, though it may be due to the stretching of the vault during intussusception or the response of the internal sphincter to repeated prolapse and localized ischemia [14]. Pudendal nerve latency may also be tested, but in many patients with pudendal neuralgia, this will be normal.

Defecating proctography (Chapter 5) is very helpful when an underlying diagnosis of prolapse is suspected. When chronic idiopathic perineal pain and obstructed defecation are present, the proctogram will demonstrate these findings in 75% of patients. When a patient presents with chronic idiopathic perineal pain alone, a posterior prolapse can be identifed in 50% of cases.

Proctography may underestimate the presence of posterior compartment prolapse. It is of paramount importance to pursue a potential prolapse disorder in patients with chronic idiopathic perineal pain where there is a high clinical suspicion and inconclusive proctography. This is especially important if an enterocele is seen on proctography. Enterocele causes a feeling of pelvic pressure and pain and is suggestive of a posterior compartment prolapse and general pelvic floor weakness [21]. Examination under anesthesia is an extremely useful diagnostic tool where proctography has failed, as the true grade of prolapse can be assessed with the patient pain free and relaxed. In our experience the preferred technique for assessment of prolapse would be to use the circular anal dilator device (Frankenman International Ltd, Hong Kong). The advantage over the use of the cumbersome Eisenhammer speculum is that the prolapse can fall circumferentially into the proctoscope without being trapped under the bivalvular long blades [20].

11.10 Multidisciplinary Approach

Patients with chronic idiopathic perineal pain should be assessed by a colorectal surgeon and a chronic pain specialist to assess for a pelvic floor disorder and possible pain syndrome. It is imperative to have established this clinical relationship prior to rushing into any surgical intervention [16].

A chronic pain care package can be formulated for the individual patient, and it may involve pharmacological, rehabilitational, and psychological approaches. This teamwork is vital.

Pharmacological treatment uses many of the treatments established for chronic pain in other parts of the body. One of the most common is the tricyclic antidepressant amitriptyline, with the antiepileptic drugs, most commonly gabapentin, also in common usage. Opioids may be useful though they may exacerbate constipation.

If there is a pudendal nerve entrapment, then an injection of steroid and local anesthetic under the guidance of a nerve stimulator to identify the nerve at the ischial spine may be useful while blocks of other nerves may also be undertaken and where necessary done under radiological guidance. There is increasing interest in nerve decompression, which is usually undertaken via the transgluteal or transperineal route [22].

Many patients with chronic idiopathic perineal pain will have evidence of posterior compartment prolapse [14]. Many, but not all, of these patients have symptoms of obstructed defecation. Published data are awaited, but there is some emerging evidence that with careful case selection, treatment of this prolapse may bring about relief of the pain.

11.11 Conclusions

The diagnosis of perineal pain syndromes is difficult because they constitute overlapping functional entities. Organic pathology should be excluded in the first instance. Specific nerve entrapment syndromes, while a relatively small part of the group as a whole, should also be sought, as their treatment is quite different and specific.

Historically, for the management of patients with chronic idiopathic perineal pain, there has been something of a “silo mentality”, whereby patients with similar presentations and signs receive very different treatments determined by little more than which specialty they happen to see. Working in groups and adopting a multidisciplinary approach will allow better regulation of treatment and opportunities for learning and research in this emerging field.

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Part IV

Conservative Treatment

Biofeedback and Pelvic Floor Disorders

12

Federica Cadeddu, Franco Salis, and Giovanni Milito

12.1 Biofeedback Therapy for Dyssynergic Defecation

12.1.1 Pelvic Floor Dyssynergia

Chronic constipation is a common self-reported gastrointestinal problem that affects between 2% and 34% of adults in various populations studied [1].

Approximately half of constipated patients suffer from obstructed defecation. Obstructed defecation is a broad term of the pathophysiologic condition describing the inability to evacuate contents from the rectum. Obstructed defecation is often a functional disorder, associated with psychoneurosis, rectal hyposensation, and anismus. It may result from functional, metabolic, mechanical, and anatomical derangements involving a rectoanal evacuatory mechanism. Failure to release and paradoxical contraction of puborectalis muscle and anal sphincters during straining are thought to be the main functional causes of obstructed defecation [2, 3].

Pelvic floor dyssynergia is usually defined on the basis of symptoms and physiologic and radiologic studies. Symptoms include a feeling of incomplete evacuation and rectal obstruction, passage of hard stools, rectal or vaginal digitations, and excessive straining in the constipated patient (stool frequency of fewer than three times per week).

Diagnostic criteria for pelvic floor dyssynergia include those for functional constipation, namely two or more of six symptoms present for the last 3 months with an onset more than 6 months in the past; the symptoms are straining, lumpy or hard stools, sensation of incomplete evacuation, sensation of anorectal

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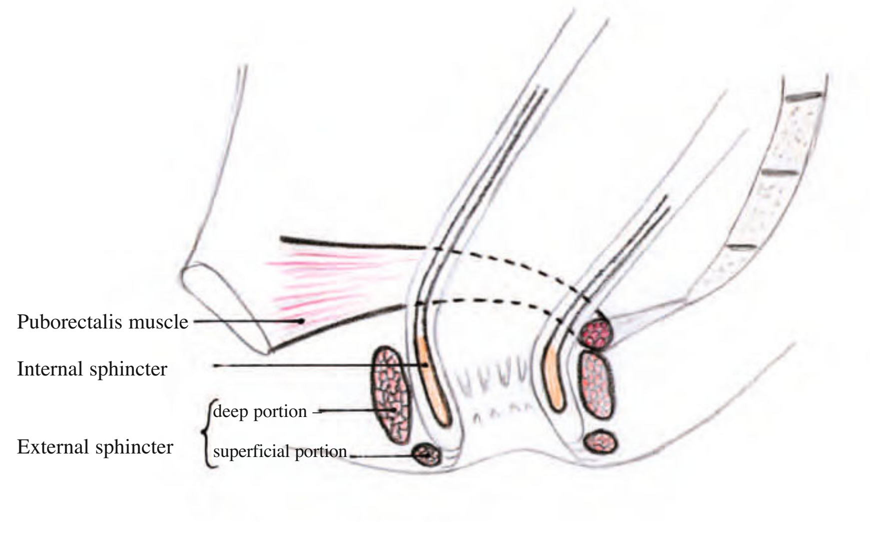

Fig. 12.1 Anatomy of anal sphincters and puborectalis muscle. *Red* puborectalis muscle, *yellow* external sphincter deep portion, *pale yellow* external sphincter superficial portion, *orange* internal sphincter

obstruction/blockage, or manual maneuvers to facilitate defecation for more than one-quarter of bowel movements, or less than three bowel movements per week [4, 5].

To meet the criteria for a diagnosis of pelvic floor dyssynergia, the patient must also undergo objective diagnostic testing and demonstrate at least two of three abnormalities: impaired evacuation of the rectum, inappropriate contraction or less than 20% relaxation of the pelvic floor muscles (Figs. 12.1 and 12.2) and inadequate propulsive forces during defecation [4].

Concerning the diagnosis, careful perineal and digital rectal examination, colonic transit time study, anorectal manometry, anal electromyography (EMG) defecography, or dynamic magnetic resonance imaging (MRI) of the pelvic floor usually help to assess a correct diagnosis.

Anorectal manometry provides a comprehensive assessment of anal pressures, rectoanal reflexes, rectal pressures, sensation, and compliance. Several types of recording devices are available, but perfused catheters and balloon probes are among the most commonly used. A paradoxical increment in anal pressure on straining efforts is a distinctive feature of dyssynergic defecation [4] (Figs. 12.3 and 12.4). An increment in muscle motor activity on straining may be demonstrated by means of EMG either by intra-anal electrodes or by electrodes taped to the perianal skin.

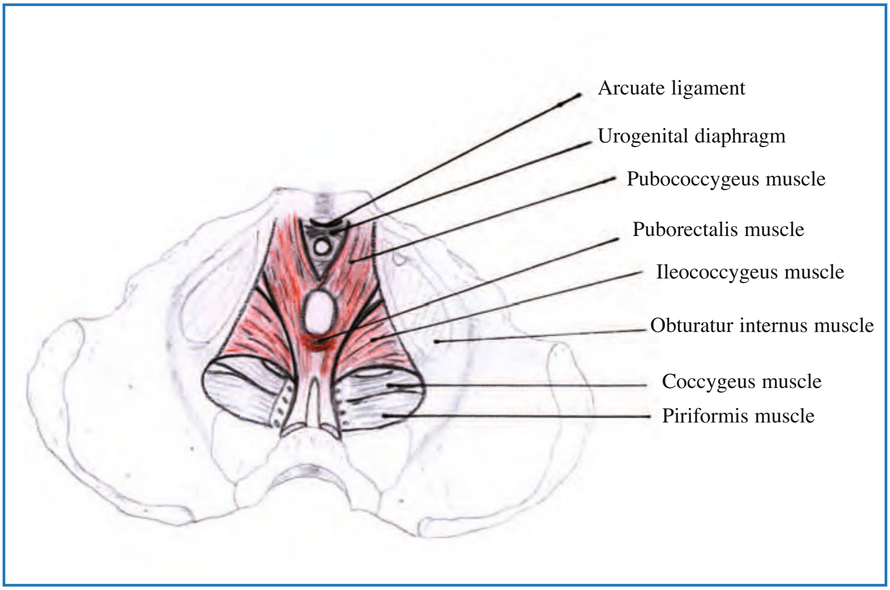

Fig. 12.2 Anatomy of levator ani complex

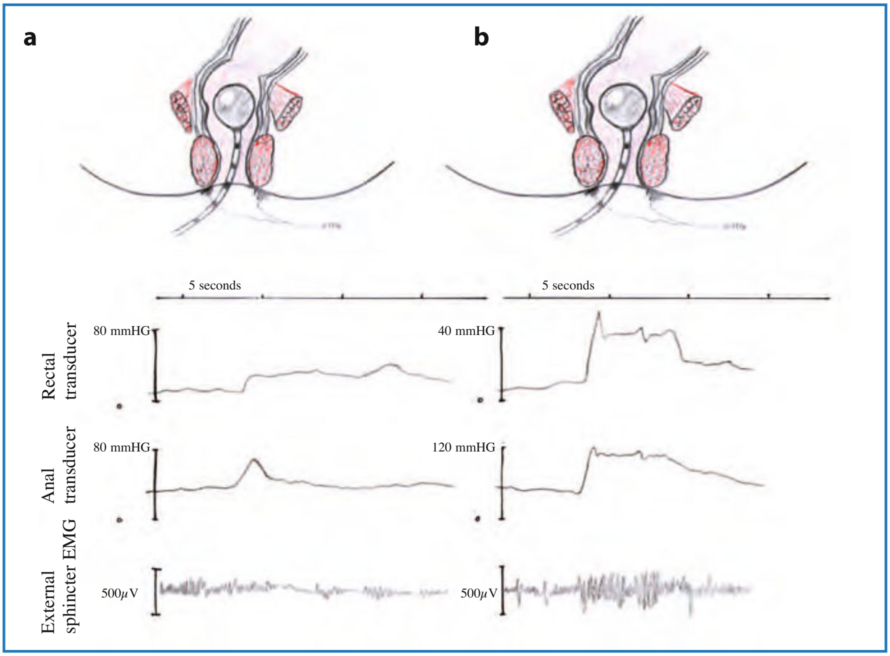

Fig. 12.3 Anal manometry and electromyography during defecation in a normal person (**a**) and in presence of pelvic floor dyssynergia (**b**)

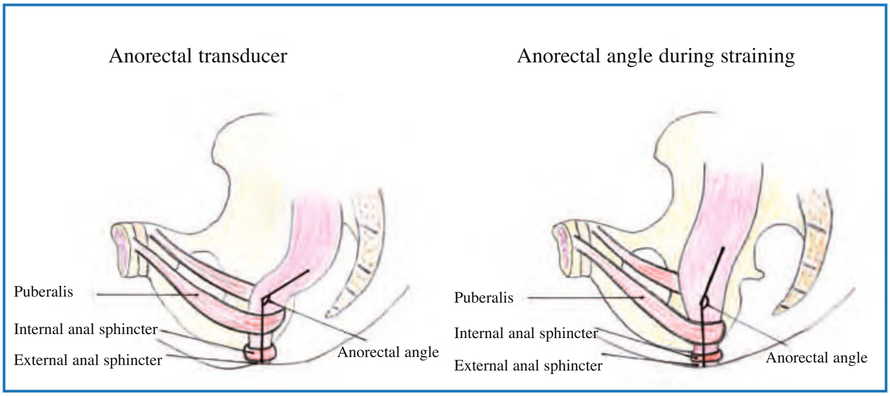

Fig. 12.4 Anorectal angle at rest and during straining in absence of pelvic floor dyssynergia

Defecography is a radiographic test providing morphological and functional information on the anorectum. Several parameters may be assessed, such as pelvic floor descent, anorectal angle, rectocele, and rectal prolapse. Failure of the anorectal angle to become more oblique on straining provides indirect evidence of defective pelvic floor relaxation, and impaired evacuation of contrast material is also suggestive of dyssynergia [4].

Anal EMG may be recorded either by intra-anal probes or by perianal EMG electrodes attached to the skin [6, 7]. The EMG activity used in biofeedback training is the averaged activity of large numbers of muscle cells rather than the activity of small groups of muscle cells innervated by a single axon. This averaged EMG activity is recorded with large electrodes on the skin or the mucosa of the anal canal rather than with needle electrodes. Averaged EMG recorded in this way is proportional to the strength of contraction of the underlying muscles (Fig. 12.4).

Defective expulsion is commonly investigated by asking the patient to defecate a 50 ml water-filled rectal balloon; patients with functional defecation disorders usually fail this test [7]. Some patients also have a higher threshold for perceiving the urge to defecate [6], but the clinical significance of this sensory dysfunction is ill-defined, in contrast to the relevance of rectal sensory impairment in fecal incontinence [8].

Patients with functional defecation disorders are often unresponsive to conservative medical management, and the surgical division of the puborectalis muscle (which has been proposed for the treatment of dyssynergic defecation) has resulted in poor benefit and an unacceptable risk of anal incontinence [1, 3]. Treatment with botulinum toxin injection may provide temporary improvement, but it remains an investigational treatment. Therefore, the gold standard of therapy of pelvic floor dyssynergia is conservative and is based on a high-fiber diet, physical activity, and biofeedback training [2].

12.1.2 Biofeedback Techniques for Pelvic Floor Dyssynergia

Biofeedback is a conditioning treatment where information about a physiologic process (contraction and relaxation of a muscle) is converted to a simple visual or auditory signal to enable the patient to learn to control the disordered function. Biofeedback is considered appropriate when specific pathophysiological mechanisms are known and the voluntary control of responses can be learned with the aid of systematic information about functions not usually monitored at a conscious level [6]. Biofeedback involves the use of pressure measurements (manometry) or averaged EMG activity within the anal canal to teach patients how to relax pelvic floor muscles when straining to defecate.

Various biofeedback techniques (intra-anal and perianal EMG monitoring, manometric anal probe biofeedback, intra-rectal balloon expulsion biofeedback, ultrasound biofeedback) have been investigated, but none has a superior success rate, which ranges from 30% to over 90% [9–11].

Despite controversy about the method of biofeedback and the number of sessions needed, it seems reasonable to use this generally safe technique as the initial treatment for pelvic floor dyssynergia.

Biofeedback training protocols vary among different centers [6, 7]. A mainstay of behavior therapy is to first explain the anorectal dysfunction and discuss its relevance with the patient before approaching the treatment [3, 7]. Biofeedback interventions for pelvic floor disorders are directed at teaching patients to relax their pelvic floor muscles while simultaneously applying a downward intra-abdominal pressure to generate propulsive force (Valsalva maneuver). Patients are shown anal manometry or EMG recordings displaying their anal function and are taught through trial and error to relax the pelvic floor and anal muscles during straining [6–8]. This objective is first pursued with the help of visual feedback on pelvic floor muscle contraction, accompanied by continuous encouragement from the therapist. When the patient has learned to relax the pelvic floor muscles during straining, the visual and auditory help are gradually withdrawn [6]. Another retraining option is to simulate defecation by means of an air-filled balloon attached to a catheter, which is slowly withdrawn from the rectum while the patient concentrates on the evoked sensation and tries to facilitate its passage [3, 7]. In the next phase of training, the patient is taught to defecate the balloon by bearing down, without the assistance of the therapist. Some centers also add a balloon sensory retraining to lower the urge perception threshold [12]. The number of training sessions is not standardized, but 4–6 sessions are frequently provided. Individual training sessions last 30–60 min.

Therapeutic sessions are professionally demanding, and a highly trained and motivated therapist is essential. No study has addressed the necessary training required for an individual to administer biofeedback therapy. In particular, it is unclear whether the adequate provider should be a physician, psychologist, or nurse. Experience varies among centers, but the low cost reimbursement provided for behavior therapy is likely to influence future choices.

12.1.3 Biofeedback for Pelvic Floor Dyssynergia: Literature Results

Controlled studies systematically comparing different biofeedback protocols with each other are lacking. In the literature, the symptomatic improvement rate has been shown to vary widely between 44% and 100% in several uncontrolled clinical trials. Subsequent randomized trials have confirmed the higher efficacy of biofeedback compared with standard therapy and laxatives.

Chiarioni et al. [13] randomized 109 dyssynergic patients to EMG biofeedback training or to polyethylene glycol and assessed outcomes at 6 and 12 months. Biofeedback patients were more satisfied than the control group (80% vs. 22%, $p < 0.001$) and reported greater reductions in blocked or incomplete bowel movements, straining, abdominal pain, and use of enemas and suppositories. Stool frequency increased in both groups.

Rao et al. [14] compared anal pressure biofeedback to two control conditions – sham biofeedback and standard care – in 77 patients. Standard care subjects received diet and life style advice, laxatives, and scheduled evacuations. At 3 months follow-up, the biofeedback reported significantly more complete spontaneous bowel movements, defecation improvement, and higher satisfaction than the sham-treated group.

Heymen et al. [15] compared EMG biofeedback to two control conditions: diazepam (5 mg) (a skeletal muscle relaxant) or placebo 1 h before attempted defecation. Prior to randomization, all 117 patients were provided with enhanced standard care that included diet, lifestyle measures, stool softeners, and scheduled evacuations during a 4-week run-in and those who reported adequate relief at the end of run-in ($n = 18$, 15%) were excluded. Eighty-four patients were randomized. At 3 months follow-up, biofeedback-treated patients reported significantly more unassisted bowel movements than placebo-treated patients ($p = 0.005$) In the intent-to-treat analysis, 70% of the biofeedback group reported adequate relief compared with 23% of diazepam-treated patients ($p < 0.001$) and 38% of placebo-treated patients ($p = 0.017$).

Although it is encouraging that more controlled studies have been carried out in recent years, these trials were heterogeneous with regard to inclusion criteria, treatment protocols, and end points.

The mechanism of action of biofeedback therapy is also not known. Although various parameters of colonic and anorectal function show improvement, and one study showed improvement in distal colonic blood flow [16], the precise alterations are unclear. Recent studies using bidirectional cortical-evoked potentials and transcranial magnetic stimulations suggest significant bidirectional brain–gut dysfunction in patients with dyssynergic defecation [16]. Whether an improvement in bowel function correlates with an improvement in brain–gut dysfunction remains to be explored.

Finally, concerning the technique of choice, a recent meta-analysis showed that in open-label studies, the mean success rate with pressure biofeedback was slightly greater than with EMG biofeedback (78% vs. 70%) [17]. No differences were found between anal versus perianal EMG recording. In addition, adding balloon feedback did not seem to influence the therapeutic outcome [17]. However, the majority of studies in the last 10 years have utilized EMG biofeedback rather than pressure feedback, even in the absence of scientific evidence [17]. There are no standardized protocols, and centers use different combinations of laboratory EMG training, home EMG training, and balloon feedback, depending on the researchers' experience.

12.2 Biofeedback Therapy for Fecal Incontinence

12.2.1 Fecal Incontinence

Fecal incontinence (FI) is a debilitating and embarrassing problem facing approximately 2.2% of the US general population over 65 years old. The etiology of FI is multifactorial and can be due to several factors including neuropathic, traumatic, congenital, and obstetric trauma, as well as iatrogenic injuries caused by injudicious fistula surgery, hemorrhoidectomy, and lateral internal sphincterotomy, among others [18]. FI symptoms can range from mild to severe and the work-up and treatments of this disorder are just as varied. Patients may complain of incontinence to flatus, or liquid or solid stools. In some patients, just the concern that an accident may happen adversely affects their daily quality of life and limits their ability to interact socially due to fear and embarrassment. Several scoring systems have been created and validated to help patients and their medical practitioners quantify the severity of symptoms and the effects of FI on their daily life. These scores are used by physicians to plan treatment strategies and by researchers to study the outcomes of FI treatments [18].

The mechanism of fecal continence is extremely complex despite the simplicity that physicians often ascribe to it. The sphincter mechanism requires the ability to discriminate between solid, liquid, and gas; voluntarily allowing for the passage of one while holding the other components [19]. Treating FI requires an understanding of this complex pelvic floor musculature, innervation, and function, as well as the mechanisms that must be present to ensure continence. The internal and external sphincters and the puborectalis muscle comprise the sphincter mechanism. The internal anal sphincter (IAS) is a continuation of the circular, smooth, involuntary muscle of the rectum that accounts for the resting tone of the anus. The rectoanal inhibitory reflex allows the internal sphincter to relax in response to rectal distension, preparing the anal canal for defecation [18, 19]. The external anal sphincter (EAS) provides voluntary control over defecation and provides the squeezing pressure measured by anal manometry. The puborectalis is a U-shaped muscle that controls the rectoanal angle that increases during defecation. Both parasympathetic and sympathetic nerves provide the innervation of this sphincter complex. The pudendal nerve innervates both the puborectalis and EAS and when neurogenic incontinence is present, latency of this nerve can be detected [19]. Because of the embarrassing nature of FI, symptoms are often hidden by patients and thus are underreported and undertreated.

Once these symptoms are voiced, it is important to obtain a detailed account of the incontinence. Descriptions of partial incontinence to only gas or liquid stools, and occasional or complete involuntary passage of solid stools should be provided to assess severity. Episodes of soiling or leakage and use of protective pads for undergarments are important, as well as the thorough assessment of general bowel habits. A careful history of anorectal surgery, colorectal disease, anal intercourse, obstetric trauma, rectal prolapse, and neurologic disorders should be taken.

Details of the patient's stool frequency, consistency, or frequency of incontinent episodes should be obtained to assess the severity FI symptoms. There have been several score indices created to quantify symptoms: the Fecal Incontinence Severity Index (FISI), or the Cleveland Clinic Incontinence Score that combines the loss of flatus, liquid, and solid stools as well as impact of quality of life to assess the severity of FI. Other scoring systems specifically address the effects of FI on quality of life, as in Fecal Incontinence Quality of Life Questionnaire (FIQL) published by the American Society of Colon and Rectal Surgeons. The clinician can use these tools to assess the severity of symptoms and thus recommend a strategy for evaluation and treatment [19].

Regarding the diagnostic tests [20], the first step is to identify whether the incontinence is secondary to diarrhea. If so, endoscopic mucosal evaluation, stool tests, and breath tests may be useful. Anorectal manometry quantifies IAS and EAS function, rectal sensation, rectoanal reflexes, and rectal compliance. Anal endosonography provides an assessment of the thickness and structural integrity of the EAS and IAS and can detect scarring, loss of muscle tissue, and other local pathology. It is performed by using a 7–12 mHz rotating transducer with a focal length of 1–4 cm. More recently, three-dimensional ultrasound imaging has become available, which provides better delineation of anal sphincters and puborectalis and surrounding structures Rectal balloon distention with incremental volumes of air can be used for the assessment of both sensory responses and compliance. Incontinent patients may exhibit rectal hyposensitivity or hypersensitivity. MRI provides superior imaging with better spatial resolution of the EAS. A major contribution of anal MRI has been the recognition of external sphincter atrophy, and sometimes without pudendal neuropathy. The addition of dynamic pelvic MRI by using fast imaging sequences or MRI colpocystography, which involves rectal filling with ultrasound gel and having the patient evacuate while lying inside the magnet, may each provide better delineation of pelvic anatomy. The use of an endoanal coil significantly enhances the resolution and allows more precise definition of sphincter muscles. However, comparative studies with other technology, and costs and clinical utility have not been assessed. EMG of the anal sphincter identifies sphincter injury as well as denervation–reinnervation potentials that indicate neuropathy. Finally, the integrity of the entire spino-anorectal pathways that control anorectal function can be assessed by magnetic stimulation and recording of motor-evoked potentials [19, 20].

12.2.2 Biofeedback Techniques for Fecal Incontinence

Biofeedback treatment of FI was proposed by Engel and coworkers, 30 years ago [21]. Patients were taught to improve their ability to voluntarily contract the external anal sphincter during rectal filling, by improving the strength of the sphincter (motor skills training), or by increasing the ability to perceive weak rectal distention (discrimination training), or by combining the previous two mechanisms (training in the coordination of sphincter contractions with rectal sensation). No side-effects were reported and the treatment was generally well accepted. Further trials showed that therapeutic goals can be achieved through training that employs measurements of pressures (manometry) or electrical activity (EMG) in the anal canal [22].

12.2.2.1 Manometric Biofeedback

Biofeedback training aimed at increasing the strength of the EAS has usually been carried out by recording anal canal pressures, coupled with visual/auditory signals proportional to the pressures themselves. Anal pressure may be recorded by balloon probes or by perfused catheters [23]. During manometric recording, the patient is required to squeeze as in preventing defecation while being given visual feedback and verbal guidance on how to reach this goal. The patients may also be taught to inhibit wrong responses such as contraction of the abdominal muscles. Asking the patient to squeeze may be obtained in response to balloon distention of the rectum or without rectal distention [24]. Some authors have suggested that improving squeeze duration is more important than maximizing anal strength. Therefore, patients are taught to pursue this therapeutic goal as a part of the biofeedback protocol [24].

12.2.2.2 Electromyography Biofeedback

Strengthening the pelvic floor muscle may also be achieved by showing the patient a recording of the integrated (average) EMG activity from the striated muscles that surround the anal canal. In EMG training, the patient is asked to squeeze and relax without rectal distention, and home exercises in which the patient is required to repeatedly squeeze the pelvic floor muscles (Kegel exercises) are usually added to the training to further strengthen these muscles. Other methods of EMG recording of the pelvic floor employ an anal plug with surface electrodes; this is very easy to use and requires no preparation [25].

12.2.2.3 Sensory Discrimination Training

This is aimed at increasing the patient's ability to perceive and respond to rectal distention [26]. After inserting a catheter-mounted balloon into the recrum, the latter is inflated with different air volumes; the patient is then asked to signal when the feeling of distention is perceived, or to contract the pelvic floor muscles in response to the distention. For these purposes, easily perceived distention with large volumes of air is given at first, and the volumes of distention are gradually decreased until the patient is able to perceive them with difficulty.

Repeated distention slightly above and below the sensory threshold of the patient, coupled with the investigators' feedback on the accuracy of detection, teach the patient to recognize distention of even weaker intensity [23].This type of sensory training is often coupled to sphincter strength training, asking the patient always to contract (as strongly as possible) in response to rectal distention and providing feedback on the strength of contraction and accuracy of detection [23]. Several pieces of evidence suggest that sensory discrimination training (aimed at reducing the threshold for perception of rectal distention) is very important for an effective biofeedback procedure [21]. We have recently evaluated 24 patients with severe, solid-stool FI [27] by teaching them to squeeze in response to rectal distention; the patients were evaluated 3 months after biofeedback training, and were classified as responders (> 75% decrease of incontinence episodes) or nonresponders. Comparison of the two groups showed that responders displayed significantly lower sensory thresholds after training with respect to nonresponders, but squeeze pressures were not significantly different between groups. Sensory thresholds measured before biofeedback training were good predictors of which patients would respond to it; in fact, patients with more severe sensory impairment had poor response to biofeedback training [27]. Sphincter strength and severity of FI before biofeedback training were not useful as predictors of outcome.

12.2.3 Biofeedback and Fecal Incontinence: Literature Results

Most of the available studies concerning the use of biofeedback to treat FI have been carried out by manometric means; however, a clear superiority of pressure versus EMG feedback has not been reported [28].

A review of all the studies reported in the literature, regardless of etiology, shows that about two-thirds of patients display at least a 75% decrease in episodes of FI [29], although only about 50% develop complete continence. However, it must be stressed that: (1) no uniform criteria for defining improvement or assessing outcome have been adopted; (2) inclusion criteria differed; (3) treatment protocols varied; and (4) only few prospective, randomized, parallel-group studies have been published, not enough to draw conclusions on the overall efficacy of biofeedback training. In addition, recent randomized studies have not confirmed the optimistic outcome of previous open studies.

In a first randomized controlled study, Whitehead et al. compared biofeedback plus behavioral management with behavioral management alone in children with FI due to myelomeningocele [30]; both groups displayed significant improvement, suggesting that biofeedback has the same effects as behavioral management for most children with myelomeningocele. In a second controlled study, van der Plas and coworkers [31] studied 71 children with FI without constipation and randomized them to standard care and laxatives or standard care and laxatives plus biofeedback. At 12–18 months follow-up, approximately 50% of children in both groups showed significant improvement in symptoms. A trend toward better outcome was shown in the biofeedback group, but statistical significance was not reached. In the first randomized study of biofeedback in adults with FI, Miner et al. [32] randomized 25 patients to three sessions of either sensory discrimination training without biofeedback on sphincter strength, or equivalent distention without feedback on the accuracy of their detection of the strength of contractions. Patients in the sensory training group had significant decrease of frequency of episodes of incontinence with respect to controls, but between-group differences did not reach statistical significance (probably due to small sample size). Control patients were then given sensory training, and displayed improvement in continence. Thereafter, all patients were randomized again to sphincter-strengthening exercises without biofeedback or to squeezing in response to rectal distention with feedback. Overall, the patients had further improvement of continence in this second step of the study, but no significant differences were observed between groups, suggesting that sensory training is important for the treatment of incontinence, although the results are not definitive due to the small sample size. Recently, the St Mark group reported a large, randomized, controlled study on 171 adults with FI [33]. Patients were randomized to four groups: (1) standard care with advice; (2) standard care with advice, plus anal sphincter exercises taught verbally and via digital examinations; (3) group 2 protocol plus biofeedback therapy run at the clinic; (4) group 3 plus home biofeedback device. Approximately half of the patients in all groups reported improvement of symptoms at 1 year follow-up. Interestingly, quality-of-life measurements, bowel symptoms, and anal sphincter pressures were improved by similar percentages in all groups. Biofeedback therapy yielded no greater benefit than did standard care with advice on an intention-to-treat analysis.

Moreover, another prospective, randomized, controlled study comparing pelvic floor exercises plus anal exercises taught via digital examination with either manometry or anal ultrasound-guided biofeedback in 120 adults with FI failed to show any additional benefit of behavior therapy over Kegel exercises in terms of clinical outcome, quality-of-life measurements, and anal pressures [34]. In that trial, a clinical benefit was evident in the short term in approximately 70% of all patients. The same group then reported this clinical benefit as substantially preserved in the long-term follow-up. Interestingly, quality-of-life measurements and subjective perception of catching up with incontinence improved even in patients whose incontinence scores worsened. Therefore, intervention per se seems to improve subjective symptoms perception in FI.

12.3 Anorectal Pain

Two types of functional anorectal pain are recognized, which may overlap but have different presentation with regard to symptom duration, frequency, and intensity. Levator ani syndrome generally presents as a dull or indistinct feeling of pressure, ache, or pain in the upper rectum. Rome II diagnostic criteria require this to have been experienced 12 weeks out of the last 12 months and for the duration of the episodes to be at least 20 min [26]. It has been reported to affect 6.6% of the general population [35], is more common in women than men, and most commonly affects individuals between the ages of 30 and 60 years. Proctalgia fugax presents as sudden, severe anal, or lower rectal pain that lasts from a few seconds to a few minutes. The pain is often intense enough to disrupt normal life activities [36], but rarely occurs more often than five times a year. Population prevalence estimates for proctalgia fugax vary from 8% to 14% [35], but because of the brief and infrequent nature of the episodes, few sufferers seek medical attention for the condition.

12.3.1 Biofeedback Techniques for Anorectal Pain

All three of the prospective studies of biofeedback for anorectal pain have used pressure feedback from the EAS.

Regardless of the specific biofeedback protocols used to treat anorectal disorders, the in clinic biofeedback training is almost invariably supplemented with other potentially therapeutic components. These often include advice, reassurance and patient education, prescribed pelvic floor home exercises, practice with balloon defecation, laxatives, enemas, fiber supplements, or the use of EMG biofeedback home trainer devices.

The number of biofeedback sessions used in published studies to treat patients for functional anorectal disorders varies greatly, and ranges from 1–12 sessions. Many studies reported high success rates with as few as three or four sessions per patient.

12.3.2 Biofeedback and Anorectal Pain: Literature Results

Three clinical trials of biofeedback for functional anorectal pain were found in the literature, none of which were randomized.

Only one study was found in the literature that examined biofeedback treatment in any kind of controlled fashion. In that study, Ger and colleagues (2002) [37] provided three different treatments to adults who had anorectal pain without organic pathology and had failed conservative medical management: biofeedback (14 patients) electrogalvanic stimulation (29 patients), and steroid caudal block (11 patients). At follow-up 2–36 months after treatment completion, 43% of biofeedback patients versus 38% of those who had electrogalvanic stimulation and 18% of patients who had steroid block treatment reported successful pain relief. These results were not statistically different between groups. Apart from the lack of randomization into groups and the broad variability in follow-up time points across participants, the conclusions that may be made from this study are very limited due to the confounding factor that many participants received more than one of the test treatments, in varying order.

A couple of uncontrolled studies have suggested that biofeedback may be successfully used to treat anorectal pain. Grimaud and colleagues (1991) [38] treated 12 patients with functional anorectal pain with pressure biofeedback to enhance control of theEAS, and reported that all patients improved, with a mean of eight sessions needed to achieve benefit. The improvement was maintained in 11 of the 12 patients beyond a 16-month follow-up.

Heah et al. (1997) [39] treated 16 patients with balloon pressure biofeedback. The patients were significantly lower on pain scores as a group after treatment. Success rate was not stated in this report. However, it was noted that all but 2 of the 16 patients discontinued use of analgesics after treatment.

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Biofeedback Training and Physiokinetic Therapy

13

Filippo Pucciani

13.1 Introduction

Pelvic floor disorders affecting defecation include structural and functional disorders that clinically appear to be associated with symptoms and signs of fecal incontinence and/or obstructed defecation. Fiber supplements, laxatives, timed-toilet training, and behavioral approaches can be effective, but if symptoms persist rehabilitative treatment is the first-line treatment [1]. Unfortunately rehabilitation of fecal disorders has some drawbacks: confusion between biofeedback and pelvic floor exercises, the wide variety of methods within each modality used by single centers (equipment and training program), the wide variety of outcome measures, and few long-term follow-ups reported in the scientific literature make the choice of treatment uncertain. Moreover, rehabilitation requires a highly trained therapist, and is time-consuming both for the therapist and the patient, and therefore patients must be strongly motivated. On the other hand, there are no side-effects of rehabilitative treatment. Even if it fails, it will not have a deleterious effect on the patient's condition, and its results will not affect future decisions regarding therapy, including surgery [2, 3].

To better understand this topic, the chapter is organized into the categories of obstructed defecation and fecal incontinence, the main defecation disorders.

13.2 Rehabilitative Treatment of Obstructed Defecation

Obstructed defecation is broadly defined as the inability to evacuate contents from the rectum, with symptoms of dyschezia and a subjective sensation of anal block-

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age during defecation [4]. Symptoms and signs of outlet obstruction vary from patient to patient and are not correlated with specific anorectal causes, meaning that the patients are a heterogeneous group. Functional diseases, such as pelvic floor dyssynergia, and organic diseases, such as rectocele, rectal intussusception, and descending perineum, are the main causes of altered stool evacuation dynamics. Many patients also have a rectal sensation disorder. The treatment of obstructed defecation, after failure of medical therapy, is usually oriented towards rehabilitation, but once this option has been chosen, the problem of how to carry it out arises. There are no international agreements on the use of the various rehabilitative techniques, and the main problems are related to an absence of standards and guidelines. One option might be the multimodal rehabilitation model, performed under anorectal manometry guidelines [4]. The four rehabilitative techniques (biofeedback, pelviperineal kinesitherapy, volumetric rehabilitation, and anal electrostimulation) can be used when specific damage of a single continence mechanism, identified by manometric reports, occurs. In this way, the rehabilitation cycle is tailored to the pathophysiology of obstructed defecation in the individual patient. The algorithm of multimodal rehabilitation is shown in Fig. 13.1.

Each rehabilitative technique is chosen according to a specific manometric sign, and the techniques may be associated with each other in the following sequence of procedures: (1) volumetric rehabilitation; (2) anal electrostimulation, if necessary; (3) pelviperineal kinesitherapy; and (4) biofeedback.

13.2.1 Volumetric Rehabilitation

Volumetric rehabilitation (sensory retraining) is indicated for disordered rectal sensation and/or impaired rectal compliance. The aim is to increase the patient's ability to perceive the rectal distension induced by feces or flatus ("rectal sensation") and to improve the elastic properties of rectal wall. Volumetric rehabilitation involves twice daily administration of a tepid water enema. If the resting conscious threshold for stools is high, the initial volume is equal to the maximally tolerated manometric volume. The patient holds the liquid for 1 min. In the following days, the enema volume (20 mL) is gradually decreased until the patient achieves a normal value of rectal sensation.

13.2.2 Anal Electrostimulation

The purpose of anal electrical stimulation is to induce muscle contraction by direct stimulation or indirectly via peripheral nerve stimulation, but there is no objective effect on anal sphincter pressure. How electrostimulation works on anal function has not yet been defined, but the main possible benefit is improved anal and perineal awareness [5]. For this reason, the use of anal electrostimulation in patients affected by obstructed defecation is limited only to those patients who need a better feeling of anal and/or perineal plane, such as in those with

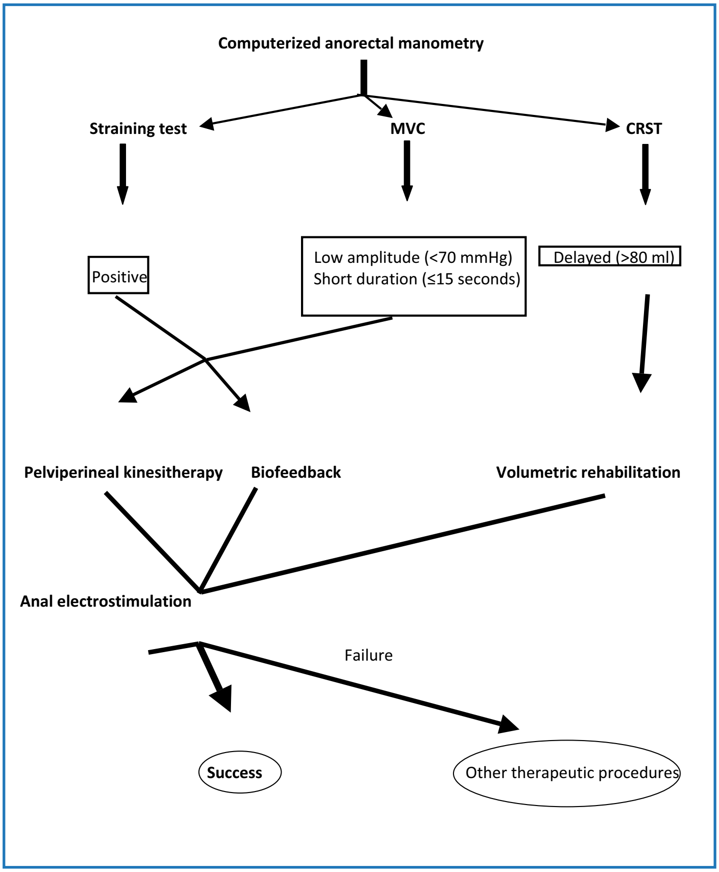

Fig. 13.1 Algorithm of multimodal rehabilitation. *CRST,* conscious rectal sensitivity threshold; *MVC*, maximal voluntary contraction [4]

descending perineum syndrome and pelvic organ prolapse. The rehabilitation cycle is performed daily for 3 months by the patient in a home environment. The device delivers a square wave of current alternating between a 5–6 s work period and a 10–12 s rest period, according to a standard sequence of pulse (width in milliseconds, frequency in Hertz).

13.2.3 Pelviperineal Kinesitherapy

This is a type of muscular training that is selectively aimed at the levator ani muscles by improving performance, extension, and elasticity. It is mainly used when there is pelvic floor dyssynergia because it is a specific muscular re-education technique for the uncoordinated pelvic floor muscles [6]. A cycle of pelviperineal kinesitherapy following a standard sequence of exercises is performed twice weekly in ten outpatient sessions, according to a previously published scheme [6]. Briefly, the sequence carries the patient from a preliminary lesson on relaxed breathing and corporeal consciousness through intermediate steps (anteversion and retroversion pelvic movements, puborectalis stretch reflexes) to the final lessons, which include abdominopelvic synergy and anal contraction exercises (i.e., bending down, coughing, and Valsalva's maneuver in supine, upright, and sitting positions).

13.2.4 Biofeedback

Biofeedback therapy is an operant conditioning [7] that consists of pelvic floor strengthening exercises together with visual/verbal feedback training [8]. It is voluntary, employs a trial-and-error process by which learning takes place, and the subject must be aware of the desired response (signals). During their first training session, patients receive instruction on how to contract and relax the external anal sphincter and puborectalis muscle, and how to improve their strength by using modified Kegel exercises. The number of sessions is customized for each patient and is performed at home using portable devices, twice per day for 20 min. The sessions last for 1 month [6].

Multimodal rehabilitation may be applied to both functional and organic anorectal diseases that cause obstructed defecation.

The results of rehabilitation cycles are reported in Fig. 13.2. The overall obstructed defecation syndrome (ODS) score shows significant improvement after rehabilitative treatment ($p < 0.001$), and is obtained independently of the causes. Pelvic floor dyssynergia, rectocele, and rectoanal intussusception all have a significantly better post-rehabilitative ODS score ($p < 0.001$), but pelvic floor dyssynergia has better results than rectoanal intussusception ($p < 0.038$). Some patients (20.5%) may become symptom-free, meaning that some symptoms or signs of obstructed defecation might persist after rehabilitation. Only 12.8% of patients have poor results and continue with medical treatment involving laxatives and/or enemas: in these cases, obstructed defecation could be the consequence of severe structural lesions. Nevertheless, even if it is difficult to discriminate between patients who will derive some benefit from rehabilitation and those who instead will require surgery, the generally accepted procedure is to begin with rehabilitation treatment [9] and, if this proves ineffective, to then consider surgery [10]. Anal relaxation during attempted defecation, duration of maximal voluntary contraction, and rectal sensation are the main anorectal functions that are positively modified by rehabilitation [1, 4]. There is no general agreement as to what factors may predict or influence the outcomes of rehabilitative treatment. In a recent study, straining and prolonged balloon expulsion independently predicted a positive outcome [11]. Nevertheless, significant anatomical damage, severe psychiatric or neurological disease, poor patient compliance, and poor patient–physiotherapist interactions could pose major obstacles to the success of rehabilitation [12].

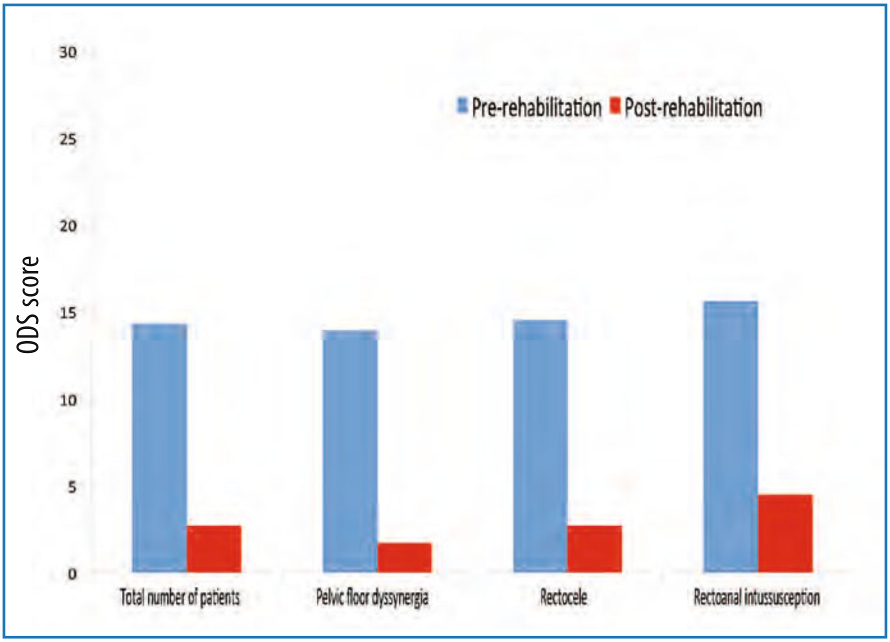

Fig. 13.2 Prerehabilitation and postrehabilitation obstructed defecation syndrome (ODS) scores [4]

13.3 Rehabilitative Treatment of Fecal Incontinence

Fecal incontinence is defined as loss of voluntary control of the passage of stool and/or flatus [13]. The pathophysiology of fecal incontinence is often multifactorial and this fundamental aspect should influence whatever treatment may be proposed. Each patient has his/her own specific pathogenic profile as a result of a mix of etiological factors: for example, 48% of patients with anal sphincter lesions may have impairment of rectal sensation [14]. Each patient thus requires a clinical approach that must be modulated according to his or her specific etiology. This basic fact must be considered when planning therapy for a patient with fecal incontinence and thus rehabilitative treatment should adhere to this statement. Different training programs must be used for different patients and distinct rehabilitation techniques should be employed only when indicated by related diagnostic reports.

The specialized management of fecal incontinence is based on diagnostic data acquired through endoanal ultrasound. The algorithm of management suggests rehabilitative treatment in incontinent patients only when normal anal sphincter anatomy or isolated anal sphincter defect < 120° is detected [14, 15]. Biofeedback and exercises may be considered as the first-line therapeutic option for many patients with fecal incontinence that has not responded to simple dietary advice and/or medication to normalize fecal consistency [16]. There are

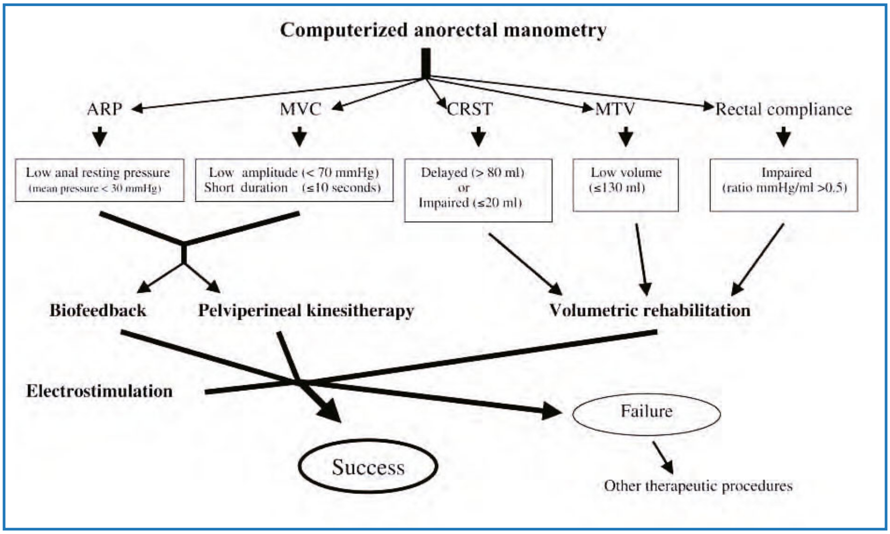

Fig. 13.3 Algorithm for a multimodal rehabilitation program for fecal incontinence. *ARP,* anal resting pressure; *CRST,* conscious rectal sensitivity threshold; *MTV,* maximal tolerated volume; *MVC,* maximal voluntary contraction [19]

no international agreements on the use of the various rehabilitative techniques for the treatment of fecal incontinence, and the main problems are related to an absence of universally accepted standards and guidelines. It is thus difficult to propose a single model of rehabilitation because it will always result in being one-sided and incomplete. The rehabilitative techniques that may be used for treating fecal incontinence include biofeedback, pelviperineal kinesitherapy, volumetric rehabilitation (sensory retraining), and anal electrostimulation. The principles of single technique functioning are the same as those described above (see Section 13.2). Biofeedback is the main technique that should be used: it is superior to pelvic floor exercises [17], but when biofeedback is combined with anal electrostimulation the results are better than biofeedback alone [18]. These two statements partially support the hypothesis that several rehabilitative techniques work on different targets and therefore it is self-evident that the techniques must be used one by one or in combination with each other only in some selective cases. For this reason the model of multimodal rehabilitation, performed under the guidance of anorectal manometry, might be a useful option to treat fecal incontinence [19]. The algorithm for multimodal rehabilitation is shown in Fig. 13.3.

The results for multimodal rehabilitation are shown in Fig. 13.4. The success rate of multimodal rehabilitation is high: 89% of patients have excellent or good results, and 38.9% of all patients are symptom-free after treatment. Unfortunately, two groups of patients seem to derive little benefit from multimodal rehabilitation. Moderate-to-poor results are found in patients affected by rectal prolapse and in

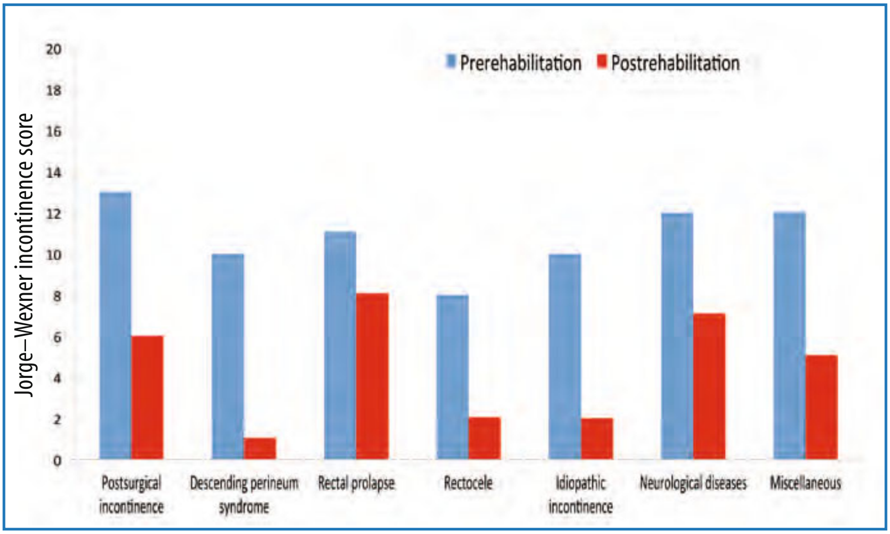

Fig. 13.4 Outcome of multimodal rehabilitation. Prerehabilitation and postrehabilitation Jorge–Wexner incontinence scores according to etiology [19]

those who have neurological disease. Rectal prolapse creates anatomical abnormalities of the pelviperineal and visceral planes while neurological diseases impair afferent and efferent cortical activity: they do not seem to be effectively influenced by rehabilitation. In contrast, fecal incontinence after sphincter-saving operations seems to be positively influenced by rehabilitation [20]. Many patients have a significantly lower post-rehabilitative Jorge–Wexner incontinence score (WIS) than before rehabilitation ($p < 0.03$), even if the score (4.87 ± 3.91) does not indicate recovery; it is in fact higher than that of patients who have not undergone an operation. Post-rehabilitation results are worse in patients who have undergone irradiation and there is a direct correlation (Spearman rank correlation coefficient 0.72) between radiotherapy and impaired fecal continence. Nevertheless, 57% of patients who undergo multimodal rehabilitation have good results; some patients (23.8%) are symptom-free and the remaining 33.2% have some, but rare, bowel function problems.

It is difficult to predict the effects of rehabilitation on fecal incontinence, because many factors can influence the outcome, including nurse–patient interaction, motivation, intact cognition, and absence of depression [21]. Positive prognostic factors are age < 50 years, WIS < 10, anal resting pressure > 50 mmHg, and maximal voluntary contraction > 80 mmHg [22].

In conclusion, rehabilitative treatment of fecal incontinence, when considered in general, is a good therapeutic option and provides useful information: it is able to identify the “non-responders” who should be referred for more expensive and invasive therapeutic procedures (e.g., sacral neuromodulation, surgery).

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Part V

Perineal and Abdominal Approaches

STARR and TRANSTARR Procedures

14

Antonio Brescia, Francesco Saverio Mari, Marcello Gasparrini, and Giuseppe R. Nigri

14.1 Introduction

Obstructed defecation syndrome (ODS) is characterized by a multifactorial etiology, resulting from the interaction of functional and anatomical factors that influence the rectoanal mechanism of evacuation [1]. The most common anatomical changes associated with ODS are rectocele and rectal intussusception [2].

The surgical treatment of ODS is directed at resolution of the obstruction (rectorectal or rectoanal intussusception, external rectal prolapse, anterior rectocele, enterocele, and/or sigmoidocele) and to improve mechanical expulsive forces.

Based on the findings that the stapled hemorrhoidopexy could improve rectal evacuation through resection of the internal mucosal prolapse, Antonio Longo proposed stapled transanal rectal resection (STARR) in 2004 [3]. This procedure is a full-thickness resection of the lower rectum, and involves the use of two circular staplers. This gives an increase in the amount of resectable tissue compared with the initial technique for treatment of hemorrhoids.

Despite good functional results in terms of resolution of ODS, STARR has some limitations related to the use of an adapted and nondedicated stapler. The most important limitation is that the amount of resectable tissue is still limited by the capacity of the two-stapler housing that is not adequate to produce good results on larger prolapses.

The natural evolution of STARR is the TRANSTARR procedure, developed around a new stapler with a crescent-shaped profile; the stapler is known as the Contour Transtar (Ethicon EndoSurgery Inc., Cincinnati, Ohio, USA). This procedure is a full-thickness transanal resection of the entire rectal circumference.

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The new device is able to overcome the limitations of STARR; the length of rectal wall to be resected can be tailored to the patient's anatomy and the surgeon's choice, and is not limited by the stapler housing. Initially proposed as an evolution of and substitute for STARR, this technique is now complementary to STARR.

14.2 Surgical Indication and Exclusion Criteria

Patient selection is the key for successful surgical therapy in patients with ODS. Only those patients who have failed prior conservative treatment should be considered as suitable candidates for the transanal stapling techniques. Before considering referral of a patient with ODS to surgery, the anatomical abnormalities that form the basis of patient's defecatory disorders should always be assessed.

Patients with anterior rectocele and/or rectal prolapse with rectoanal or rectorectal intussusception are the optimal candidates for a transanal stapling procedure. In the absence of rectocele or rectal prolapse, one should never consider a STARR or TRANSTARR procedure.

As outlined in the first consensus conference on STARR [4], and as a result of analysis of the Italian, German, and European STARR registries [5–7], it is recommended that transanal stapling techniques should never be performed in patients suffering from active anorectal infections or severe anorectal pathologies (i.e., anal stenosis, abscess or fistula, polyps, or incontinence). Also the presence of a concomitant proctitis (i.e., inflammatory bowel disease or radiation proctitis) should discourage the surgeon from performing a STARR or TRANSTARR procedure.

In the presence of inflammatory bowel disease or irritable bowel syndrome there is no agreement on whether or not to perform STARR or TRANSTARR, and many authors suggest that the indication should be considered on a case-by-case basis [4–7]. Nevertheless, the poor functional results reported for these patients suggest that a transanal stapling technique should not be recommended [5, 6].

In cases of concomitant pelvic floor anatomical disorders, such as genital prolapse, enterocele, or urinary incontinence, the appropriate surgical approach (combined, sequential, or delayed) should be evaluated on a case-by-case basis, preferably by a multidisciplinary team experienced in pelvic floor disorders [4–7]. A nonsurgical approach, such as pelvic floor rehabilitation or medical therapy, is preferred in the presence of concomitant pelvic floor functional disorders (i.e., pelvic dyssynergy, anismus, anal hypotonia, and minor fecal incontinence), although a surgical approach can be used in patients who have been carefully evaluated [4–7].

In the presence of a previous rectal anastomosis (i.e., anterior or intersphincteric rectal resections, Altemeier, STARR, and stapler hemorrhoidopexy) or foreign material adjacent to the rectum, the execution of a transanal stapling technique must be considered carefully because of the high risk of surgical complications [4–7].

Finally, the presence of concomitant psychiatric disorders should always be excluded before scheduling STARR or TRANSTARR. In fact, psychiatric disorders have been observed in a significant proportion of patients with ODS [8–9].

14.3 STARR

14.3.1 Surgical Technique

The operation should be performed under general or caudal anesthesia, with the patient placed in the lithotomy position. The anal verge should be gently dilated manually and/or using the lubricated obturator of the circular anal dilator (CAD) in order to facilitate the introduction of the CAD into the anal canal. Finally the dilator should be held against the perineal skin by four knotted sutures.

The prolapse should be evaluated by exposing it through the CAD with a mounted gauze swab (Fig. 14.1a).

Starting from the anterior rectal wall, the posterior wall must be protected by a retractor inserted in the anal canal through the lower hole of the CAD.

By introducing the purse-string anoscope in the CAD, three separate one-half (180°) purse-string sutures can be made, including the mucosa, submucosa, and rectal muscle wall, 1–2 cm above the apex of hemorrhoidal ring, in order to include both the top of the rectocele and the internal rectal prolapsed tissue (Fig. 14.1b). Polypropylene 2-0 sutures are usually used.

The opened circular stapler should be inserted into the anal canal through the CAD, with the anvil placed above the purse-strings. By using traction on the purse-strings, the prolapsed tissue is brought into the housing when closing the

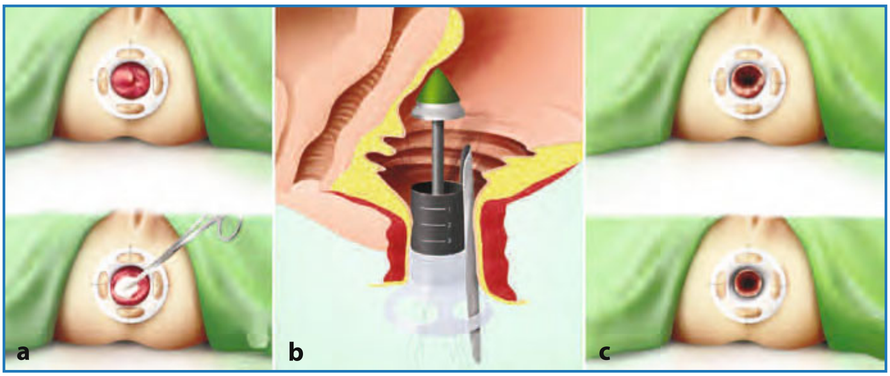

Fig 14.1 STARR technique. **a** Rectal prolapse evaluated by exposing it through the circular anal dilator with a mounted gauze swab. **b** Three separate one-half (180°) purse-string sutures are made to include the mucosa, submucosa, and rectal muscle wall, 1–2 cm above the apex of the hemorrhoidal ring. **c** The staple line is carefully inspected and eventually reinforced using reabsorbable 2-0/3-0 stitches at the end of the resection of the anterior rectal wall and subsequently after the resection of the posterior wall

stapler. During this maneuver the posterior vaginal wall should be carefully inspected in order to avoid its entrapment in the staple line. Sometimes a minimal mucosal bridge left between the two edges of the anastomosis and can be removed with scissors.

At the end of the first resection, the staple line should be carefully inspected and eventually reinforced by using reabsorbable 2-0/3-0 stitches (Fig. 14.1c). This also to improve hemostasis.

The same procedure should be repeated for the posterior rectal wall. The retractor should now be inserted into the upper hole of the CAD.

The so-called "dog ear", a protuberance that remains at the lateral intersections of the staple lines at the end of the procedure, should be oversewn.

14.3.2 Safety and Efficacy

Since its introduction, several studies have been conducted to demonstrate the safety and efficacy of STARR [9–11].

According to the data reported by the Italian, German, and European STARR registries, STARR is a safe procedure with a morbidity rate of 34% [5–7]. The most common reported complication is defecatory urgency, which affects 20–25% of patients. Although it is present in more than one-fifth of patients, the defecatory urgency tends to resolve spontaneously within a few weeks, with a very low percentage of patients continuing to have symptoms after 1 year [4–11].

Postoperative persistent pain is another complication of STARR. This complication has been reported with variable incidence (0.5–7%) in the various series described in the literature [5–11]. The pain seems to be mainly related to mistakes in surgical technique, such as the inappropriate placement of a low staple line. This is because different surgeons have different levels of familiarity with stapled-aided colonproctology techniques.

Less common, but always present in the various case series, is postoperative bleeding. This is reported in 5% of patients and often requires a reintervention [4–7].

Other complications include staple line complications (minor bleeding, infection, or partial dehiscence), fecal incontinence, septic events, and postsurgical stenosis; these occur in a small minority of patients [5–11]. Acute urinary retention reported by some authors seems to be more related to subarachnoid anesthesia rather than surgical technique [5–11].

Rectovaginal fistula, dyspareunia, and rectal necrosis are extremely uncommon, and only a few single cases have been reported [5–11].

The effectiveness of STARR in the treatment of ODS has been demonstrated by several studies [5–11]. The European STARR registry showed that symptoms of ODS were reduced after 12 months in 2,224 (78%) of 2,838 patients treated by STARR [6].

Also, the National Institute for Health and Care Excellence (NICE) recently recognized the efficacy of STARR, but stressed that, although there are limited data on this procedure, there are particularly good-quality comparative data and studies reporting on long-term outcomes [12].

Only a few trials with a median follow-up of more than 1 year have been reported. These, despite the small number of enrolled patients, appear to confirm good results for STARR in the correction of rectocele and rectal prolapse, with only a small percentage of patients reporting a worsening of symptoms [13–15].

Of note is a recently published randomized controlled trial that showed an advantage in terms of reduced intraoperative bleeding and operative time with the use of PPH03 instead of PPH01 (Ethicon EndoSurgery) [16].

Recently, the introduction of newly circular staplers with a more spacious housing, also called “high-volume circular staplers”, may be able improve the results of STARR, but no good-quality data or comparative studies are yet available on the use of these devices [17].

14.4 TRANSTARR

14.4.1 Surgical Technique

Bowel–rectum preparation and antibiotic prophylaxis are recommended before this procedure. The patient should be in the lithotomy position and under general or spinal anesthesia.

The first step is the introduction of a CAD after careful dilatation of the anal verge with the obturator provided in the TRANSTARR kit. The surgeon must check that the dentate line is protected directly below the anal dilator. The CAD must be secured to the perianal skin with four stitches at 2, 4, 8 and 10 o’clock (Fig. 14.2a).

The prolapsed tissue should be pulled gently out through the CAD using a gauze pad and Allis forceps to evaluate the extent of the prolapse and assess the amount of tissue to be resected.

With the aid of the Allis forceps, the rectal wall should be unfolded to expose the apex of the prolapse in order to place 4–5 polypropylene 2-0 stitches, resembling parachute cords (Fig. 14.2b). The sutures must be positioned with two or three full-thickness bites to gain a solid traction on the prolapse. This maneuver must be performed with the use of the access suture anoscope provided with theTRANSTARR kit, being careful not to inadvertently catch some tissue from the opposite rectal wall or the vagina. These stitches allow the surgeon to achieve symmetrical traction of the prolapse around its circumference and to obtain good tissue control during resection.

The initial step provides a longitudinal opening of the prolapse with one firing of the CCS-30 Transtar (Fig. 14.2c). However, in presence of a large prolapse, this is not always easy and it often makes the loading of the prolapsed tissue between stapler jaws more difficult because of the presence of an irregular staple line or bundled tissue. To overcome this, it has been proposed that the prolapse be opened longitudinally with a linear stapler (but this increases the cost

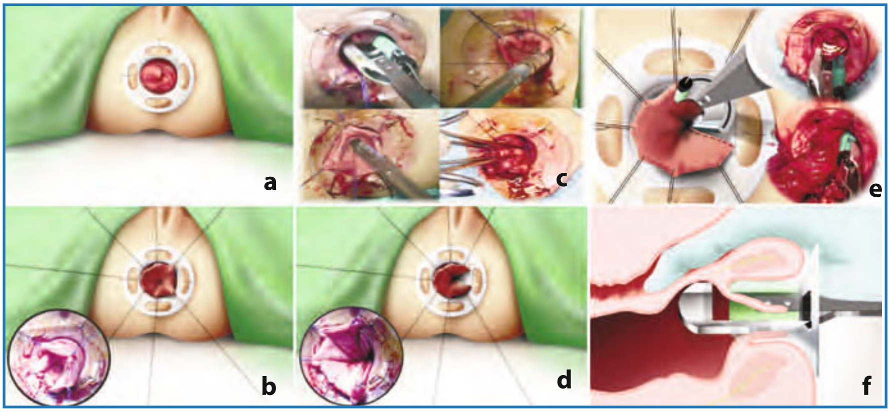

Fig. 14.2 TRANSTARR technique. **a** A circular anal dilator is introduced and secured to perianal skin with four stitches at 2, 4, 8 and 10 o'clock. **b** 4–5 polypropylene 2-0 sutures are placed in the form of parachute cords to control the prolapse during the resection. **c** Longitudinal opening of the prolapse with one firing of the Transtar CCS-30, with a linear stapler or between two Kocher clamps. **d** Rectal prolapse opened longitudinally. **e** Circumferential rectal resection with the Contour Transtar. **f** The posterior vaginal wall is inspected with a finger during the resection of the anterior rectal wall to prevent its entrapment in the staple line, as this can result in formation of a rectovaginal fistula

of the procedure), or by using two Kocher clamps placed at 2 and 4 o'clock to grab the prolapsed tissue, and then opening the prolapse with a cautery between the clamps (Fig. 14.2c, d) [18, 19].

Another one or two polypropylene 2-0 stitches should be placed on both sides of the deep vertex of the prolapse opening, to handle the prolapse during its insertion between the CCS-30 jaws for the first transverse firing. These stitches also act as a reference for the start and end-points of the circumferential resection, allowing the surgeon to prevent spiraling of the staple line. In fact, if the stapler is not well positioned at the bottom of the prolapse opening or it is not perpendicular to the rectum, an irregular or spiraling resection will result, thereby increasing the risk of complications. Using traction on the parachute stitches, it is then possible to start the circumferential rectal resection (Fig. 14.2e).

This maneuver is performed counterclockwise by ensuring that the stapler is placed at the base of the prolapse and perpendicular to the CAD. It is important not to bundle the tissue between the stapler jaws and to maintain the stapler at the same depth, using the CAD as a reference, to reduce the risk of spiraling and the formation of dog ears at the beginning and end of the mechanical suture. During the resection of the anterior rectal wall, the surgeon must be careful not to entrap the posterior vaginal wall in the suture, which can result in formation of a rectovaginal fistula (Fig. 14.2f). This can be achieved by pulling the posterior vaginal wall upward, and inspecting the vagina before firing the stapler.

Usually between four and six recharges are needed to complete resection of the rectum. If a number greater than six cartridges is needed, spiraling should be suspected.

At the end of the procedure, it is possible to place some reabsorbable stitches along the staple line to reinforce the suture and improve hemostasis, especially at the beginning and end-points of the metallic staples.

The resected specimen should always be inspected before the end of the procedure to exclude the presence of tissue not belonging to the rectum (enterocele, sigmoidocele). Before removing the CAD, some surgeons prefer to leave a hemostatic cylindrical sponge of regenerative oxidized cellulose in the rectum to further improve hemostasis.

14.4.2 Safety and Efficacy

Since the introduction of TRANSTARR in 2006, there have been only a few studies conducted to demonstrate the safety and efficacy of the procedure [19–25].

As a result of its recent introduction, there are contrasting data on morbidity of the TRANSTARR procedure, with figures ranging from 7–16% to 60–62% [19–26]. The case series with the higher morbidity are probably subject to complications related to the learning curve for the procedure. The data reported by colorectal surgeons who are experienced in transanal stapling techniques show a lower morbidity rate [19, 21, 23–26].

Following TRANSTARR, as well as STARR, the most common postoperative complication is fecal urgency, which affects 14–28% of patients [19–25]. The incidence of this complication seems to be lower for TRANSTARR than STARR. This is probably related to the fact that the CCS-30 allows uniform rectal resection without reducing the size of the rectal ampulla. The fecal urgency usually resolves spontaneously within a few weeks of surgery, as reported for the STARR procedure.

Postoperative pain and bleeding are less frequent for TRANSTARR than STARR, with an incidence of 0.6% and 1.5%, respectively [24, 26].

Gas or fecal incontinence are rare after TRANSTARR (2–3%), but this can be a serious complication because of psychological implications [19, 23]. To reduce the risk of postoperative incontinence, it is important to assess the anal sphincter contractile deficit with an anorectal manometry and endorectal ultrasound before scheduling the patient for TRANSTARR. The role of preoperative pelvic floor rehabilitation is paramount to improve the anal sphincter contractile function and help previously incontinent or hypocontinent patients to become suitable for TRANSTARR [19].

Staple line complications, such as spiraling, dehiscence, infection, or retained staple granuloma, have been reported for TRANSTARR; these were mainly reported at the beginning of the learning curve for the procedure [19–26].

Other rare, but feared, complications, such as rectovaginal fistula, dyspareunia, rectal wall necrosis, retroperitoneal sepsis, and retroperitoneal or endoabdominal bleeding, have been reported following TRANSTARR [19–26]. These complications are typically related to technical errors such as entrapment of the vaginal posterior wall in the suture line, or excessive resection of the rectal wall.

The results confirm the statements made by some authors that the TRANSTARR is a safe procedure, but it should be carried out by surgeons with appropriate training and experience in transanal stapled surgery [19–26]. Therefore TRANSTARR, in experienced hands, has shown good results in ODS treatment. This is mainly due to its capacity to ensure a real tailored therapy, allowing the surgeon to decide the amount of prolapsed tissue to be resected on a case-by-case basis.

The three larger studies reported in the literature show an improvement of ODS symptoms in 88%, 83% and 77% of patients [19, 21, 26]. These results appear to be stable after 1 year of follow-up.

Despite all the studies reported in the literature agreeing that TRANSTARR allows the surgeon to resect a greater amount of prolapsed tissue than STARR, none is able to state whether transanal resection of more tissue improves the functional outcome [22–25, 27]. This has prompted most surgeons not to consider TRANSTARR as a replacement for STARR, but rather as a complementary procedure [22–25, 27]. Therefore, the decision on which technique to use should be assessed case by case, on the basis of the extent of prolapsed tissue in each patient, using STARR for the treatment of small internal rectal prolapses or male patients, and reserving TRANSTARR for treatment major or external rectal prolapses.

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Delorme's Procedure

15

Mario Trompetto and Silvia Cornaglia

15.1 Introduction

Rectal prolapse is common and is associated with symptoms of obstructed defecation, straining, impaired continence, and anismus. It has an estimated incidence of 4 per 1,000 population [1]. The incidence is highest in elderly women, with a female:male ratio of between 6:1 and 10:1 in this age group. In younger patients the condition is much less common and is usually associated with evacuation difficulty; in this age group the sex ratio is approximately one [2]. Complete rectal prolapse is defined as a full-thickness protrusion of the rectal wall through the anal canal [3]. When the prolapsed rectal wall does not protrude beyond the anus it is referred to as intussusception or internal rectal prolapse. Mucosal prolapse is the protrusion of rectal mucosa only [4, 5]. Whether a minor prolapse can lead to a complete prolapse remains the subject of debate.

While a complete prolapse is easily diagnosed by clinical examination, an internal prolapse is more difficult to detect. Digital examination reveals an internal prolapse in only 40% of cases [6, 7]. Preoperative assessment should include a complete evaluation of the colon with colonoscopy to exclude any coexisting condition. A colonic transit study is useful when rectal prolapse is associated with constipation. Obstructed defecation is usually investigated by defecography or dynamic magnetic resonance imaging, which can highlight other pelvic floor disorders.

The aim of treatment is to restore the normal anatomy, with the hope of improving function. When nonoperative therapy (including bulking agents, stool softeners, laxatives, or suppositories [6]) is unsuccessful, surgery should be con-

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sidered. The available operations can be divided into perineal and abdominal. Of the former, Delorme's procedure and perineal rectosigmodectomy (Altemeier's procedure) are the most commonly performed.

15.2 Delorme's Procedure

Delorme's procedure was described in 1900 by the military surgeon Edmond Delorme as a well-tolerated procedure that could be carried out, if necessary, under local anesthetic [8]. Its main anatomical indication is a complete rectal prolapse not exceeding more than 10 cm [9].

15.2.1 Technique

Either the lithotomy position or the prone jack-knife position can be used. The rectum is prolapsed to its maximum extent by gentle traction. A circular incision of the mucosa is made 1–2 cm proximal to the dentate line. Submucosal infiltration with epinephrine (1:200,000) saline solution is used to raise the mucosa from the circular muscle and to induce vasospasm of the submucosal vessels. A cylinder of mucus membrane is dissected from the muscle layer by scissors or diathermy dissection. The mucosectomy is then taken as far proximally as the length of the prolapse, so that the length of the removed cylinder is twice the length of the clinical prolapse (Fig. 15.1). Before dividing the mucosa at the chosen level, stay sutures are inserted into the mucosa above the intended point of division. This prevents upward retraction of the upper rectum after division. The rectal muscle is then plicated by six or so longitudinally placed sutures to create a concertina-like effect (Fig. 15.2). These stitches are then tied to achieve mucosal opposition and plication of redundant rectal muscle. Further mucomucosal sutures may be necessary to complete the mucosal endorectal anastomosis [10].

Delorme's procedure is a well-tolerated perineal operation for a full-thickness rectal prolapse. However, prolapse recurrence is common and the reported recurrence rate varies widely (Table 15.1) [8, 11–13]. Delorme's procedure has low morbidity, and can be performed on unfit and frail elderly patients with significant comorbidities [14]. Good bowel function can be achieved [15], with incontinence reduction and improvement in rectal sensation [16]. Although abdominal operations have a lower recurrence rate, it is feasible to perform Delorme's procedure again in cases of recurrence, without increased complications. Delorme's procedure can achieve a favorable and better outcome for internal rectal prolapse treatment by applying stringent patient selection criteria [17, 18]. Pitfalls in performing the procedure relate primarily to associated perineal and colonic conditions. In fact, a data review showed that proximal internal prolapse with rectosacral separation at defecography, preoperative chronic diarrhea, fecal incontinence, weak sphincter tone, previous sphincter injury, and descending perineum (more than 9 cm on straining) were associated with poorer outcomes [18].

Fig. 15.1 Complete mucus membrane cylinder at the end of the dissection. (Reproduced from [9], with permission)

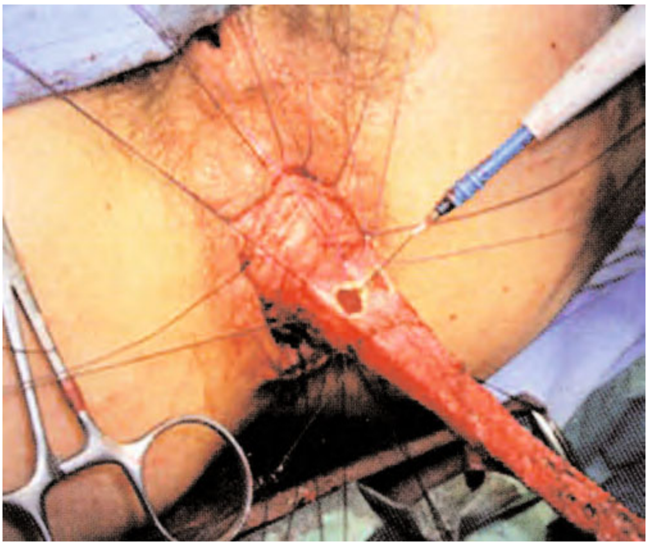

Fig. 15.2 Rectal muscle plication and mucosal section. (Reproduced from [9], with permission)

Inadequate mucosectomy because of extensive diverticular disease can prohibit effective and complete proximal mucosectomy, leading to early recurrence of the prolapse [19].

Table 15.1 Delorme's procedure: results

Study [Reference]	N. pts	Recurrence (%)
Lechaux et al. (1995) [8]	85	13.5
Tsunoda et al. (2003) [11]	31	13
Pascual et al. (2006) [12]	21	9.5
Lieberth et al. (2009) [13]	66	14.5

15.3 Internal Delorme's Procedure

A modified Delorme's procedure has been designed to treat internal rectal prolapse in symptomatic rectal obstructed defecation.

15.3.1 Technique

With the patient in the lithotomy position under epidural anesthesia, a specially designed anoscope is inserted to visualize the distal rectum. The anoscope has the same characteristics of the procedure of prolapse and hemorrhoids (PPH) anoscope, consisting of a tube 30 mm long and 29 mm diameter. It is fixed to the perineum by four stitches. Rectal submucosa is infiltrated with epinephrine and saline solution (1:200,000). The operation starts with a circular incision of the mucosa at 2 cm proximal to the dentate line using monopolar electrocauthery. Mucosal circumferential dissection from the rectal muscle layer proceeds proximally upwards for 80–150 mm, until the surgeon can feel an increased resistance while tractioning on the redundant mucosa. At the level of the resistance the mucosa is divided and the muscle is plicated longitudinally by eight 2.0 absorbable sutures. An interrupted mucomucosal suture completes the endorectal anastomosis (Figs. 15.3–15.6) [20].

In cases of associated weak pelvic floor, or type II or III rectocele, a levatorplasty is performed through a posterior transverse vaginal incision [20].

In our institution, from October 2001 to March 2009, 167 consecutive patients underwent internal Delorme's procedure, with or without levatorplasty, for symptomatic rectal obstructed defecation associated to rectal intussusception and rectocele. At a mean follow-up of.3.0 ± 1.5 years, fecal urgency changed from 22% to 17.6% ($p = 0.754$), and tenesmus fell from 53.9% to 17.1% ($p < 0.001$). The Cleveland Clinic Constipation Score (CCCS) and obstructed defecation syndrome score fell by 50% or more in 82% and 73.7% of cases, respectively. The CCCS did not worsen in patients who remained incontinent, while 45.7% of previously incontinent patients regained normal continence. The Patient Assessment of Constipation Quality of Life (PAC-QoL) showed a decline of the overall score preoperatively to postoperatively, with a reduction of anxiety/depression, and physical and psychological discomfort ($p < 0.001$). Seventeen patients (10.2%)

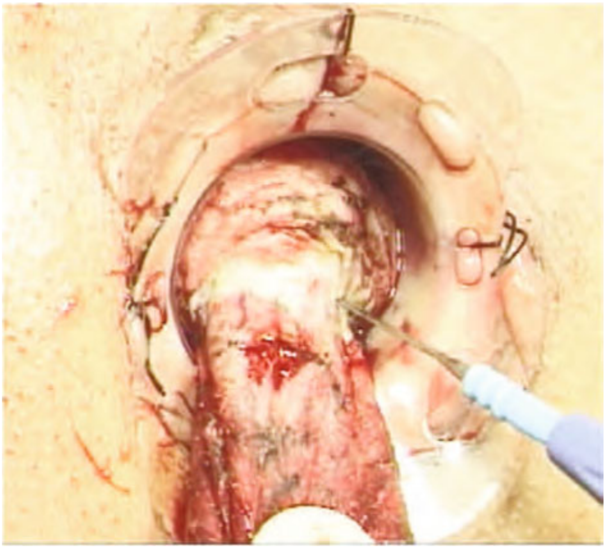

Fig. 15.3 Mucosal circumferential dissection from the rectal muscle layer

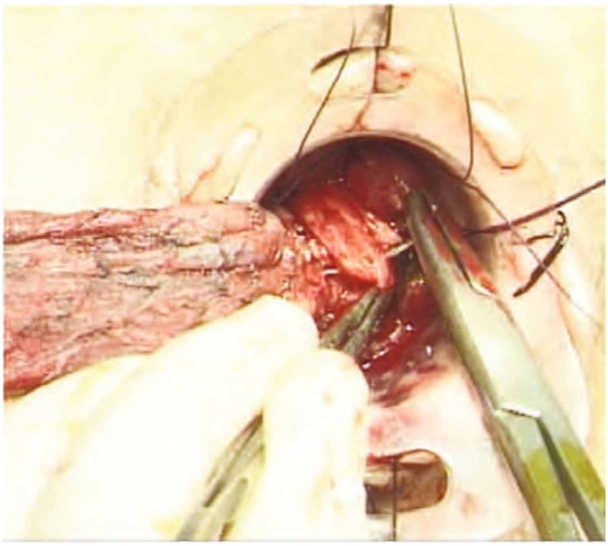

Fig. 15.4 Longitudinal rectal muscle plication

developed a postoperative complication including anal fissure (4.2%), proctalgia (3%), suture line dehiscence with stenosis (1.8%), and *Clostridium difficile* colitis (1.2%) [20]. The recurrence rate of 5.4% is comparable with previously published large series of Delorme's procedure [21, 22]. It is also comparable with the recurrence rate reported in stapled transanal rectal resection (STARR) and TRANSTARR procedure studies [23, 24]. Postoperative urgency decrease in

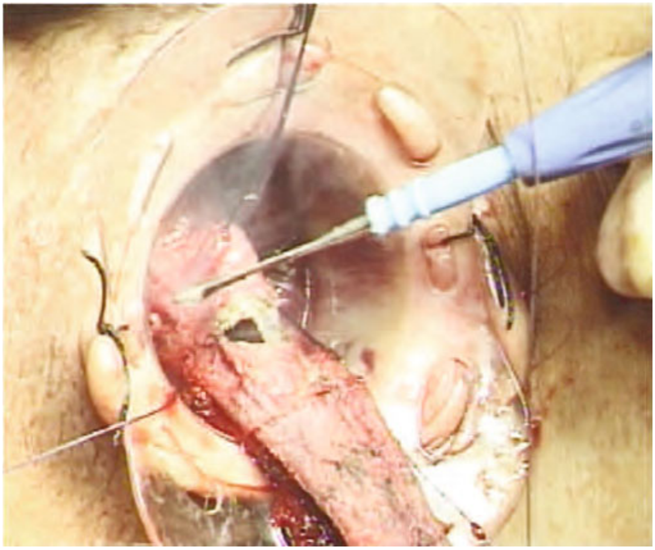

Fig. 15.5 Mucosal section

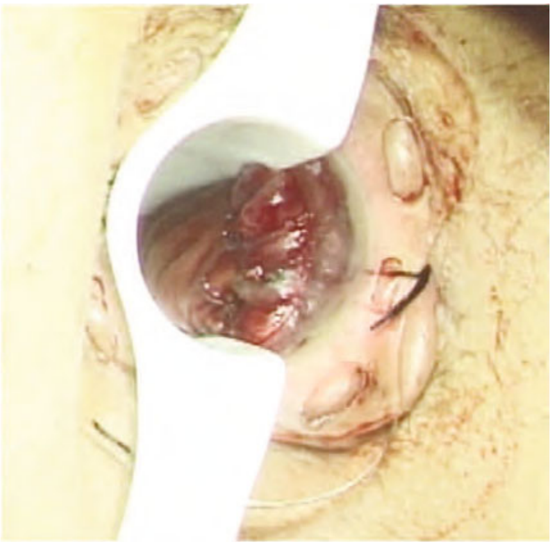

Fig. 15.6 Mucomucosal sutures complete the endorectal anastomosis

internal Delorme's procedure, although not statistically significant, is a crucial outcome compared with the potential complication and high urgency rate recorded after the STARR procedure [24–26]. Therefore compared with other treatments, which are discussed in other chapters, internal Delorme's procedure can be considered a cheap, effective, and safe procedure for rectal obstructed defecation that is caused by rectal intussusceptions, with or without rectocele.

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The Altemeier's Procedure for External Rectal Prolapse

16

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16.1 Introduction

During the 19th and 20th centuries, different perineal approaches were proposed for the treatment of external rectal prolapse, and despite the high recurrence rate of the prolapse they were preferred to the abdominal approach. In recent decades, the improvement in general anesthesia and perioperative care, and the widespread use of laparoscopic techniques, have enabled the abdominal approach to become more common, as it is believed to carry a lower recurrence rate and probably better functional results.

However, the perineal approach to rectal prolapse has not been abandoned altogether, and it is usually indicated in elderly, high-risk, frail patients for emergency incarcerated external prolapse [1] and gangrenous rectal prolapse [2], and it is often preferred to the abdominal approach in the USA because it is less invasive and results in a shorter length of hospital stay [3].

Perineal rectosigmoidectomy to treat external full-thickness rectal prolapse was first described by Altemeier in 1952 [4]. The procedure consists of a perianal rectosigmoidectomy, followed by a coloanal anastomosis, which is hand-sewn or stapled, and associated with a levatorplasty. It is indicated in symptomatic patients with an external prolapse exceeding 5 cm, which has an important impact on the quality of life because of bleeding, mucus discharge, and fecal incontinence.

16.2 Surgical Technique

Antibiotics and antithrombosis prophylaxis are indicated in the perioperative period.

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Preoperative bowel cleaning is also suggested. The anesthesia can be epidural (this is suggested because of fewer complications); general or local anesthesia have also been used by some surgeons. Patients can be placed in a lithotomy or jack-knife position; the latter is preferred because of its better and safer view of the operating field.

Using a Lone-Star self-retractor, the anal canal and the dentate line become more evident and the full-thickness rectal prolapse can be exteriorized with Babcock forceps. A mark is made with diathermy on the prolapsed mucosa to identify the dissection line; this line should be far enough away from the internal anal sphincter (5–6 cm from the anal verge) so that if a stapled anastomosis is planned it can be performed safely without the inclusion of the internal anal sphincter fibers.

The dissection is performed circumferentially by diathermy, including all the layers of the rectal wall, mobilizing all the extraperitoneal rectum, and sealing all the mesorectal vessels (with diathermy, ultrasound, or radiofrequency) close to the viscerum where they enter the posterior part of the rectum. When all the extraperitoneal rectum has been mobilized, the pouch of Douglas is opened and the peritoneal cavity can be explored. The dissection continues following the sigmoid wall, until the colon can be exteriorized without tension.

A posterior levatorplasty can be performed before resecting the colon, as this procedure is believed to decrease recurrence rate [5]. The levator ani muscle is exposed through the self retractor, and two or three nonabsorbable interrupted stitches (2-0 Prolene) are applied to its posterior plication. The sutures should allow a finger to be passed easily through the colon and the plicated muscle. Reclosure of the pouch of Douglas or the peritoneum is not strictly necessary.

The rectal wall is then cut anteriorly and a first absorbable stitch (3-0 Vicryl) is passed from the colonic wall to the anal canal, including both mucosa and muscle layers. The same action is repeated laterally, in the same way, leaving the posterior rectal wall as the last place to fix, after complete resection of the elongated colon. At least other two stitches are then apposed between each cardinal point in the same way. An excessive number of stitches or an uninterrupted suture could lead to stricture of the coloanal anastomosis.

During performance of the anastomosis, care should be taken to prevent contamination of the pouch of Douglas by stool. Once the hemostasis is controlled and the anastomosis is completed, the colon can be replaced inside the peritoneal cavity.

The coloanal anastomosis can be made by a circular stapler (31, 33, or 34 mm): a purse-string with nonabsorbable stitches (2-0 Prolene) is made on the proximal colonic wall where the head of the stapler is placed and another purse-string is fashioned on the anorectum around the stapler. After the introduction of the stapler into the anus, the sutures are narrowed and tied, and the device is activated and withdrawn. The resected sample should include about 1 cm of colon and anorectum. A hemostatic sponge can be left into the anus.

There is no need for postoperative medication, and postoperative analgesics can be delivered at the patient's request; antibiotic prophylaxis is suggested for up to 2–3 days postoperatively, and oral feeding can be resumed after 1–2 days [4].

16.3 Complications

The overall complication rate ranges between 0% and 13% [6–9], and most complications are minor. Rare major complications reported include pelvic hematoma, anastomotic dehiscence and stricture, sigmoid perforation, pararectal abscess, and strangulated ileus trough transcoloanal anastomosis [10]. The mortality rate is relatively low (0–6%) [11–13] despite the inclusion of elderly frail patients in the case series, probably because of the mini-invasive approach of the procedure, the shorter hospital stay, and early mobilization.

16.4 Recurrence

The major drawback of Altemeier's procedure is the high recurrence rate; the medical literature reports a wide range of recurrence from 0% to 58% [14–19], regardless of technical details and length of follow-up. Recurrence usually occurs in the first 2 years postoperatively, although the definition of recurrence is still not clear, because in some studies the presence of a minimal mucosal prolapse is also considered to be a recurrence. Most authors report a recurrence in about 10–20% of cases [12–13, 20]. A few authors [21, 22] have reported a lower recurrence rate (about 5–6%), but the sample size was too small (18 and 41 patients) and the follow-up period was too short (10 months) to produce meaningful results; in other studies with a larger sample of patients and longer follow-up, the reported recurrence rate was 14% and 18%, regardless of the length of the colon resected or the levatorplasty [7, 23].

The association of levatorplasty with the technique was introduced as a means of reducing recurrence. Chun et al. [5] proved its efficacy in a study that was not randomized or controlled, showing that after a mean follow-up of 28 months, recurrence rate was 20.6% in patients without levatorplasty compared with 7.7% in the levatorplasty group, with no significant changes in functional outcomes between the two groups. These results were confirmed by Habr-Gama et al. [9], who reported a 7% recurrence rate after 24 months, irrespective of the coloanal anastomosis produced.

Another critical point for prolapse recurrence could be the length of the resected specimen, although no studies have confirmed this hypothesis. However, if there is residual mobile colon and weakness of the connective tissue in the pelvic diaphragm, then this might contribute to recurrence of the prolapse.

Recurrent prolapse can be safely re-treated by using the perineal route: among the treatments proposed, another Altemeier procedure or Delorme procedure can be performed, however an abdominal rectopexy is sometimes considered in patients fit to have an abdominal operation. Other procedures, such as postanal repair, anal bulking agent injection, or sacral nerve stimulation [18] are often required to help the patient with associated fecal incontinence.

16.5 Functional Outcome

The functional outcome in this operation is of paramount importance; nevertheless, this information is lacking in most studies, and a validated questionnaire on the quality of life has been reported in only a few recent papers.

About 80% of patients who undergo to the Altemeier procedure have fecal incontinence associated with external rectal prolapse [12, 15, 18, 23], and this has been reported to be improved in about 70–100% of patients after the operation [5, 9, 17]; on the other hand, however, some patients complain of new-onset minor fecal incontinence (soiling, liquid stool) after treatment.

The reasons for fecal incontinence include inhibition of the internal anal sphincter by the prolapse itself or impairment of pelvic autonomic nerves. However, it has been shown that pudendal neuropathy is not related to the incontinence, because even patients with severe pudendal neuropathy show continence improvement after the Altemeier procedure [24]. It is thought that removal of the rectal ampulla, with the loss of its function of reservoir and compliance, could account for worsening of incontinence.

16.6 Comparison with Other Procedures

The old debate as to whether the abdominal or the perineal approach for full-thickness rectal prolapse is best was recently investigated by a multicenter European randomized controlled trial (the Prosper Trial), in which nearly 300 patients with full-thickness rectal prolapse were randomly treated with different approaches (abdominal versus perineal, suture versus resection rectopexy, Delorme versus Altemeier). Although not all the patients recruited in the trial were randomized for the treatment, the results showed no statistically significant differences in the abdominal versus perineal group, in terms of recurrence and quality of life [25].

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The Express Procedure for Internal Rectal Prolapse

17

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17.1 Introduction

External pelvic rectal suspension (Express procedure) is a developing operation aimed at restoring the anatomical position of the internal rectal prolapse, while hopefully improving the underlying physiological abnormality. The procedure is carried out transperineally with limited rectal mobilization and, where appropriate, can be combined with surgical correction of a rectocele. The operation consists of "hitching up" the rectum and reinforcement of the rectovaginal wall utilizing a commercially available long-lasting collagen biomaterial (Permacol™ ; Tissue Science Laboratories plc, Aldershot, UK).

17.2 Patient Selection

The procedure is offered to patients with severe rectal evacuatory dysfunction, who have been shown on proctography to have a circumferential, full-thickness intussusception that impedes rectal evacuation. All patients must have tried a course of optimal conservative management and a supervised bowel-retraining program prior to consideration for surgery. An associated rectocele is repaired only if it is greater than 2 cm diameter and contained residual barium after evacuation on proctography.

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17.3 Surgical Technique

The patient is prepared with a phosphate enema on the day of the operation, to ensure that the rectum is empty before the procedure. The operation is carried under either general or regional anesthesia, with the patient placed in the Lloyd-Davies position on the operating table. A dose of cefuroxime 750 mg and metronidazole 500 mg is administered at induction and a urinary catheter is inserted in the bladder. After infiltration in the rectovaginal plane with a 1 in 300,000 adrenaline saline solution, a crescent skin incision is made in the perineum midway between the vagina and the anus. The dissection starts in a plane just anterior to the external anal sphincter and extends cranially to enter the rectovaginal plane, taking care not to injure the sphincter complex, the rectum, or the vagina. A Lone Star anal retractor applied to the edges of the wound facilitates the dissection. Meticulous hemostasis is performed, since bleeding from the vaginal venous plexus is common. Once the rectovaginal plane is entered the dissection is extended up to the posterior vaginal fornix to the level of Denonvillier's fascia. The posterior wall of the vagina is retracted anteriorly and the medial borders of the levator ani muscle exposed. The anterior rectal wall is gently dissected from the puborectalis muscle on both sides to achieve mobilization of the rectum as laterally as possible. Lateral retraction of the puborectalis muscle may help the lateral rectal dissection. This dissection allows access to approximately 12–15 cm of the anterolateral aspect of the distal rectum. In the male patient, a similar dissection is performed extending behind the prostate. Close dissection to the rectal wall is of paramount importance especially at the inferolateral aspect of the prostate to minimize hazard to the pelvic nerves.

Once the perineal dissection is completed, two skin incisions of 2 cm diameter are made just medial and above the level of the pubic tubercle, one on each side. Two 0 polydioxanone sutures (PDS™ ; Ethicon, Edinburgh, UK) on a J needle are inserted into the periosteum and tendinous insertions overlying the pubis on both sides. These sutures are left long with their needles intact and clipped. The incisions are deepened to gain access to the retropubic space. A purpose-designed tunneller is inserted via the perineal wound lateral to the vagina, upwards anterior to the bladder through the retropubic space of Retzius and behind the pubic bone to emerge through the suprapubic wound (Fig. 17.1a). The plane is delineated by blunt dissection as far as possible from above and below so as to guide the tip of the tunneller as it is advanced upwards so as to prevent injury to the bladder and the vagina.

The sharp point of the tunneller is replaced by a plastic olive which has attached to it a T-shaped strip of Permacol™ (Fig. 17.1b). This strip is then drawn down to the perineal wound and its transverse part, measuring 2 cm in width, is sutured to the anterolateral rectal wall with two 0 PDS™ sutures with its lower edge at approximately 6–8 cm above the superior border of the sphincter complex (Fig. 17.1c). The vertical part of the strip is left emerging from the suprapubic wound with an artery forceps attached. This maneuver is repeated on the opposite side. Once in place, vertical traction is exerted on the strips via the

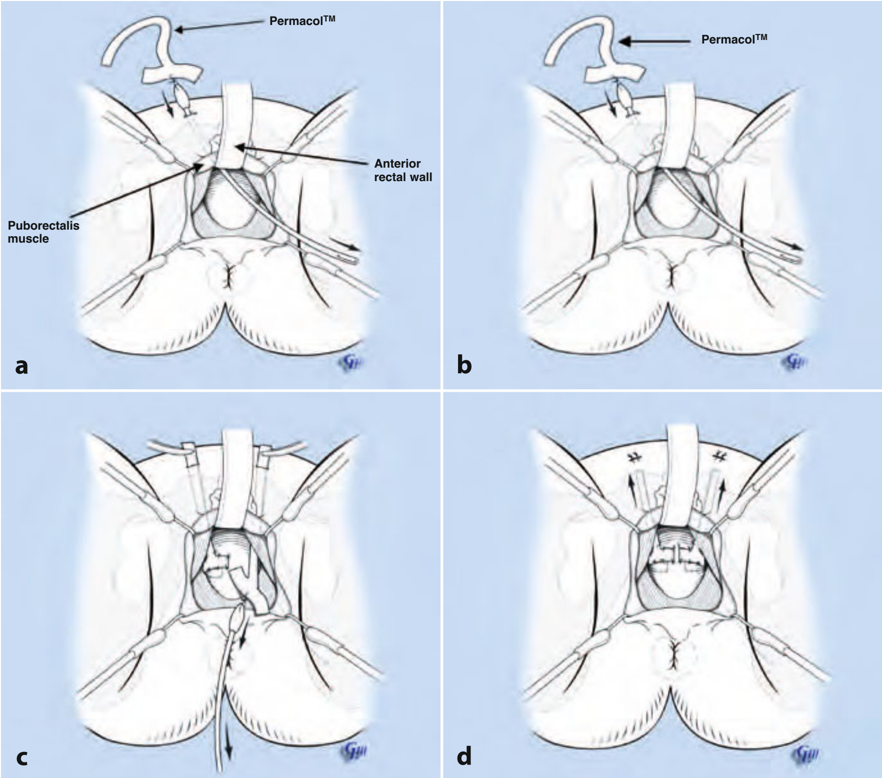

Fig. 17.1 Express procedure for intussusception. **a** A purpose-designed tunneller is inserted via the perineal wound (lateral to the vagina) upwards behind the pubic bone to emerge through the suprapubic wound taking great care to prevent injury to the bladder. **b** The sharp point of the tunneller is replaced by a plastic olive, which has attached to it a T-shaped strip of Permacol™. **c** The Permacol™ strip is drawn down to the perineal wound and positioned so the transverse part of the strip lies on the anterolateral wall of the rectum at approximately 8 cm above the superior border of the sphincter complex. The second strip is similarly placed on the opposite side. **d** After gentle upward traction on the Permacol™ strips, they are sutured to the periosteum of the pubic bone. (Reproduced from [1], with permission)

suprapubic wounds. Once firm but not excessive traction of the rectal wall is achieved, the proximal parts of the T-shaped strips of Permacol™ are sutured to the periosteum of the pubic bone with the two interrupted 0 PDS™ sutures previously placed (Fig. 17.1d). If a rectocele is also present, it can be repaired at the same time using a patch of Permacol™. The patch is shaped 5 × 5 cm in size with two extensions on the lateral sides. The patch is sutured over the anterior rectal wall with interrupted 2.0 PDS™ sutures (Fig. 17.2). The lateral wings are routed behind the puborectalis and sutured to the periosteum overlying the medial aspect of the ischium in line with the rectocele on either side with two sutures of 0 PDS™ on a J needle. This is performed from within the perineal wound, the

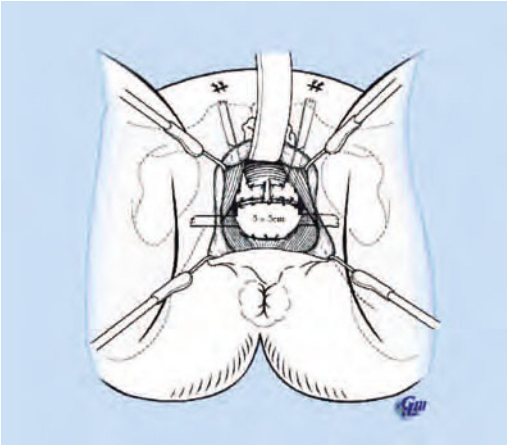

Fig. 17.2 Concomitant rectocele repair. A patch of Permacol™ is sutured over the defect in the rectovaginal septum and the wings are sutured to the ischial tuberosities. (Reproduced from [1], with permission)

rationale being to reinforce the rectovagianal septum and at the same time limit the anterior protrusion and ballooning effect of the anterior rectal wall causing the rectocele.

17.4 Results

Our initial experience with this procedure included 17 patients [1]. Thirteen patients (all female) had a concomitant rectocoele repair. Clinical details are summarized in Table 17.1. The median follow-up period was 12 months (range 6–20 months).

There were no major intraoperative complications. One patient, in whom the anterior rectal wall was injured and repaired at the time of the operation, subsequently developed sepsis in the rectovaginal plane, which required drainage and a defunctioning stoma. Two further patients developed local sepsis, one requiring surgical drainage. Despite the sepsis, none of the patients required removal of the Permacol™. Postoperative complications also included neuralgic pain (n = 3), which resolved in all cases during follow-up. No patient reported any changes in sexual function, and in particular none of the women reported dyspareunia.

When reviewed at 6 months, all patients reported a significant improvement in symptoms related to prolapse and evacuatory function. Incontinence did not deteriorate in any of the patients. Quality of life also significantly improved. Anorectal physiology demonstrated a significant reduction in maximum tolerable volume and pelvic floor descent. All other measurements remained unchanged. Fourteen patients underwent postoperative proctographic evaluation. In ten of these patients the intussusception appeared improved by surgery. Furthermore, 11 of the 14 patients who underwent postoperative proctography had undergone a rectocele repair. Eight of these had no evidence of rectocele on

Table 17.1 Demographics and symptoms for patients with rectal intussusception ($n = 17$)

Patient characteristics and symptoms	
Age (years)	47 (20–67)
Gender (M:F)	4:13
Symptom duration (months)	36 (5–400)
Previous pelvic surgery (*n*)	9 (2 gracilis neosphincter, 4 colposuspension, 3 hysterectomy)
Parity	3 (0–5)
Symptom:	
Obstructed defecation	16
Straining	13
Anorectal pain	8
Prolapse	7
Bleeding per rectum	7
Toilet revisiting	7
Mucus per rectum	6
Fecal incontinence	5
Urinary incontinence	5

For age, parity, and symptom duration values represent median (range). The frequency of each symptom is represented by the number of patients (of 17) reporting that symptom

postoperative proctography. In the remaining three patients who all presented with very large rectocoeles (8 cm, 8 cm, and 6.5 cm), the size of the rectocele was markedly reduced postoperatively (3 cm, 2.5 cm, and 2.5 cm, respectively).

The postoperative functional outcome did not significantly differ in patients, with or without postoperative radiological improvement.

17.5 Discussion

Patients with rectal evacuatory dysfunction may present with a variety of symptoms, often nonspecific and with very variable impact on quality of life. In these patients defecography is used to demonstrate possible morphological abnormality. However similar morphological abnormalities can also be identified in normal subjects [2], and therefore cannot be used on their own as an indication for surgery. Furthermore, as confirmed in our experience, improvement of symptoms following surgical intervention does not necessarily correlate with improved anatomical appearance on postoperative evacuatory proctography. Nevertheless, it is our belief that in patients without pelvic floor dyssynergia in whom severe symptoms have failed to respond to optimal conservative treatments, gross anatomical abnormalities revealed on evacuatory proctography may contribute to their symptoms. Notwithstanding these limitations, the basis of this new technique was to correct the anatomical abnormalities in a way that is less invasive and more effective than traditional approaches.

Rectal intussusception is normally initiated by an anterior take-off point at approximately 6–8 cm from the anorectal junction [3, 4]. Our aim was to fix this area to prevent the process of intussusception. To reach this area via an abdominal approach, rectal mobilization to the pelvic floor is necessary. Such mobilization carries potential hazard to the pelvic autonomic nerves and may contribute to postoperative constipation [5]. Furthermore, incomplete rectal mobilization during abdominal rectopexy may result in inadequate fixation and lead to unsatisfactory results. The Express procedure through the perineal approach allows relatively easy access to the crucial area of the take-off point without violation of the peritoneal cavity and hopefully with less hazard to the pelvic nerves. In our experience it is not associated with worsening incontinence. The insertion of strips of Permacol™ to the anterior rectal wall to prevent the initial take-off of the rectal wall also provides structural support to the entire pelvic floor, as confirmed by a significant reduction in pelvic floor descent. Further the Permacol™ patch in the rectovaginal plane, with its lateral attachments to the ischium, buttresses the anterior rectal wall and successfully corrects the associated rectocele as demonstrated on proctographic postoperatively.

Dissection of the rectovaginal plane required with the Express procedure can be challenging and perforation of the vagina or rectum may occur. Despite repair of such defects it was feared that the presence of foreign material would impair healing and result in extrusion, as has been the case with synthetic meshes in rectocele repair (unpublished observations). In the authors' experience even when local sepsis developed, extrusion or erosion of the implants never occurred and the Permacol™ never had to be removed [1, 6].

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Transperineal Rectocele Correction

18

Giovanni Milito, Federica Cadeddu, and Giorgio Lisi

18.1 Introduction

A rectocele is a herniation of the rectum through the rectovaginal fascia and posterior vaginal wall causing a protrusion into the vaginal lumen. It is a common disorder in women with a history of multiple vaginal deliveries, and it is asymptomatic in 80% of cases [1]. Symptomatic rectocele is less common, usually affects postmenopausal females, and results in obstructed defecation and constipation (Table 18.1) [2, 3].

Rectocele can be classified according to its position: low, middle, or high; and/or their size: small (< 2 cm), medium (2–4 cm), or large (4 cm). Size is measured anteriorly from a line drawn upward from the anterior wall of the anal canal on proctography [4]. It can also be classified into three clinical stages at straining during defecation proctography (Table 18.2).

Surgery should be considered when conservative therapy fails and careful patient selection, based on an accurate morphofunctional assessment, is crucial to obtain a satisfactory outcome [5].

The purposes of surgical repair in the management of rectocele repair are essentially the restoration of normal vaginal anatomy and the restoration or maintenance of normal bladder, bowel, and sexual function.

Transperineal repair of the fascial defect may provide restoration of normal anatomy and symptomatic relief. A variety of synthetic and nonsynthetic graft materials have been used in rectocele repair to enhance anatomical and fuctional results, and improve long-term outcomes. Symptomatic rectocele results in obstructed defecation and constipation. Surgical repair may provide symptomatic relief.

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Table 18.1 Symptoms associated with rectocele

Symptom	Prevalence (%)
Obstructed defecation	75–100
Manual assistance of defecation	20–75
Rectal pain	12–70
Rectal bleeding	20–60
Incontinence	10–30

Table 18.2 Classification of rectocele

I	Digitiform rectocele of single hernia through the rectovaginal septum
II	Big sacculation, lax rectovaginal septum, anterior rectal mucosal prolapse, deep pouch of Douglas
III	Rectocele associated with intussusception and/or prolapse of the rectum

Recent advances in pelvic reconstructive surgery are due, in part, to the availability of new graft materials that allow reinforcement and repair of large pelvic fascial defects, minimizing adverse graft-related effects and postoperative complications [6].

18.2 Pretreatment Evaluation

Although rectoanal intussusception may be observed during physical examination, it is much more likely to be detected during defecography, which remains the most useful diagnostic tool when applied to a symptomatic subject. Defecography is crucial to document the presence of anatomical changes stemming from the symptoms of obstructed defecation. In particular, it is fundamental in order to distinguish between rectoanal intussusceptions and rectal internal mucosal prolapse, and to describe and quantify rectoanal intussusception. It also reveals the presence of other abnormalities, such as the presence of a rectocele or weakened pelvic floor with perineal descent, or failure of the puborectalis to relax during straining and evacuation, which is often associated with pelvic perineal dyssynergia. Rectoanal intussusception, as reported in the literature, appears to be the main reason for obstructed defecation. Defecography seems to be the examination of choice because it allows assessment of not only the rectum, but also the rectovaginal space and vagina in order to investigate the presence of an associated enterocele, or failure of the medium and/or anterior compartment.

However, it should be noted that a transient infolding of the rectal wall can occur during evacuation, even in asymptomatic subjects. In more complex cases in which all pelvic compartments are involved, the introduction of dynamic magnetic resonance imaging has opened up the possibility of better understanding the relationships between the pelvic floor organs and the structures involved. Pelviperineal neurophysiological tests (electromyographic recording of the anal sphincter) and anorectal manometry are also useful, particularly for the evaluation of sphincter tone. Anorectal manometry is very important and it can detect pelviperineal dyssynergia; it provides the basic diagnostic criteria for deciding to carry out pelviperineal rehabilitation.

18.3 Management and Contraindications

Specific selection criteria for the surgical repair of a rectocele are the subject of debate. Surgical repair has been recommended when the rectocele is greater than 3 cm in depth, if there is significant barium trapping or defecography, or if digital assistance of defecation is frequently necessary for satisfactory emptying [8, 9]. However, multiple studies have shown no correlation between the size of a rectocele or the extent of barium trapping and the degree of symptoms or outcome of rectocele repair [10, 11]. Some authors [5, 6, 12] have shown that the main causes of functional failure after classical rectocele repair are:

1. Rectal intussusception
2. Rectal prolapse
3. Enterocele

Therefore it is mandatory that rectocele correction via the transperineal approach must be used only in simple type 1 rectocele, otherwise it would be impossible to correct a rectal intussusception or rectal prolapse by repairing only the fascial defect and normal anatomy would not be restored.

18.4 Surgical Treatment

Anatomofuctional abnormalities can be independent of clinical symptoms, and their surgical treatment must be considered carefully. The risk following careful morphological and physiological investigation is overestimation of the disturbance, and overindication for treatment. Stool softeners, laxatives, and behavioral measures help some patients, but often do not offer satisfactory long-term results. However, the most severely symptomatic patients may be candidates for surgery.

The aims of surgical repair in the management of rectocele repair are essentially: the restoration of normal vaginal anatomy, and the restoration or maintenance of normal bladder and sexual function. Formerly, colorectal surgeons used traditional methods to repair rectoceles per anus by mucosal resection and anterior rectal wall plication. Gynecologists adopted a vaginal approach, excising part of the posterior vaginal wall combined with an anterior levatorplasty [13].

There are significant drawbacks to both techniques. Transanal repair has been shown to significantly reduce both resting and squeeze pressures postoperatively, despite minimizing the amount of anal retraction [14], and it results in a higher rate of enterocele recurrence compared with posterior vaginal wall repair.

Fig. 18.1 Transverse perineal incision

Fig. 18.2 The plane between the rectum and the posterior vaginal wall is dissected to the vaginal apex, the perineal fascia, and the median margins of the elevator plates

Conversely, posterior vaginal wall repair may result in dyspareunia and higher postoperative analgesic requirement, and it might not eliminate the symptom of incomplete evacuation [15]. Richardson [16] recognized that repair of the fascial defect is more important than imbricating the vaginal or rectal walls and was the first to describe repair via a posterior vaginal wall incision and apposition of edges of the defect with interrupted sutures. Consequently, augmentation of transvaginal repair with mesh interposition has been advocated [12, 17, 18].

18.4.1 Technique

A transverse perineal incision is made (Fig. 18.1). The plane between the external anal sphincter and the posterior vaginal wall is developed with diathermy to ensure meticulous hemostasis. The dissection is extended to the vaginal apex to expose the rectocele, the perirectal fascia, and the levator arc (Fig. 18.2).

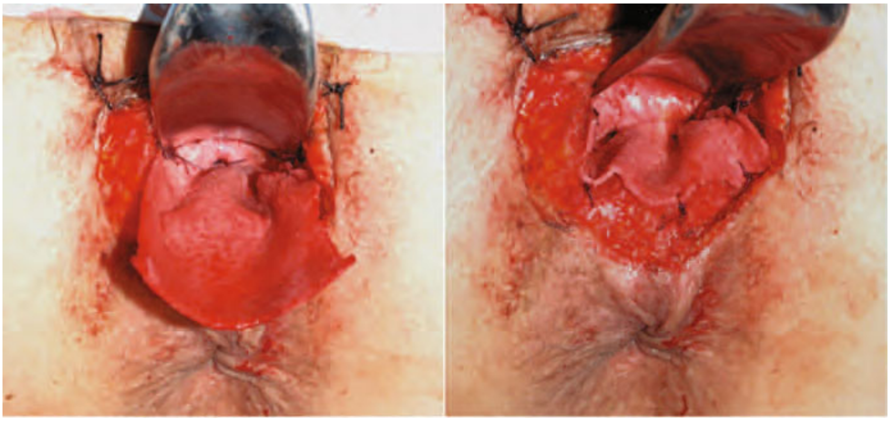

Fig. 18.3 Transperineal rectocele repair with biomesh. The mesh is placed in the rectovaginal space and fixed with interrupted sutures to the levator ani plate on both sides

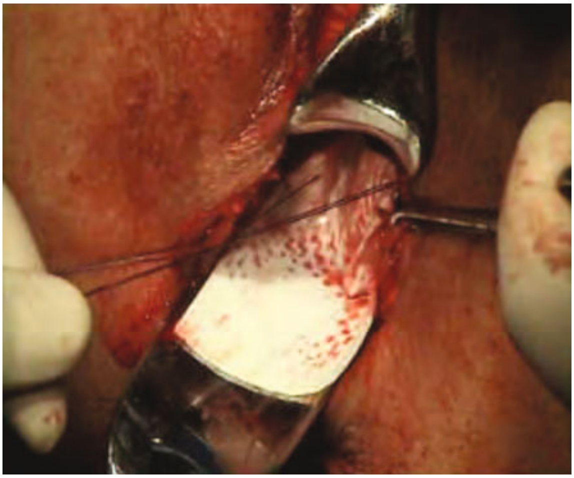

Fig. 18.4 Four to five absorbable sutures are placed in levator plate laterally on each side, beginning near the vaginal apex and continuing distally toward the perineal body

The plane between the rectum and the posterior vaginal wall is dissected until the vaginal apex, the perineal fascia and the median margins of the elevator plates.

Previously, following the site-specific repair, four to five absorbable sutures were placed in the levator arc, beginning near the vaginal apex and continuing distally toward the perineal body, and a vaginal pack was placed in situ. Today, it has been demonstrated that in using this technique, suture points and a vaginal pack are not required [4–6, 19].

The biomesh is affixed to the sutures and laid in place in the rectovaginal space (Fig. 18.3).

Using the same type of sutures, the graft is sutured to the levator arc on the opposite side, followed by closure of perineal incision (Fig. 18.4). A urinary catheter is positioned for the first 24 hours.

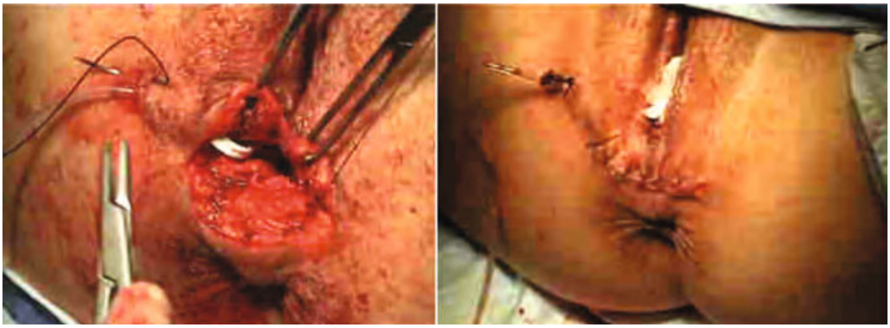

Fig. 18.5 A vaginal pack and urinary catheter are put in place for the first 24 h

Prophylactic antibiotics and antimicrobial irrigation solution are used to decrease the risk of postoperative infection. Patients receive metronidazole 500 mg intravenously three times daily at the beginning of the operation and for 5 days after surgery [6].

18.4.2 Comments

The goals of surgery in the management of rectocele are the restoration of normal anatomy and the restitution or maintenance of normal bowel and sexual function [13, 20].

Three different approaches have been reported for rectocele repair: (1) the transanal approach, which consists of mucosal resection and anterior rectal wall plication; (2) the transvaginal approach, which includes excision of part of the posterior vaginal wall and anterior levatorplasty; and (3) the transperineal approach, which consists of extraluminal anterior access to the rectocele, and biomesh placement in the rectovaginal space [6, 8, 21].

Both transanal and transvaginal repairs have shown several limitations: resting and squeeze pressure reduction after transanal repair, and dyspareunia and obstructed defecation persistence after transvaginal repair [21]. Rectovaginal septum reinforcement using biomesh via the transperineal approach has shown a good functional outcome (Table 18.3).

Table 18.3 Reported patient series that have used the transperineal approach

Study [Reference]	No. Pts.	Follow-up	Cure rate	Complications %
Kohli et al. (2003) [18]	43	12	100	–
Leventoglu et al. (2007) [22]	84	14	100	8.4
De Tayrac et al. (2007) [23]	143	13	96.5	6.8
Smart et al. (2007) [5]	10	–	91	7
Milito et al. (2010) [6]	10	24	100	1 urinary infection

Although only a few clinical studies of transperineal rectocele repair with biomesh have been reported, a review of the literature shows that good results have been reported by all the authors.

18.5 Summary

In summary, transperineal rectocele repair with biomesh appears to be an effective and safe procedure that avoids complications associated with synthetic mesh, as it avoids using rectal sutures and preserves both the rectum and the vagina [24].

Using biomesh seems especially helpful in the perineal repairs that are at high risk of wound contamination, with the possibility of chronic infection and fistulation [19, 25].

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19 Mesh Rectopexy (Ripstein, Orr-Loygue, Wells, and Frykman-Goldberg)

Aldo Infantino and Andrea Lauretta

19.1 Introduction

There is general agreement that surgical treatment is essential for complete rectal prolapse (CRP). Rectoanal intussusception (RAI), also known as internal prolapse, is often regarded as a medical condition; it can be found in healthy subjects [1] and the interpretation of radiological images remains controversial [2]. Therefore surgical treatment for symptomatic RAI is still a matter of debate, and bowel retraining (i.e., high-fiber diet, bulk laxatives, avoidance of straining and digitation, and pelvic floor exercises) must be considered as a first approach, leaving surgery as the last option for cases where conservative therapy fails. Fecal incontinence (FI) and obstructed defecation syndrome (ODS) make CRP and RAI very disabling conditions. FI is present in 30–80% of patients with CRP [3], and also in up to 44% [4] of those with RAI. ODS is often characterized by strenuous effort to expel stools, feeling of incomplete evacuation, rectal tenesmus and frequent visits to the toilet, digitation, and the use of enemas and/or suppositories [5]. Furthermore RAI and CRP are often associated with a more complex pelvic floor prolapse. Many patients who complain of a single pelvic compartment prolapse may be affected by prolapse of multiple pelvic compartments [6]. Multiple pelvic defects, variously associated with one another and to different degrees, can be present at the same time: rectocele and rectal occult mucosal or full-thickness prolapse are often associated with enterocele, and uterine, vaginal, and bladder prolapses [7]. A unique pathophysiologic theory has been suggested [8]. Furthermore, the central problem is not exclusively mechanic but also, if not mostly, biological. This is confirmed by the involvement of the psyche [9],

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and also by changes to intestinal motility in the whole gastrointestinal tract, not just the large bowel [10]. Consequently, the management and treatment of CRP and RAI is, to date, far from standardized. Surgical treatments are commonly categorized into abdominal and perineal approaches. Abdominal rectopexy is considered more invasive than the perineal approach, although, with the advent of laparoscopy, this is no longer the case [11, 12]. The benefits of the abdominal approach consist principally of reduced recurrence rates and better functional results. Abdominal procedures share the common surgical aims of rectal mobilization and fixation, but differ in the extent of rectal mobilization and the method of fixation used. There remains significant controversy concerning the most appropriate technique: whether or not to use mesh to fix the rectum to the sacrum; ventral (Ripstein technique) or posterior (Wells' or Orr-Loygue) technique; rectopexy with or without sigmoid resection; and the type of mesh used (whether it is absorbable or not, or even biological).

19.2 Surgical Techniques

19.2.1 Ripstein Technique

The Ripstein technique consists of complete mobilization of the rectum and securing it to the hollow of the sacrum by using a fascia lata graft. Synthetic mesh has replaced the fascia lata graft and a laparoscopic approach is performed. The results of this procedure have not shown great success: persistence of preoperative constipation was more common than after resection rectopexy (57% vs. 17%; $p = 0.03$), and new-onset constipation affected 12% of patients after the procedure [13]. Schultz et al. showed that the increased constipation was a particular problem among patients with internal rectal intussusception [14]. This was explained by an increased intestinal transit time after the procedure [15]. The Ripstein procedure has been proven to achieve good anatomic repair of the prolapse, associated with improved continence; however, in the presence of constipation, procedures other than the Ripstein technique should be preferred [13].

19.2.2 Wells' Technique

In the the Wells' technique the perirectal peritoneum is opened on both sides, and the rectum is fully mobilized with the mesorectum dissected to the level of the levator plane, avoiding injury of the presacral nerve plexi. A nonabsorbable mesh, 4 × 6 cm, is fixed to the sacral hollow and the lateral wings of the mesh are fixed to the lateral walls of the rectum [16]. Laparoscopy has also been successfully applied to this technique, with no major intraoperative or postoperative complications. In a report on 77 patients, constipation was improved in 36% of cases; but 18% of the patients complained of new-onset constipation, even though 90% of the patients were satisfied at long-term follow-up [17]. A modification of the technique has been proposed in cases of rectal and vaginal prolapse after hysterectomy: Wells' rectopexy with the sling extended to anchor the vaginal vault after correction of the enterocele [18].

19.2.3 Orr–Loygue Technique

Orr proposed fixation of the rectum, after complete isolation of the organ, to the sacral promontory using two strips of muscular fascia sutured distally to the lateral sides of the rectum and proximally to the presacral fascia. Loygue [19] modified the technique by the use of a synthetic mesh, 3 cm wide, sutured to the anterolateral side of the lower extraperitoneal rectum, with 4–5 nonabsorbable sutures; to avoid any tension the meshes are sutured to the sacral promontory at a distance of 2–3 cm from each other, using a nerve-sparing technique. A modified Orr–Loygue technique has been used in our surgical unit, with the aim of reducing rectal dissection and improving nerve sparing: a limited posterior and lateral rectal dissection avoiding any lateral ligament division is performed. A polypropylene mesh, trouser-shaped, is fixed to the sacral hollow and sutured to the anterolateral rectal walls. The distal ends of the mesh are sutured to the vaginal fornix or vaginal vault. This procedure has been associated with good functional results in more than 90 patients, and postoperative constipation occurred in only 2 of 99 patients [20]. In a systematic review, the effectiveness of ventral rectopexy surgery for treatment of CPR and RAI has been evaluated [21]. In 12 nonrandomized case series studies with 728 patients, seven studies used the Orr–Loygue procedure (ventral rectopexy with posterior rectal mobilization to the pelvic floor) and five studies used ventral rectopexy without posterior rectal mobilization. Overall weighted mean percentage decreases in fecal incontinence rate and constipation were 45% and 24%, respectively, with a low relapse rate (3.4%). New-onset constipation after surgery was observed with a weighted mean rate of 14.4%. The authors concluded that greater reduction in postoperative constipation is obtained by avoiding posterior rectal mobilization [21]. Even when performed with reduced posterior rectal mobilization, the Orr–Loygue procedure is still associated with new-onset constipation, although to a lesser extent than other rectopexy procedures.

19.2.4 Frykman–Goldberg Procedure

Sigmoidectomy for rectal prolapse has been proposed by Frykman and Goldberg, in an attempt to avoid postoperative constipation [22]. Resection rectopexy (Frykman–Goldberg procedure), in which a rectopexy is combined with a sigmoid resection, mitigates postoperative constipation and has consequently been favored [23]. Encouraging results have been published: outlet obstruction and fecal incontinence resolved in 81% and 72%, respectively, of patients operated for CRP. Postoperatively only two patients complained of a new rectal voiding alteration [24]. Resection does avoid constipation, but it carries risks related to the anastomosis [25, 26]. Compared with the Wells' procedure, resection rectopexy has lower morbidity, but produces similar functional results and has a similar relapse rate [27].

19.3 Discussion

The lack of prospective randomized trials does not allow us to draw any definitive conclusions for the best surgical treatment for CRP and RAI. Unfortunately, many studies are not comparable because of the different classifications used, the different definitions of success, and the short follow-up times. The definitive treatment for CRP is surgical, while the correct approach for RAI remains a gray area. RAI is difficult to treat and results are often disappointing; the initial approach should be conservative: dietary advice, biofeedback, and rehabilitation of the pelvic floor muscles can help to reduce outlet obstruction and incontinence. Even when stringent patient selection criteria are applied, rectopexy is associated with symptom improvement in only two-thirds of patients affected by RAI [28]. Surgical treatment of rectal prolapse can be undertaken through the abdominal or perineal route, but the recommended route has not yet been defined. The perineal approach has a lower rate of complications and is normally reserved for more fragile patients. However, laparoscopy [29, 30] has more recently reopened the debate on the best approach, because it is less traumatic and it is feasible for all open procedures. In fact laparoscopy has low postoperative morbidity and mortality rates: 4–9% and 0–3%, respectively [31]. It is associated with less postoperative pain, minor analgesic requirement, better cosmetic result, faster recovery time, and less time taken off work [26, 32, 33]. Several studies have confirmed that comparison between the "open" technique and laparoscopy favors the latter [34–36]. In addition, a study on economic impact showed that laparoscopic rectopexy compared with the open procedure, other than giving better clinical results, costs less [37]. Finally, it has been demonstrated that laparoscopy is particularly suitable for elderly or frail patients [38]. Therefore age is not only no longer a limitation for abdominal rectopexy, and it has been shown to have no influence on functional results, since results have been shown to be similar in patients who are older than 70 years compared with those who are younger than 70 years [39]. We can conclude that, once the abdominal route has been chosen, the procedure should be performed laparoscopically even though the current available data do not indicate that one technique is better than the other. Postoperative constipation, mainly due to rectal denervation secondary to sectioning of the lateral ligaments and complete rectal mobilization [40, 41], is the main drawback of abdominal rectopexy. The Orr–Loygue technique should reduce this functional complication, especially when avoiding extensive isolation of the rectum, as proposed by our group;

however, no comparative studies have been published to confirm this hypothesis. Results of data reported in the literature indicate that the Ripstein procedure produces the less-favorable results in terms of postoperative function [42]. The Orr–Loygue technique appears to be superior to the Ripstein procedure because the free anterior rectal wall avoids stenosis and results in better rectal motility. Functional results after using the Orr–Loygue procedure are also better than those of the Wells' technique, but, as mentioned above, no comparative studies have been published to confirm this. Portier et al. [43] indicated that limited dissection of the rectum produced good results in terms of recurrence rate, and constipation and FI improvement. Seventy-three patients underwent Orr–Loygue ventral rectopexy with limited dissection for either CRP or IRA: recurrence rates were 5.9% and 0%, respectively; FI and constipation were resolved in 58.1% and 51.9% of cases of CRP, and in 70.6% and 60% of cases of IRA, with a patient satisfaction of 94.5% [43]. Although it is beyond the scope of this chapter, the growing popularity of ventral rectopexy, as described by D'Hoore, should be addressed [44]. The preservation of lateral ligaments and the absence of posterior dissection reduce the risk of autonomic nerve injury to virtually zero. This technique, and a modification published recently by our group [45], seems to produce a definitive answer to the postoperative constipation issue. Finally, whatever technique is used, the combined repair of central and posterior compartments of the perineum is mandatory, in order to avoid multiple operations with a higher risk of complications [46]. In cases of associated genital prolapsed, uterine fixation to the sacral promontory associated with Orr-Loygue rectopexy has proved to be reliable, with a low complication rate and no recurrence at 20 months of follow-up [47]. In cases of vaginal vault prolapse or enterocele, the use of abdominal colposacropexy with mesh has a cure rate of 90% [48]. Abdominal rectocolpopexy is the recommended procedure for cases of associated middle and posterior compartment defects [44, 45].

19.4 Final Consideration

In conclusion, if sacral rectopexy with mesh is proposed, the modified Orr–Loygue technique is recommended because it is less aggressive and most effective at restoring anatomy and improving FI and ODS. Nerve preservation, limiting isolation and dissection of the posterior rectal wall, and maintaining lateral ligament integrity, is essential to prevent postoperative constipation. Although there is no overwhelming clinical evidence to indicate a preference for one surgical procedure over another, once the surgeon has chosen the abdominal route the a laparoscopic approach seems to be the best option since it offers a greater chance of early recovery, a minor incidence of morbidity, and it is less expensive. There is evidence that any associated central compartment defects should be treated at the same time.

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Rectopexy without Mesh

20

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20.1 Introduction

Suture rectopexy is one of the most widely used abdominal approaches to the treatment of full-thickness rectal prolapse. Cutait is credited with the first description of suture rectopexy [1, 2]. It is a safe procedure with low morbidity and mortality [2, 3]. Other abdominal approaches have results that are comparable to suture rectopexy and are described elsewhere [3, 4]. Recurrence rates after suture rectopexy for prolapse have been consistently reported to be less than 10%, which are lower than reported for perineal approaches [5, 6]. Traditionally, suture rectopexy and other abdominal approaches such as mesh rectopexy have been used in relatively healthy patients. In older or frail individuals a perineal approach is more likely to be chosen, as the patient does not need to recover from an abdominal incision. This dogma has recently been challenged. In a review of the American College of Surgeons National Surgical Quality Improvement Participant data, suture rectopexy and other abdominal approaches were found to be safe and feasible in high-risk patients, including octogenarians and those with an American Society of Anesthesiologists score greater than 3 [2]. Technical factors may impact the success of suture rectopexy, such as the extent of rectal mobilization, choice of open or minimally invasive approach, and the decision to include colon resection as part of the surgical procedure.

20.2 Surgical Approach

Suture rectopexy may be approached by open or minimally invasive techniques.

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The patient is placed in a modified lithotomy position. The open technique incision may be lower midline or Phannensteil. Laparoscopically, bilateral ports are required. The sigmoid colon and rectum are first identified and assessed for redundancy. The ureters must be identified and avoided during dissection. The peritoneal reflection is incised and rectal dissection is performed. The rectum is mobilized posteriorly through the avascular plane, with care taken to avoid hypogastric nerve injury and bleeding. A deep posterior rectal dissection to the level of the pelvic floor is important. Once posteriorly mobilized, lateral dissection of the rectum is done to the level of the lateral stalks. The lateral ligaments may or may not be divided, and the choice to divide the lateral ligaments is discussed later in this chapter. The rectum is then sutured to the sacral promontory using nonabsorbable sutures. One to three sutures are placed on each side, tacking the lateral rectal ligaments to the presacral fascia bilaterally. Great care must be taken not to penetrate the rectum with the sutures. If a resection is included, the rectopexy sutures should be placed several centimeters distal to the anastomosis to help avoid angulation of the anastomosis. In addition, the splenic flexure, inferior mesenteric artery and vein, and superior rectal artery and vein are preserved. Flexible endoscopy is performed to assess the anastomosis and as part of an air leak test after creation of the anastomosis. After verification of anastomotic integrity, the rectopexy sutures are tied and then endoscopy and air testing are repeated to ensure that the rectal lumen has not been narrowed by the rectopexy sutures. Although some angulation is expected, if stenosis is noted one or more of the rectopexy sutures should be removed and the endoscopy repeated.

20.2.1 Minimally Invasive Techniques

As with many operations, minimally invasive approaches have been developed for suture rectopexy for rectal prolapse. Laparoscopic rectopexy has been shown to have favorable results, with recurrence and complication rates comparable to open rectopexy in numerous prospective studies [7–10]. A recent meta-analysis found no significant difference in recurrence, as well as postoperative constipation and incontinence [5]. However, all of these studies have included relatively few patients. A Cochrane review of the literature concluded that no one technique of rectopexy is superior, with very few high-quality randomized studies available [3]. It is clear that laparoscopic rectopexy is safe, has good outcomes, and may be offered to patients requiring rectopexy [11]. As laparoscopy continues to grow in its use in colorectal surgery, more and more surgeons will likely offer their preferred method of rectopexy (suture or mesh) through a laparoscopic approach to facilitate faster recovery. More recently, the robotic platform has been used for suture rectopexy. In a small study of six patients, robotic-assisted rectopexy was found to be safe, with low morbidity, and no short-term recurrence [12]. Early experiences have found that the robotic approach is more expensive and takes longer than laparoscopic rectopexy [12, 13]. The robotic approach may potentially facilitate the suturing portion of the procedure through the use of the articulating instruments with their additional degrees of freedom compared to laparoscopic instruments. This feature may be especially helpful for those surgeons who do not perform frequent laparoscopic suturing and feel they are not facile with laparoscopic rectopexy. More long-term data are needed on the outcomes, cost effectiveness, and feasibility of robotic-assisted suture rectopexy.

20.2.2 Bowel Resection and Rectopexy (Frykman–Goldberg Procedure)

The practice of performing a bowel resection in addition to a suture rectopexy is sometimes utilized, especially in the setting of rectal prolapse combined with constipation. This is known as the Frykman–Golberg procedure [14]. Both anterior resection and sigmoid resection, along with rectopexy, have been described in an effort to reduce redundancy and possible torsion of the sigmoid colon, and to achieve a straighter colon with the intact splenic flexure providing an additional point of fixation. These proposed benefits have not been consistently borne out in the literature, with similar recurrence rates when compared to rectopexy alone [15, 16]. In the setting of severe constipation, resection of redundant colon does appear to be associated with reduction in constipation. Prospective studies have shown that laparoscopic and open resection combined with rectopexy are followed by significant improvement in constipation in select patients, but only one of these studies compared rectopexy alone with rectopexy plus resection [16–18]. In general, a resection may be appropriate in patients left with significant potential redundancy of the sigmoid colon following rectopexy, putting them at risk for volvulus or kinking of the bowel above the rectopexy fixation point; this might lead to continued constipation.

20.2.3 Lateral Rectal Ligaments

The treatment of the lateral rectal ligaments as part of the rectal mobilization during rectopexy has been a point of debate. Numerous studies of both laparoscopic and open suture rectopexy have addressed the approach to the lateral ligaments [17, 19–24]. Pooled results show a trend toward improvement in constipation and continence with preservation of the lateral ligaments [6]. These findings may be due to presumed nerve injury that occurs with division of the ligaments, causing rectal denervation and constipation. Without ligament division, the risk of recurrent prolapse may be slightly higher, though there is insufficient evidence in the literature to make any definitive conclusions, especially since recurrence rates are low [3]. Thus, it is likely sufficient to preserve the distal lateral ligaments and ensure that only the anterior and posterior rectal planes are fully dissected to the levator muscles. This measure will avoid unwanted functional outcomes such as constipation and likely will not contribute to a clinically significantly higher risk of recurrent full-thickness prolapse.

20.3 Recurrent Rectal Prolapse

Overall outcomes of suture rectopexy for rectal prolapse are excellent. The primary outcome of interest is recurrent rectal prolapse, with constipation and incontinence being predominant secondary outcomes of interest. A recent randomized trial of various treatments of rectal prolapse, including rectopexy, resection rectopexy, and perineal approaches, found that no technique had a statistically superior recurrence rate [4]. However, that study did not attain the participant recruitment for which it was powered. The most recent meta-analysis published found that in studies of suture rectopexy with more than ten participants per study, the long-term recurrence rate ranged from 0% to 9% for the open approach and from 0% to 7% for the laparoscopic approach (nonsignificant difference) [5]. In the majority of larger studies, improvements are noted in validated postoperative constipation and continence scores [5]. A few studies have found worsened constipation, highlighting the necessity of a proper history preoperatively and consideration of adding a resection to the procedure and preserving the lateral ligaments at the time of surgery [5, 6]. A transient reduction in continence may be seen in the early postoperative period, as the sphincter complex has been chronically dilated in many cases due to the mass effect of the prolapsed rectum. Long term, however, suture rectopexy almost always results in improved continence in pooled analyses [5, 6]. All of these outcomes should be addressed with potential surgical candidates during preoperative discussions to plan for realistic outcomes.

20.4 Summary

In conclusion, suture rectopexy is a very effective and durable treatment for full-thickness rectal prolapse, with recurrence rates below 10%. It is also a safe procedure, with morbidity and mortality rates less than 1%. Proper technique is essential to achieve good results, and the surgical principles include rectal mobilization with complete anterior and posterior mobilization with preservation of the distal lateral stalks, bilateral multipoint fixation with nonabsorbable sutures, and intraoperative flexible endoscopy. The lateral rectal ligaments should be preserved. Laparoscopic and open approaches achieve similar outcomes, with faster recovery in the laparoscopic group. The robotic platform may theoretically make minimally invasive suture rectopexy easier for some surgeons. Although a sigmoid resection is not mandatory, it may be valuable in patients with very redundant colons or severe preoperative constipation. In addition to treatment of the rectal prolapse itself, most patients experience improvement in both constipation and continence following suture rectopexy. In patients who can tolerate an abdominal procedure, suture rectopexy is an excellent choice for the treatment of full-thickness rectal prolapse; surgeons treating rectal prolapse should be familiar with both the resectional and nonresectional techniques.

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Laparoscopic Ventral Rectocolpopexy for Rectal Prolapse Syndromes: Restoration of Anatomy and Improvement of Function

21

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21.1 Introduction

Treatment of rectal prolapse syndromes, including external rectal prolapse, internal intussusception (or internal rectal prolapse), and rectocele remains one of the most difficult clinical problems in colorectal surgery [1, 2]. These conditions can lead to different anorectal disorders varying from obstructive defecation to fecal incontinence due to chronic sphincter damage [2, 3].

Several surgical procedures have been developed in an attempt to repair these conditions that are distressing for the patient [4]. No standard method has been accepted by the surgical community to date, although abdominal rectopexy is considered to be superior to perineal or transanal approaches because of lower recurrence rates and better functional outcome [5, 6]. Unfortunately, the induction or worsening of postoperative constipation has been observed as the most common side-effect of rectopexy. An inherent step in classic rectopexy is the full mobilization of the rectum. Autonomic nerve injury during extensive posterolateral rectosigmoid mobilization may lead to postoperative dysmotility and impaired evacuation [7]. In contrast, transanal partial rectum resection or plication may induce or worsen incontinence [6, 8]. Laparoscopic ventral recto(colpo)pexy (LVR) using a polypropylene mesh has been introduced with the aim of combining a good functional outcome of the abdominal procedure while avoiding both postoperative constipation and incontinence [9–12]. The aim of this chapter is to present the technical aspects involved in LVR, accompanied by a brief overview of the functional outcome and discussion relating to the merits and indications of this procedure.

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21.2 Surgical Technique of LVR

21.2.1 Patient Preparation and Installation

All patients receive limited bowel preparation (fleet enema) and a single dose of a broad-spectrum antibiotic. Thrombosis prophylaxis using low-molecular-weight heparin is continued during the hospital stay. Patients are placed on a mouldable "bean bag", allowing them to be in a safe steep Trendelenburg position during the laparoscopic procedure. The patient is positioned in a modified lithotomy position with both arms along the body, and catheterized. After installation of a pneumoperitoneum, a 5 mm port is placed under the umbilicus, and the camera is inserted. It is helpful to have an angled 30° scope, especially for the deepest dissection. Three additional ports are inserted: into the right iliac fossa (12 mm), the right lateral abdominal wall (5 mm), and the left lower quadrant (5 mm). Both the surgeon and the assistant surgeon (camera operator) are standing on the right side of the patient. With the patient in a steep Trendelenburg position, all the small bowel is retracted out of the pelvis. A temporary hysteropexy using transparietal sutures through the round ligaments enhances the pelvic view. Dissection is performed using either ultrasonic shears or monopolar coagulation.

21.2.2 Peritoneal Incision and Sacral Promontory Dissection

The assistant surgeon retracts the mesosigmoid to the left. The right ureter is visualized as it crosses the right iliac artery. A peritoneal incision is made over the right side of the sacral promontory to expose the vertebral ligament, which should be sufficiently dissected to allow safe mesh fixation at the end of the procedure. A dissection that is too medial must be avoided to safeguard the left iliac vein. Special care is taken not to damage the right hypogastric nerve and the median sacral vessels at the pelvic inlet.

The peritoneal incision is then extended caudally in an inverted J-form from the sacral promontory along the line of the right uterosacral ligament to the deepest part of the pouch of Douglas.

21.2.3 Opening the Rectovaginal Septum

Denonvilliers' fascia is incised, and the rectovaginal septum is opened widely after firm retraction of the deepest part of the pouch of Douglas. Dissection is performed on the anterior aspect of the rectum, leaving all fibrous tissue against the posterior vaginal wall, and it is continued as deep down as possible to the perineal body (transverse white fibers). Lateral and posterior dissection is avoided. Thus, rectal mobilization or transsection of the so-called lateral ligaments is not performed. At this stage, the surgeon can decide to resect the redundant

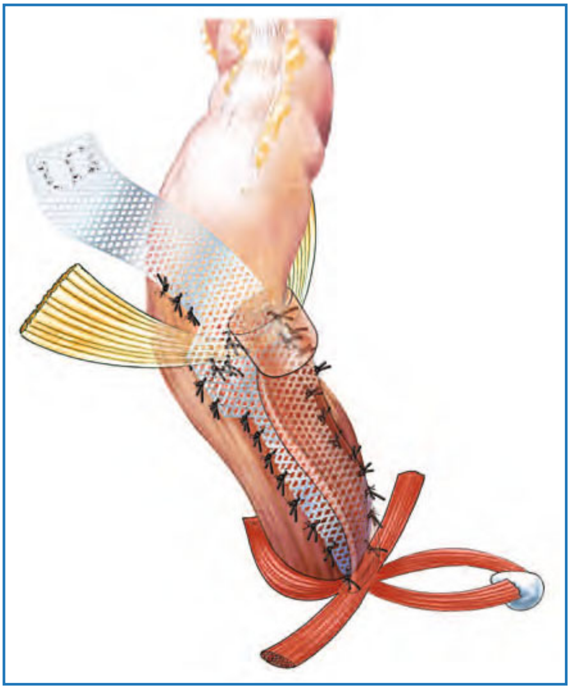

Fig. 21.1 The ventral position of the mesh allows correction of rectorectal intussusception, reinforcement of the rectovaginal septum and performance of a colpopexy. Closure of the peritoneum above the mesh elevates the pouch of Douglas

pouch of Douglas (Douglasectomy) to ensure that the mesh is sutured to the seromuscular layer of the ventral rectum. However, care should be taken not to enter the rectum inadvertently, and hemostasis should be meticulous. In the rare event of perforating the vagina, provided it is small and there is no contamination, this is repaired with an absorbable suture and the procedure is continued. If the rectum is perforated, the procedure should not be continued.

21.2.4 Mesh Fixation (Rectum–Promontory)

A Marlex mesh (Bard, Crawley, UK) trimmed to approximately 3 × 17 cm is used in all patients. The mesh can be left wider at the site where you expect the site of the colpopexy, to allow adequate vault suspension (Fig. 21.1). The mesh is sutured to the ventral aspect of the distal rectum using nonabsorbable sutures (EthibondExcel 0; Ethicon, Johnson & Johnson, Brussels, Belgium). The sutures are passed through the right lower quadrant (12 mm) port. Extracorporeal suturing seems the most appropriate in the deepest part (at the level of the perineal body). Further sutures fix the mesh to the lateral seromuscular border of the rectum, proximal and distal to the incised pouch of Douglas (Fig. 21.2). Those sutures will prevent a higher rectal intussusception. The position of the mesh allows reinforcement of the rectovaginal septum. Care should be taken to ensure

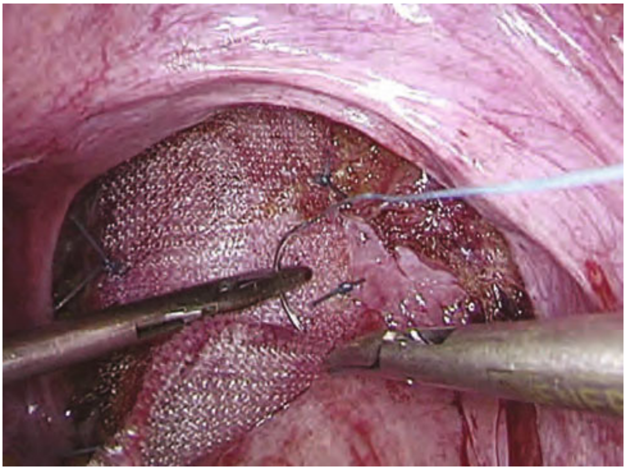

Fig. 21.2 The strip of polypropylene is sutured to the anterior aspect of the rectum

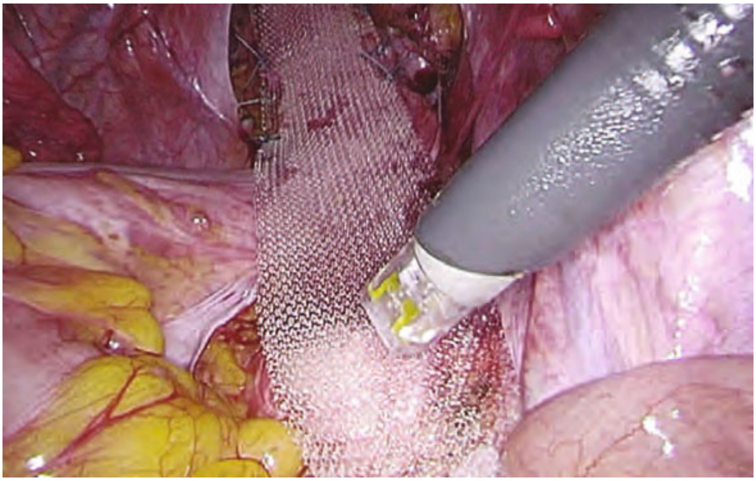

Fig. 21.3 Proximal fixation of the mesh to the sacral promontory using a stapler device

that the mesh lies flat upon the rectum to avoid any mechanical erosion due to mesh kinking.

The mesh is then fixed to the sacral promontory using an endoscopic “tacker” device (Endopath EMS; Ethicon Endo-surgery, Norderstedt, Germany) (Fig. 21.3), and secured with one stitch of Ethibond 2.0. No traction is exerted on the rectum, but the prolapse should be reduced at the time of mesh fixation. The rectum remains in the sacrococcygeal hollow. The surgeon should take care not to strangle the rectosigmoid between the sacral promontory and the mesh.

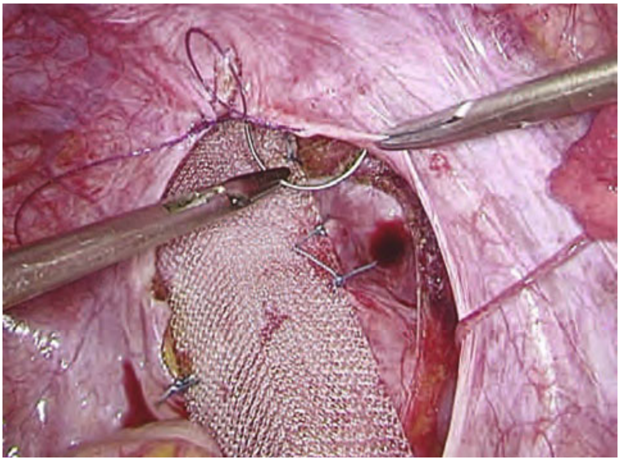

Fig. 21.4 The lateral borders of the peritoneum are closed over the mesh elevating the neo-Douglas over the colpopexy

21.2.5 Colpopexy and Peritoneal Closure

The posterior vaginal apex (vaginal vault) is then identified and elevated by a vaginal trainer and sutured to same strip of mesh. Two lateral sutures incorporate the (remainder of the) uterosacral ligament. If an enterocele is present, more sutures must be made. Ideally, the sutures should not perforate the vaginal wall. This maneuver allows closure of the rectovaginal septum and suspension of the middle pelvic compartment. In this way, a vaginal vault prolapse or enterocele is corrected.

The lateral borders are closed over the mesh using the V-Loc 90 absorbable wound closure device (Covidien, Mansfield, Massachusetts, USA) elevating the pouch of Douglas over the colpopexy (and creating a neo-Douglas) (Fig. 21.4). This maneuver is important to avoid any later small-bowel entrapment and/or erosion.

No peritoneal drain is left in place. Ports are removed in a routine fashion, and only the fascia at the 12 mm port is closed.

21.2.6 Perineotomy (Facultative)

It can be difficult to complete the rectovaginal septum dissection to the level of the pelvic floor. This maneuver is important in treating a complex, supra-anal rectocele. In this specific situation, the surgeon can decide to complete the laparoscopic dissection with a small perineotomy. The incision is made immediately dorsal to the vaginal orifice to open the perineal body. Dissection should be meticulous to avoid any perforation of the vagina or rectum. After perineotomy, this dissection joins the laparoscopic dissection plane, allowing mesh fixation in the deepest part of the rectovaginal septum and restoring the perineal body. However, a perineotomy can be avoided in most patients with a total rectal prolapse and should only be performed when laparoscopic dissection at the level of the perineal body fails.

21.2.7 Postoperative Treatment

The patient can resume oral intake the day of surgery. A fiber-enriched diet is prescribed. The urinary catheter is removed the following day, and mobilization is started. According to clinical progress, the patient can be discharged from day 1 onwards. Straining efforts and heavy lifting are discouraged for 4–6 weeks after surgery.

21.3 Outcome after LVR

From January 1999 to December 2008, 405 patients underwent LVR for rectal prolapse syndromes. The mean age was 54.6 years [standard deviation (SD) 15.2] and median age was 55 years (range 16–88). Most patients were women ($n = 376$, 93%). Of the 405 patients, 168 (41.5%) had undergone previous pelvic surgery, the most common of which was hysterectomy in 154 patients (39%) (Table 21.1). In 27 patients (6.8%), LVR was performed for recurrent rectal prolapse.

Most of the patients had an internal rectal prolapse (45.9%, $n = 186$). Other indications were total rectal prolapse (43%, $n = 174$) and isolated rectocele and/or enterocele (11.1%, $n = 45$). In 95 of the patients (23.5%) the laparoscopic dissection of the rectovaginal septum was completed with a small perineotomy to treat a complex supra-anal rectocele, as previously described [13].

Table 21.1 Previous pelvic surgery in 168 patients who underwent laparoscopic ventral rectopexy for rectal prolapse syndromes

Procedure	*n* (%)
Hysterectomy	154 (39.1)
Cystopexy	36 (9.1)
Rectopexy	19 (4.8)
Delorme/Altemeier	8 (2.0)
Cesarian section	15 (3.8)
Sphincter repair	4 (1.0)
Gynecological procedure	4 (1.0)
Colectomy	3 (0.8)
Kidney transplantation	1 (0.3)
Prostatectomy	1 (0.3)
Total	**168 (41.5)**

Data concerning operative difficulties and conversion, postoperative morbidity, and recurrence were gathered from a prospective database. Postoperative complications were graded according to Clavien–Dindo [14, 15]. The mean follow-up was 25.3 months (SD ±30, range 6–143). An extensive institutional questionnaire that assessed symptoms of anorectal and sexual dysfunction was used.

Data are presented as mean and SD, median and range. The Wilcoxon signed rank test was used for nonparametric paired data and a *t* test for paired and unpaired samples. $p < 0.050$ was considered statistically significant.

21.3.1 Conversions

Conversion to laparotomy was required in eight patients (2%). Five patients underwent conversion because of adhesions as a result of multiple abdominal operations. In three patients, acute bleeding from the left iliac vein occurred, requiring urgent laparotomy to obtain hemostasis. All underwent open ventral rectopexy. There were no other intraoperative complications and no blood transfusion was required.

21.3.2 Morbidity

Perioperative mortality did not occur. Morbidity was noted in 74 patients (18%), but it was minor (grade I and II complications) in the majority of patients: urinary tract infection in 23 patients (5.9%), superficial wound dehiscence in 18 patients (4.6%), prolonged ileus treated conservatively in 12 patients (3.1%), and postoperative hematoma or bleeding in nine patients (2.3%) (Table 21.2). Six patients (1.5%) underwent a re-intervention under general anesthesia within 30 days after surgery (grade III complications, Table 21.3).

Ten patients (2.5%) developed dyspareunia during follow-up. Prolonged (6 weeks) neuralgia at the right lower quadrant port was documented in six patients (1.5%). Five patients (1.3%) with mesh erosion were seen. All these

Table 21.2 Grade I and II complications

Complication	n (%)
Urinary tract infection	23 (5.9)
Superficial wound dehiscence	18 (4.6)
Postoperative ileus	12 (3.1)
Hematoma/bleeding	9 (2.3)
Cardiac problems	6 (1.3)
Fever	3 (0.8)
Pain	4 (1.0)
Total	**74 (18)**

Table 21.3 Grade III complications

Complication	*n* (postoperative day)
Drainage perineal hematoma	1 (day 1)
Omental bleeding	1 (day 1)
Bowel perforation	1 (day 2)
Examination under anesthesia	1 (day 3)
Adhesiolysis	1 (day 11)
Strangulation	1 (day 28)
Total	**6 (1.5%)**

patients underwent a combined approach with perineotomy for a grade III supra-anal rectocele. In another five patients (1.3%), a trocar site hernia was diagnosed. No major septic complications (pelvic abscess, mesh infection, or lumbar discitis) were observed.

21.3.3 Hospital Stay

Overall, the mean hospital stay was 4.5 days (SD 2.1; median 4 days, range 2–21). We observed a significant reduction of hospital stay over time. The median hospital stay for the last 50 patients was 3.2 days, significantly shorter than the hospital stay of 5.1 days for the first 50 patients ($p = 0.03$).

21.3.4 Recurrence

Clinical recurrence was noted in 4.6% of 174 patients after LVR for total rectal prolapse. Only four of these eight patients underwent further perineal surgery: colporaphia posterior resection of mucosal prolapse.

The recurrence rate for internal rectal prolapse after LVR was low (0.5%), but the need for further perineal surgery during follow-up was higher (4.3%) (Table 21.4).

Failure of the mesh fixation to the sacral promontory was noted in four patients during re-laparoscopy (Table 21.5). In one patient, dehiscence of the rectal fixation was seen, and in another incomplete reduction of the prolapse at the time of mesh fixation evidently resulted in a persistent prolapse.

Table 21.4 Recurrence after laparoscopic ventral recto(colpo)pexy and need for further perineal surgery during follow-up

	Total no. of rectal prolapses (%)	Internal rectal prolapses (%)
Recurrence	8/174 (4.6)	1/185 (0.5)
Need for further perineal surgery	4/174 (2.3)	8/185 (4.3)

Table 21.5 Recurrences after laparoscopic ventral recto(colpo)pexy and subsequent surgical therapy

Type of recurrence	Time post-operation (months)	Site of failure	Reoperation
Total prolapse	6	Promontory	Laparoscopy resection rectopexy (Frykman–Goldberg)
Total prolapse	6	Promontory	Laparoscopic refixation
Total prolapse	13	Incomplete reduction	Altemeier procedure
Internal prolapse	36	Rectal fixation	Laparoscopic refixation
Total prolapse	36	Promontory	Laparoscopic refixation
Total prolapse	72	Promontory	Laparoscopic refixation

21.3.5 Symptomatic Outcome

After LVR for total rectal prolapse a significant improvement was noted in 85.6% of patients at final follow-up. Symptoms of obstructed defecation resolved completely in 71.1% of patients, while new-onset constipation was documented in only ten patients (2.3%). Fecal incontinence improved in 84.5% of patients.

Obstructed defecation, present in 120 patients with internal rectal prolapse before LVR, resolved in 59.2% of patients. Constipation was induced in 3%. Fecal incontinence was improved in 88.9% of patients with internal rectal prolapse. At final follow-up, 70.4% of patients reported improvement of functional outcome after LVR for internal rectal prolapse. Thus, symptomatic improvement was significantly lower ($p < 0.050$) than in patients with total rectal prolapse.

21.4 Discussion

Surgical treatment of rectal prolapse syndromes, including total rectal prolapse, internal intussusception (or internal prolapse), and rectocele, remains one of the most controversial areas in colorectal surgery [1, 2]. Different opinions and a large number of different operations are described in the literature [4]. LVR was developed in an attempt to fulfill the three main objectives of prolapse surgery: restoration of the anatomy in a reliable, safe, and reproducible way; improvement of anorectal function (fecal incontinence and obstructed defecation); and avoidance of functional sequellae, i.e., constipation, incontinence [9, 10]. Although roughly 40% of patients in this study had had previous pelvic surgery, the need for conversion to laparotomy was very limited. Dissection starts at the sacral promontory with preservation of the right hypogastric nerve. Special care is taken not to damage the left iliac vein at the pelvic inlet. Acute bleeding from the left iliac vein occurred in three patients and required urgent laparotomy.

Dissection in the rectovaginal septum should be very meticulous to avoid any perforation. It can be difficult to complete the dissection down to the pelvic floor. This maneuver is important in treating a low, supra-anal rectocele. In this specific situation, the laparoscopic dissection in the rectovaginal septum can be completed via a small perineotomy. In the long term, five mesh erosions were noted, all into the vagina. All these patients underwent a combined approach with perineotomy for a grade III supra-anal rectocele. No mesh infection or erosion into the rectum was observed in this series. It can be concluded that the use of a polypropylene mesh on the anterior surface of the rectum is safe.

The observed recurrence rate of 4.6% is in line with the reported recurrence rates for classical mesh rectopexy [16]. Failure of the mesh fixation to the sacral promontory was noted in four patients during re-laparoscopy. An adequate anchorage of the mesh to the sacral promontory is essential and this seems to be the Achilles tendon of the procedure.

After LVR for total rectal prolapse, a significant improvement occurred in 85% of patients at final follow-up. The symptoms of obstructed defecation resolved completely in 71% of patients, while constipation was induced in only 2.3%. Incontinence improved in 85% of patients. The same tendency can be seen for internal rectal prolapses, although the overall symptomatic improvement was 15% lower, especially in patients with obstructed defecation. Surgeons need to be aware that functional factors may also play a role in obstructed defecation. Therefore, potential functional problems should be investigated prior to LVR in patients with internal rectal prolapse. Moreover, mechanical and functional obstruction may co-exist. Presence of a functional problem might explain why anatomical reconstruction will not, or only partly, improve function in some patients. It is evident that LVR benefits a selected group of patients with internal rectal prolapse. The challenge is to identify which patients.

In conclusion, early and late outcomes after LVR performed during a 10-year period in patients with rectal prolapse syndromes were reviewed. LVC, with or without perineotomy, was found to be safe, with relatively low morbidity. Functional outcome supports its efficacy. The indication for LVR in patients with internal rectal prolapse should be optimized.

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22 Pelvic Organ Prolapse Suspension

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22.1 Background

It may seem strange for a coloproctologist to propose a new procedure for correcting genital prolapse and therefore it is necessary to relate the background to this initiative; however, this will be limited to the most relevant data. At the European Center of Coloproctology and Pelvic Diseases, Vienna, we examined about 1,000 women affected by disorders of evacuation between the years 1999 and 2001.

The data we are interested in reporting in order to explain the technique relate to patients with genital prolapse or those who had already undergone surgery for this condition. Of 322 patients, who had previously undergone operations for genital prolapse, 306 (95%) had symptoms of obstructed defecation, with an average Longo obstructed defecation syndrome (ODS) score of 9.5 (range 4–36). Thirty-nine (12%) had impaired fecal incontinence (FI), with an average Wexner incontinence score of 4 (range 1–16) [1]. Only 12 patients (3.7%) had undergone defecography before surgery. A review of the literature shows that only 25% of publications reporting results after correction of genital prolapse, using any technique, quote the effects of the surgery on obstructed defecation and/or FI. Moreover very few studies use a score for ODS or FI preoperatively and postoperatively. This suggests that urogynecologists do not focus enough attention on the rectum and defecation disorders, and that coloproctologists have probably not gone into enough depth in investigating the association between urogenital prolapse and rectal prolapse. In 615 women with varying degrees of genital prolapse who requested examination at our center for ODS or active FI, dynamic pelvigraphy revealed an association between genital prolapse and internal or external rectal prolapse and/or rectocele in 100% of cases.

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To determine whether this association is constant, or whether it affects only women with symptoms of obstructed defecation, in collaboration with gynecologists we submitted 25 women with genital prolapse to dynamic pelvigraphy; the prolapse was between 2 and 4° according to the HWS Baden–Walker classification, and the women did not show symptoms of obstructed defecation or active FI. In all 25 women (100%) we found an internal rectal prolapse associated with rectocele. In these patients, dynamic pelvigraphy showed that the rectum was emptied by the extrinsic compression of the uterus and bladder. We have used this observation to provide an explanation for evacuation in some of these patients, although they had a major internal rectal prolapse or rectocele.

From 2000 to 2001, gynecologists submitted the aforementioned group of 25 women, plus a further 23 women with similar clinical characteristics, to traditional operations for urogenital prolapse; preoperative and postoperative assessment of internal rectal prolapse and/or rectocele, including ODS, was evaluated by a coloproctologist. Twenty-nine of these women underwent a colpohysterectomy with anterior colpoplasty (ten women), anterior and posterior colpoplasty with mesh (six women), posterior colpoperineoplasty (eight women, of which five were with mesh). Dynamic pelvigraphy examination performed at 3–6 months in 27 of the women showed the presence of rectal prolapse in all cases. Patients who had undergone posterior colpoperineoplasty showed a significant reduction of the rectocele postoperatively, but a greater degree of rectal prolapse. The most significant finding was that 11/29 (37.9%) had developed de novo ODS, with a Longo ODS score of 4.8 (range 3–22). Twenty-one women were subjected to laparoscopic colposacropexy. In this group, the rectal prolapse was not corrected in any of the women, but in 10 cases it was improved, along with improvement in the rectocele. However, ten patients (47.6%) developed ODS with a Longo ODS score of 4.2 (range 2–32). Postoperative dynamic pelvigraphy of all the patients who had developed ODS showed that rectal emptying was incomplete and began after several attempts of intensive straining. Even those patients who reported normal emptying of the bowel preoperatively needed a greater number of attempts to empty the rectum postoperatively.

These observations led us to conclude that: a uterovaginal prolapse should be considered a total pelvic prolapse because it always includes a cystocele and a rectal prolapse, which may be symptomatic of ODS or asymptomatic; conventional techniques are not capable of simultaneously correcting rectal prolapse; de novo ODS can be induced.

From a review of the literature on urogenital prolapses it was noted that about 30% of women undergoing surgery for genitourinary prolapse required a further operation [2]. We therefore concluded that there is considerable room for improvement in conventional surgery for pelvic organ prolapse.

We made some anatomical–functional hypotheses on why it is possible to observe a rectal prolapse without a genital prolapse, but, in contrast, the genital prolapse always involves a rectal prolapse. In fact, the rectum has only two types of ligaments. The lateral ligaments support the lower third of the rectum only. The upper two-thirds section of the rectum is maintained in the normal craniocaudal position by the rear sacral ligaments, which consist of thin connective fibers that lie obliquely and allow discrete movements of the rectum, such as a relaxation and shortening; at the top is the pelvic visceral peritoneum (pouch of Douglas) with the underlying connective tissue elastic fibers covering the anterior intraperitoneal rectum supporting it toward the top, anteriorly; in women, the rectum is connected to the vagina on the posterior fornix by connective muscle fibers, in the middle portion of the oblique fibers, which also allow a reasonable range of motion on the walls of the two organs, and in fact they are connected anatomically. This ligamentous labile structure of the middle and upper rectum means that the descent of the posterior pelvic peritoneum and vagina inevitably drags down the upper and middle rectum, often causing the formation of a loop rectocele and consequently a rectocele dilatation. Therefore, all vaginal prolapses, which involve the pouch of Douglas, always induce a rectal prolapse. Instead, as the uterus and vagina have an extremely strong ligamentous structure, both craniocaudally and laterally, a primary rectal prolapse does not necessarily lead to a genital prolapse.

Another important clinical observation at the European Center of Coloproctology and Pelvic Diseases, Vienna, regards the lower incidence and the severity of disorders of urinary incontinence, ODS and FI in patients who had undergone hysterectomy for benign or malignant diseases of the uterus, compared with patients who had undergone a hysterectomy for genital prolapse. We believe that this difference in incidence can be attributed to major changes in pelvic anatomy induced by the prolapses themselves and the traditional techniques of correction of genital prolapse. Colposacropexy does not correct the rectal prolapse and results in a partial occlusion of the pouch of Douglas. There is also stiffness of the pouch as a consequence of the bridge formed with mesh that runs from the vagina to the sacrum. Furthermore, this technique leaves a large anterior pelvic space where the bladder can expand abnormally, resulting in disorders of micturition. The partial obliteration of the pouch of Douglas and the resulting inelasticity contribute to ineffective straining for evacuation. We think that this might be a cause of de novo ODS, or that it might lead to a worsening of a pre-existing ODS.

Colpohysterectomy brings about several problems because of the attachment of the vaginal vault. The suspension of the vaginal vault to the sacrospinous ligament is too low and posterior, and this frequently causes urinary stress incontinence and ODS, as we have often noted. Suspension of the vaginal vault to the uterosacral ligaments causes obliteration of the pouch of Douglas, and straining for defecation becomes ineffective. In addition, the placement of mesh in the rectovaginal septum induces an inelasticity of the anterior rectal wall making it difficult to empty the rectum, and also because this intervention compresses the rectocele resulting in rectoanal intussusception. Further problems of evacuation are created by elevatorplasty, which tends to strangle the rectum.

Finally, analysis of the dynamics of over 5,000 pelvigraphies has suggested the following concept: the uterus and broad ligaments have an important anatomical–physiological role because they divide the pelvis in two compartments: anterior and posterior. During contraction of the abdominal muscles, a normoflected uterus compresses the bladder promoting urination, while the small intestine slides on the uterus towards the pouch of Douglas where it compresses the sigmoid rectum, fostering evacuation. Hysterectomy transforms the pelvis so that it becomes a unique compartment, allowing the bladder to expand abnormally resulting in urinary disorders, and, not infrequently, we have observed enormous bladders compressing the sigmoid posteriorly. In contrast, the sigmoid can also move itself anteriorally, interfering with the bladder filling and normal emptying.

It should not be overlooked that hysterectomy almost always has a traumatic psychological impact on women and that it poses the greatest risks of complications in surgery for genital prolapse. We believe that there is no need to remove the uterus, which in 90% of cases is healthy even if it is prolapsed.

For these reasons, we decided to try to improve surgery for pelvic organ prolapse. Our goal was to obtain the simultaneous correction of prolapse of all the pelvic organs and resolution of the related symptoms. We set out to obtain the most anatomically and minimally invasive correction procedure possible. To understand the anatomical and physiological rational basis of the technique, we will explain some of the concepts. A uterovaginal prolapse is downward displacement of the neck and the uterine body so that it gradually occupies the vaginal lumen, tending to lean outward. The process begins with the introversion of the vaginal vault and cervix. Subsequently, the vagina loses the weak lateral intrapelvic anchors and invaginates on itself, tending to move outward and dragging the rectum and bladder behind it. This results in a complete pelvic prolapse, even though there may be different levels of involvement of the three pelvic compartments. In the early stages of a hysterocele, the formation of cystoceles, rectoceles, or enteroceles may cause compression on the vaginal walls, resulting in weakening or dystrophy. However, the rectocele, cystocele or enterocele might have been present before the genital prolapse and already caused dystrophic vaginal damage. Vaginal dystrophic damage is very common in advanced stages of genital prolapse, especially if it is associated with an elytrocele.

It is extremely important to emphasize that the damage to the vaginal wall is always secondary, never primary, and so correction or strengthening the vaginal walls without correction of the pathology, rectocele and/or cystocele that led to the trophic alterations is not, in our opinion, a rational approach.

It should be noted that rectocele and cystocele may occur without a vaginal prolapse. It remains unclear whether the pressure exerted by a rectocele on the posterior vaginal walls during the effort of evacuation may be a possible or concomitant cause of genital prolapse, as well as a cystocele on the anterior wall. Cystocele and rectocele can certainly cause sliding, with elongation of the anterior and/or posterior vaginal walls, leaving the uterine cervix in place only if the Mackenrodt ligaments resist the sliding. Trophic vaginal damage is often absent or minimal; in addition, our clinical observations led us to believe that if the mechanical insult stops, the dystrophic changes are partially reversible.

The anatomical and pathological observations led us to conceive POPS (pelvic organ prolapse suspension), which is described as follows. A prolapse of the vaginal vault is not possible if the Mackenrodt ligaments are intact. In other words, we found that the stretching or breaking of the Mackenrodt cardinal ligaments is a necessary condition for the occurrence of hysterocele, and that other changes such as lengthening of the uterosacral ligaments, round ligaments, pubocervical ligaments etc. were a consequence of the traction on them caused by the prolapsing uterus.

We concluded that reconstructing the anchor of the vaginal vault to the Mackenrodt ligaments must be the first goal in surgery for pelvic organ prolapse. Other accessory procedures may be useful or necessary to restore the anatomy, and especially to correct sexual, urination, and defecation dysfunctions. In particular, it is possible to add to this basic technique the plastic shortening of the round ligaments in order to prevent uterine retroflexion. In order to achieve optimal correction of internal rectal prolapse and rectocele, a stapled transanal rectal resection (STARR) procedure can also be carried out.

22.2 Introduction

Pelvic floor disorders are an increasing problem in the health care of women. Pelvic organ prolapse is a major cause of morbidity in women, affecting 30–40% of parous women, and its incidence increases with age [1, 3]. Up to 24% of women in the US experience a pelvic floor disorder, and this percentage can be as high as 50% in women over 50 years [4]. Symptomatic pelvic organ prolapse can have an important impact on general health-related quality of life (QoL); it can interfere with physical mobility and sleep, and cause pain, emotional reactions, social isolation, and lack of energy [5].

Pelvic organ prolapse disorders are also associated with a profound adverse effect on QoL, and there is a significant correlation between impairment of total prolapse QoL (P-QoL) scores and increasing stage of uterovaginal prolapse. The impact of pelvic floor disorders on health-related QoL is similar to the impact of other chronic and debilitating medical conditions such as stroke, cancer, diabetes, and dementia [6]. The lifetime risk of undergoing at least one surgical procedure for prolapse and urinary incontinence can be as high as 18% by the age of 79 years and the reoperation rate for recurrence of these disorders is close to 30% [7]. Over the next 30 years, it is predicted that the demand for services for female pelvic organ diseases will increase at twice the rate of growth of the same population, and that the number of surgical operations carried out for urinary incontinence and pelvic organ prolapse will increase substantially over the next 40 years [8].

The high prevalence of pelvic organ prolapse results in high socioeconomic costs and a significant impact on the QoL of these patients. During the last century, hundreds of surgical procedures were described for the treatment of pelvic organ prolapse; these mainly addressed single compartment prolapse, and they produced contrasting results, underlining the need to continue the search for the ideal surgical treatment. The ideal treatment should correct a rectal prolapse and/or rectal intussusception and derived symptoms, which range from FI to ODS [2]. In addition, the treatment should address middle and anterior compartment prolapses when they are present. The impact of surgical correction of prolapse on symptoms remains unclear. Several studies suggest an improvement in constipation levels [9], while others have demonstrated worsening of symptoms or a significant degree of new-onset constipation [10]. Furthermore, preoperative clinical–instrumental evaluations rarely include anatomical–functional examinations of the rectum, thus neglecting the fact that the rectum is one of the pelvic organs that has a high impact on the dynamics of the pelvis, because it is subjected to mechanical strain on a daily basis. If ODS persists or is created de novo in patients undergoing surgery for pelvic organ prolapse, this often results in intense straining which represents a daily mechanical stress on all the pelvic organs and supporting structures. We do not exclude that this could be a major cause of the high rate of relapse after conventional surgery. For these reasons, we believe that correcting ODS is a prerequisite in order to avoid relapses and improve the QoL. Traditionally, abdominal approaches are preferable to perineal approaches because of the lower long-term recurrence rate and better correction of incontinence [3]. However, when rectal prolapse is treated with posterior rectopexy, although incontinence is improved, the associated constipation tends to get worse after surgery [2, 3]. Occasionally new-onset constipation is a consequence of rectal denervation secondary to posterolateral mobilization and division of the lateral ligaments. Concomitant colonic resection is effective at overcoming this problem, but it risks the occurrence of anastomotic leakage or anastomotic stricture. Moreover, it has been suggested recently that a key role of the sigmoid colon is as a fecal reservoir, and that on another level it helps to maintain fecal continence [4].

Based on these assumptions, we have developed a procedure known as POPS (pelvic organ prolapse suspension). We have developed significant experience in this technique over a long period of time. In this chapter, we describe the surgical technique itself, and preliminary results of statistically processed data.

22.3 Surgical Laparoscopic Technique

All patients are given an enema on the day of the operation. Antibiotic prophylaxis (2 g cephalosporin) is given to the patients in theater. General anesthesia is used in all cases. The patient is placed in a lithotomy position with both arms near the body with the thighs spread moderately and bent upwards. After appropriate preparation and draping, a Foley catheter is placed in the bladder and a circular anal dilator (CAD) kit for hemorrhoidopexy is introduced through the anus and fixed by four stitches. The extent of rectal prolapse is assessed through a gauze mounted on a Klemmer clamp. The operation positions are: surgeon on the right side of the patient, first assistant to the left side of the surgeon, and second assistant between the legs of the patient. The pneumoperitoneum is established using a subumbilical open technique and a 30° laparoscope is introduced. One 10-mm trocar is inserted under laparoscopic vision into the intersection between umbilical–transversal line in the right side, and a 5-mm trocar is inserted symmetrically in the left side. The procedures include the following steps. (1) Exploration of the peritoneal cavity and then moving the patient to the Trendelenburg position (30°). (2) A vaginal valve is pushed up the anterior fornix for adequate exposure of the pelvic peritoneum. (3) Using a 30 × 30 cm prolene mesh (Ethicon), V-shaped strips (25 cm long, 2 cm wide) are prepared. (4) The mesh is introduced through a 10-mm trocar, then a 2-cm incision of the peritoneum in the apex of the anterior vaginal fornix is made and the mesh is then fixed using a prolene 0 stitch on the anterior vaginal vault or, if the patient has had hysterectomy, on the vaginal apex. (5) On the right side, 2-cm cutaneous incisions are made 2 cm above and 2 cm posterior to the anterior superior iliac spine. The aponeurosis of the external oblique muscle is incised, and by dissociating the fibers of the internal oblique and transverse abdominus muscles using scissors, the subperitoneum is reached. Forceps are introduced through this incision (we formerly used long Klemmer forceps, but we now prefer Click Line, sec. Cuschieri, with a curved distal part of diameter 5 mm, length 43 cm; Karl Storz Endoscopy [UK] Ltd, Slough, UK) and we can follow the tip of the instrument through the transparency of the peritoneum. (6) By advancing this clamp, under laparoscopic vision, a subperitoneal tunnel is created to reach the anterior fornix of the vagina. The tunnel passes 2 cm above the peritoneal reflection of the colon, 2–3 cm below the insertion of the round ligament in the internal inguinal orifice. Reaching the anterior vaginal fornix, the tip of the clamp is then forced out of the peritoneal incision previously performed, and one end of the V-mesh is taken and pulled out through the subperitoneal tunnel. (7) Repeating the same steps, the left strip of the mesh is pulled out. (8) The mesh is fixed to both of the lateral vaginal fornices by two further stitches of prolene 0. Pelvic organ suspension is achieved by symmetrical traction on both mesh strips (Fig. 22.1). (9) The second assistant advises when the vaginal vault is suspended at the desired level to completely reduce the vaginal prolapse, but avoid excessive tension on the vaginal walls. This adjustment takes place after exsufflation of CO_2. (10) A 5-cm length of excess mesh strip is positioned by tunneling the fascia of the muscle, above the incision, and fixed by vicryl 2-0 stitches. The skin is closed with an intradermic suture.

In patients who have had a hysterectomy, two separate meshes are used for each side (right and left), and these are then sutured at each side of the vagina, remaining below the perineum, thereby avoiding the possibility of contamination of the mesh due to the opening of the vagina and erosion of the mesh on the top of the stump.

In the event that the vaginal prolapse is prevalent posteriorly, the mesh is fixed on the posterior vaginal fornix; a uterine manipulator is useful because it offers appropriate exposure of the posterior vaginal fornix and the pouch of Douglas.

In patients with advanced cystocele with redundancy and dystrophy of the anterior vaginal wall, the space between the bladder and the vagina is opened and a 5-cm wide, 10-cm long V-shaped mesh is sutured and applied and fixed in the vesicovaginal space. Plication of round ligaments can be added to this basic procedure in order to avoid uterine retroversion.

Any sigmoid rectum intussusceptions are corrected by fixing the mesosigma distal to the left branch of the mesh.

At the end of the procedure, through the CAD, an evaluation of the rectal prolapse is performed. If a residual rectoanal prolapse and/or an anterior rectocele persists, then a STARR procedure is performed.

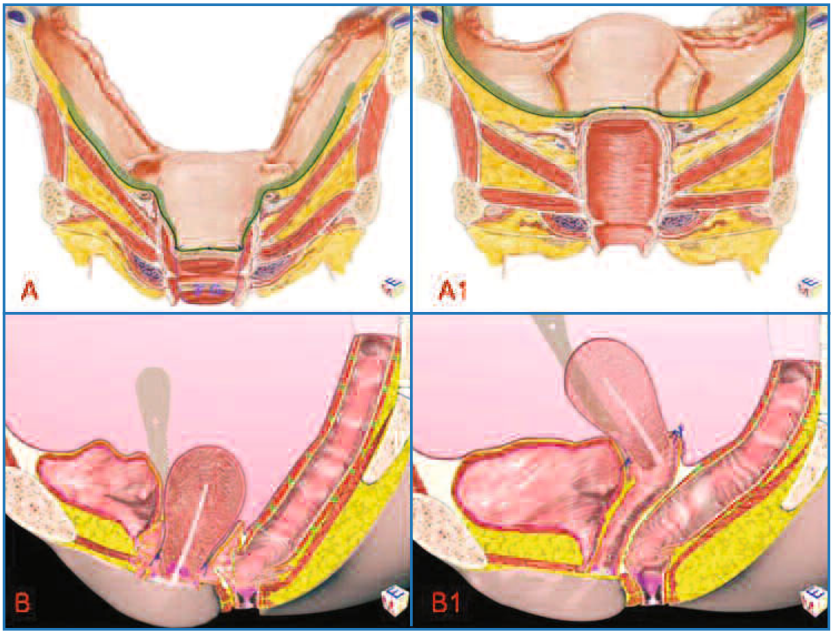

Fig. 22.1 Front (**a**) and lateral (**b**) view of the pelvic organ prolapse suspension procedure. A V-shaped mesh is fixed to the anterior and lateral vaginal fornix (**a**, **b**). The end of strips, the abdominal lateral subperitoneal tunnel, were pulled out through the lateral skin incisions above the iliac crest. A symmetrical traction on both strips reduce the genital prolapse, the cistocele and the rectal prolapse (A1+B1)

Indications for an approach by laparotomy are: previous Wertheim hysterectomy, or other complex operation in the pelvis performed via laparotomy; if hysterectomy for fibromatosis is planned; if a mesh for the reinforcement of the anterior vaginal wall and vaginoplasty is necessary.

The laparotomy technique is performed using the same steps as the laparoscopic approach, and the access to the pelvis is obtained by using a previous laparotomy incision (Pfannenstiel or umbilicus pubic incision).

The patient is discharged about 2–3 days after surgery.

22.4 Preliminary Results

From September 2001 to December 2010, we enrolled 486 consecutive women with symptomatic pelvic organ prolapse. The most frequent surgical complications were wound infections and postoperative rectal bleeding in 24 of 226 patients; these complications were associated with the STARR procedure. One patient developed acute postoperative bowel obstruction caused by twisting of the sigmoid colon on the fixing points. One patient developed left renal colic with ureteropyelodilatation caused by urethral kinking due to traction of the mesh on the overlying peritoneum. It was resolved by placing a transurethral catheter in the bladder for 30 days. The anatomotic STARR dehiscences were treated conservatively. The overall rate of surgical complications was 14.3%. Patients were discharged on average after 2.7 days (range 2–16). The mean catheterization time was 30 hours, and the incidence of urinary retention was 3.1%.

Of the 486 patients enrolled in the study, 482 were followed-up at 1 month, 426 at 3 months (of which 404 underwent a repeat dynamic pelvigraphy), 390 at 6 months, 304 at 1 year, 242 at 3 years, and 144 at 5 years. Defecation urgency (7.2%) was the main complication reported at 1 month, and this was resolved in all patients within 3 months. Postoperative pain was slight, on average. No cases of de novo dyspareunia were reported, and all 26 patients who reported this affliction preoperatively were cured or showed significant improvement.

When evaluated clinically, the anatomical results and pelvic organ prolapse stage were excellent. In particular, hysterocele was well corrected in 100% of patients. However, in 29 patients (5.97%) there was a residual grade I cystocele, and in 19 patients (3.9%) there was a grade I posterior colpocele. Pelvigraphy confirmed the excellent anatomical results: in 31.2%, a residual modest rectocele was observed; in 3.9%, a residual posterior colpocele grade I was evident; in 18 patients, a residual rectoanal intussusception was detected, and 10 of these patients also had a residual rectocele, and then underwent STARR for symptoms of ODS.

In 23.76% of patients, a deep pouch of Douglas was residual, but paradoxically in this subgroup the average postoperative ODS score was 1.4, while the same score was at least 3.03 for the group as a whole. In fact, the depth measurement of the pouch of Douglas was compared with the vaginal vault, which was often a little higher than the norm: the measurement of the distance of the pouch of Douglas to the pubococcygeal line was found to be normal in 93.5% of patients. There was a significant improvement in the descent of the perineum, especially in patients who underwent the STARR procedure.

We found six patients (1.23%) with vaginal prolapse relapse; five of these patients had previously undergone hysterectomy. All recurrences occurred within 6 months of surgery and we found that in all cases the cause was detachment of the vagina from the mesh. Four patients underwent reoperations to restore the suture between the vaginal vault and the mesh, using a prolene 0 continuous suture.

After the follow-up at 6 months we did not record any cases of relapse. Colposcopy detected only one case of moderate erosion of the mesh, and this was treated by removing the portion of the mesh that had emerged through the vagina.

Preliminary results regarding the effectiveness of the technique on urination disorders were recorded in terms of the number and percentage of patients who reported the symptom preoperatively and postoperatively (6 months). *Urogenital distress inventory* scores are currently being analyzed statistically. However, it is evident that there is a dramatic fall in the percentage of patients affected with these disorders. Symptoms of ODS were present in 70.98% of patients; it is important to note that 32% of these patients had been diagnosed with irritable bowel syndrome and 9.6% had reported slow transit constipation or dolichocolon. The Longo ODS score fell from a mean of 14.55 to a mean of 3.03. Taking into account the 52 patients with fecal or gas incontinence, 18 had an external rectal prolapse and marked anal sphincter hypotony, average 12.5 (range 0–25), and 24 had a rectoanal intussusception. Transanal ultrasonography excluded injuries in the continuity of the anal sphincters, even in 22 patients who presented with a thinner rectal wall. A total of 25 of 52 patients showed complete successful treatment immediately after surgery, the 18 patients with an external rectal prolapse showed improvement up to 1 year after surgery, and 12 were referred for biofeedback. However, almost all patients with FI showed improvement. Therefore, in all cases, active FI or sphincter hypotony was secondary to rectal prolapse. The functional results obtained had a very favorable impact on the QoL for patients: they were able to resume normal activities, with improvements in discomfort, anxiety, and depression.

22.5 Conclusions

We are aware that, in the opinion of urogynecologists, the proposed technique could prompt several arguments and questions, and be subject to many doubts. For this reason, we want to collect data for a sufficiently long follow-up period and include many more patients to support our claims.

In light of the results and feedback we have received from colleagues who have used the POPS procedure, we can confirm that POPS, performed when necessary in conjunction with STARR, has produced more effective results than those reported in the literature for traditional techniques, both transvaginal and colposacrosuspension procedures. We believe that correction of the rectal prolapse and rectocele, which are always associated with a genital prolapse, is a fundamental in this surgery. In fact, the high rate of constipation, residual and de novo, reported in the literature is probably due to the failure to correct the rectal prolapse. Certainly, the occlusion of the pouch Douglas, which is involved in some conventional procedures, including colposacropexy and plication of the uterosacral ligaments, contributes worsening of ODS. Also, Douglassectomy often results in rigidity of the peritoneal pouch, and adversely affects physiological defecation.

The high percentage of ODS in patients undergoing conventional surgery for pelvic organ prolapse may be the cause of the high recurrence rate. In fact, patients with ODS have to strain more for evacuation, causing more mechanical stress to the pelvis. When the pouch of Douglas is occluded, the stress is mainly in the middle and anterior compartments. Therefore, it might be a cause of partial or total recurrence.

We reiterate that rectocele is certainly a primary disease of the rectum, and dilatation is due to a thinning or disappearance of the muscular tunics of the distal rectum; posterior colpocele and related anatomical and structural alterations of the posterior vaginal wall must be considered secondary alterations. Therefore applying a mesh between the rectum and vagina, while restoring the look of the vagina, does not solve the cause and symptoms of ODS, but increases the rate of dyspareunia and complications. In addition, if the rectocele continues to push on the mesh it will bring about recurrence of the colpocele and erosion of the mesh.

For these reasons, STARR improves ODS by resecting the rectocele and restoring muscular continuity, in addition to correcting the rectocolpocele.

Any excessive posterior vaginal redundancy can be corrected by stretching and suturing the posterior vaginal fornix to the subperitoneal mesh of the POPS. The preservation of the uterus, suspending it in a natural position, produces significant surgical, functional and psychological benefits. In fact, all the complications related to surgical hysterectomy are avoided; the uterus will continue to divide the pelvis into two compartments and modulate straining for evacuation and urination, and at the same time preventing excessive dilation of bladder. Finally, we found that hysterectomy is a serious psychological trauma for women that can affect their sexual activity.

In conclusion, we believe that the procedure we have proposed, given the results, is excellent for use in patients with elongated vagina walls that retain a good trophism. Our proposal must be seen as a contribution from a coloproctologist to a gynecologist to enable better comprehension of the role of the rectum in pelvic floor surgery. We have emphasized that the genital apparatus also functions as an anatomical support for the bladder and rectum and, therefore, inevitably a genital prolapse results in serious anatomical and functional alterations of these organs. Obviously, the gynecologist remains the specialist for pelvic organ prolapse referral, but we have shown that it is essential to have greater multidisciplinary collaboration.

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Part VI

Special Subjects

Complications of Surgery: Prevention and Management

23

Gabriele Naldini and Claudia Menconi

23.1 Introduction

Discussion of the prevention and treatment of complications of surgery for pelvic floor disorders is particularly challenging because there are many reports of complications in the literature, but very few references to the possible causes and how to avoid and manage them.

The literature usually reports the final result of these complications (stoma, Hartmann's procedure, etc.), but this does not help the surgeon to choose of the correct therapeutic strategy when there is a problem to solve.

Often, considering the potentially serious complications of pelvic floor surgery, some surgeons can be critical about the indications for surgery because pelvic floor disorders are benign diseases.

Anyone with knowledge of the functional pathology of the pelvic floor knows that problems of constipation or incontinence can be devastating in terms of the physical and psychological wellbeing of patients, resulting in a poor quality of life.

We must give the patient accurate information on the potential of the procedure to heal them, together with a careful description of possible postoperative problems.

Our opinion is that the colorectal and pelvic floor surgeon should become very familiar with this type of surgery, and that it should be offered to the patients to relieve their discomfort .

In each topic discussed below, the possible prevention of complications will be addressed, from technical and indication points of view, along with the intraoperative management of the patient, and the postoperative and possible negative sequelae of surgery.

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Updates in Surgery
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23.2 Fecal Incontinence

23.2.1 Sphincteroplasty

The most feared complication of sphincteroplasty is wound infection [1], because it can cause dehiscence of the suture muscle, resulting in poor function results [2], and it may result in a rectovaginal fistula [3]. At the same time, a diverting stoma does not improve the results of the operation, but increases the morbidity related to the stoma itself [4]. A stoma is usually recommended in cases of complications or after further attempts to repair the sphincter [4, 5].

Intraoperative care should consist of: (1) performing the section on the muscle directly in the scar area without removing it completely, but incorporating it in the suture so as to give better stability to the suture; (2) avoiding excessive isolation of the stump muscle in order to reduce the possibility of devascularization or denervation.

If anal ultrasound and intraoperative appearance show that the section of the sphincter does not appear to be complete, a sphincter placation should be carried out to reduce the rate and severity of complications.

Although there is no evidence in the literature, it is very likely that in the majority of patients who show poor functional results after surgery that there could be a partial or complete dehiscence of the suture [6]. There are very few studies showing a correlation between endoanal ultrasound examination and dehiscence of sphincteroplasty and poor results [7].

23.2.2 Sacral Neuromodulation

Sacral neuromodulation (SNM) is currently the first surgical treatment of choice after medical therapy and rehabilitation for medium-to-severe fecal incontinence. This is because it is minimally invasive, it can be used for a large number of indications, and it produces excellent results; these are among the main features that make it preferable to other surgical methods.

We believe it is necessary to point out two aspects that should be better defined in the literature. The first is the term ‘sphincter defect’, which is too generic and has led to lesions extending up to 180° being included for treatment by SNM. It is very difficult to believe that anatomical alteration of a sphincter defect that involves the entire anal canal to 180° may benefit from treatment with SNM.

The second aspect is the outcome judgment criteria for the decision to perform a permanent implant. The success criterion for SNM is considered to be an improvement in fecal incontinence of greater than 50% for 50% of the day. We believe that this judgment criterion does not show a true improvement in quality of life.

The technique for implantation of the electrode is simple, but there may be potential problems. The literature reports complication rates of 21.6–22%, with

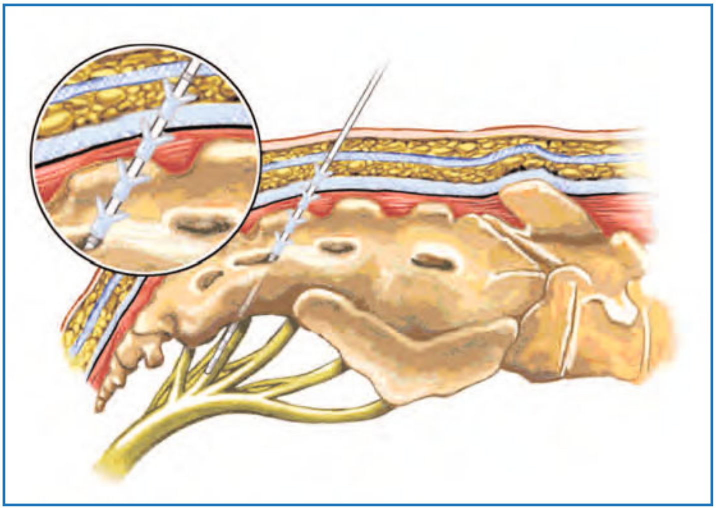

Fig. 23.1 The position of a quadripolar electrode in the third sacral foramen and the anatomical structures around it

33% of patients requiring surgical revision [8, 9]. The most important problems after implantation are pain at the implant area, infection, and the displacement of the electrode.

In order to prevent complications of the procedure, it is important to remember the following: (1) it is a prosthetic procedure, which requires maximum sterility despite the fact that the operative field may involve exposure of the anus for the visualization of the motor and sensory response; (2) all steps of the procedure should be performed under X-ray control in order to reduce positioning errors; (3) it is important to be very careful during the procedure, especially with thin patients, because there is the possibility that, however correct the positioning of the electrode (confirmed by X-ray during the procedure) part of the anchoring tines and their respective protective cover could be positioned outside the sacral fascia, generating dangerous subcutaneous electrode corners which can cause displacement, breakage or pain. (Fig. 23.1); (4) to avoid breakage of the electrode, close attention should be paid to the angles, especially in the area of the electrode where the lining of the anchor tines finishes. We have noticed that it is in this area that the electrodes may break because of the angle of the electrodes (Fig. 23.2).

Treatment of complications of SNM should be as follows: (1) in cases of infection at the area of the electrode, removal of the electrode is recommended to avoid major problems; (2) in cases of pain, assess whether it persists after stopping stimulation, and whether it disappears after reprogramming the stimulation; (3) in cases of electrode breakage, which is characterized by loss of efficacy and increased impedance, the electrode must be replaced and the same foramen can be used without any problems.

Fig. 23.2 An implanted tined lead broken during the removal procedure

Contrary to what one might think, a critical step is the removal of the electrode for inefficacy or rupture. The literature describes an important hemorrhagic complication for which the patient was taken to the operating theatre twice for packing at the site of the sacral foramen, transfused, and then discharged after 32 days [10]. There are also many reports of rupture of electrodes that remain in the area of the sacral foramen; this outcome, especially from a medicolegal point of view, could be a major problem because the patient has a foreign object that has been left in the body after the failure of the procedure. This is especially important because an abdominopelvic MRI cannot be performed on these patients. In such cases, it is recommended that the surgical access area is enlarged to try to identify the distal stump of the electrode so that it can be removed. In cases of electrode failure, there are no reports in the literature indicating that it should be removed with a neurosurgical approach.

23.2.3 Bulking Agents, Dynamic Graciloplasty, and Artificial Sphincter

Bulking agents have been shown to have low levels [11] or no morbidity [12]. However, some cases of foreign body granulomas have been described after the use of bulking agents [13]. A risk factor for local complications is the presence of multiple scars from previous surgery, for example for an anal fistula, or the presence of active perineal sepsis, even if it is subclinical. Dynamic graciloplasty (DGP) has a very high morbidity rate (69%) [14]; revision surgery, involving the removal of electrodes and implantable pulse generator, is necessary in around 22% of patients. In the use of an artificial bowel sphincter (ABS), removal of the device because of ulcers, sepsis, or ineffectiveness occurs at rates ranging from 37% [15] to 46% [16].

When taking these points into consideration, we believe that DGP or ABS should be considered as rescue procedures, and proposed only to patients that have no surgical options other than a permanent stoma.

23.3 Obstructed Defecation

23.3.1 Stapled Transanal Rectal Resection

Stapled transanal rectal resection (STARR) is the most talked-about technique that has been proposed in recent years, because of its revolutionary etiopathogenetic aspects and also because of commercial support. The liveliness of discussions on STARR in scientific circles has led to a increase in knowledge about the procedure. Unfortunately, in the world of the coloproctologist, there are those who see only advantages and good results for the procedure, and those who see only complications. The surgeon should be able to appreciate the excellent results produced by the technique and work out how to reduce possible complications. The complications of STARR are discussed below.

23.3.1.1 Anal Pain

To prevent anal pain, patients who have preoperative symptoms of anal or perineal pain should not be subjected to the procedure. Pain is not a typical symptom of rectocele or prolapse, therefore it is risky to operate on a pelvic floor that has an unknown or other source of pain because this procedure will possibly aggravate it.

If the patient still has significant pain 3 or 4 weeks after the operation, especially if it is on the suture line and the pain was not present before surgery, the cause is most likely due to the staples or the hemostatic stitches, which have probably involved, even if only superficially, the underlying musculature. It should be remembered that the correct level for the sutures is usually at the height of the puborectalis sling and if this involves the underlying muscle or if there is excessive fibrosis under the suture it could fix the rectum to the floor below. If this happens, the typical continuous pain is made worse by defecation. The surgeon must be able to recognize if the cause of the patient's problem is the surgical procedure itself, and must therefore endeavor to resolve it.

Our approach in cases of pain on the suture line is aggressive, with reintervention and removal of most of the suture line, in particular the part of the suture that is most sore and which generally corresponds to the least mobile zones on the underlying tissues.

The continuity of the mucosa should be restored by suturing with absorbable stitches. In our experience (18 cases that have not yet been published), we were able to achieve complete pain resolution in more than 75% of patients using this treatment. This percentage is reduced to less than 48% if the same procedure is performed more than 2 months later. It is essential to make sure that the pain does not become chronic. In clinical practice, we have not found any benefits in the treatment of chronic pain by removing of only some of the staples, as has been described by other authors [17].

In the first few weeks after surgery, if the patient reports that the anal pain is resistant to standard analgesic therapy, the use of neuromodulation drugs such as pregabalin or gabapentin may be helpful. It might also be helpful to consult an anesthesiologist who specializes specifically in the treatment of pain. In our experience [18], which is different from other authors [9], we have had only a few good results in the treatment of pain with SNM after a STARR procedure. We judge a medical failure to be the need for a permanent SNM implantation for pain after the surgical procedure.

23.3.1.2 Anal stenosis

To prevent anal stenosis, avoid sutures that are clearly too low, as well those that are clearly too high. High sutures predispose to stenosis, causing a rectal hourglass shape, and this stenosis interferes with the dynamics of feces expulsion. In practice, the suture level should always fall just above the apex of the hemorrhoidal tissue.

In our experience, we have used all types of staplers available on the market to perform STARR. Stenosis has been found to occur using all types of staplers, including the CCS-30. A trigger for stenosis can be the presence of preoperative proctitis or the occurrence of diarrhea with tenesmus after surgery. The type of staples used might be another factor to take into account: when comparing staples made of pure titanium with those made with titanium alloy, the majority of inflammatory responses were found to be to the alloy [19].

Since anal stenosis is a mechanical anastomosis, it is extremely rigid and does not respond to dilatations with anal dilators or pneumatic endoscopic dilations.

For treatment of anal stenosis, it is advisable to operate again and remove as much as possible of the suture line. Following this, it is necessary to maintain the caliber with mechanical dilatation in combination with transanal mesalazine.

23.3.1.3 Pararectal Hematoma

This is a very dangerous condition because it can also be the cause of further complications such as anastomotic dehiscence, delayed bleeding, or perineal sepsis, which are all equally serious complaints.

Prevention involves the correct choice of and use of the stapler. Because of the full thickness of the anastomosis, it will always include a large amount of mesorectum, and for this reason it is essential to use staplers with correct capacity. Although there have been no complications reported in the literature [20], we consider it extremely risky and wrong to use a stapler with a locking mechanism in the range 0.75–1.5 mm to perform a full-thickness rectal resection. The problem is not with the intraluminal tissues, but with the extraluminal tissues. Also the continuity and speed of the closing action of the stapler should be observed carefully; an unstable closure (a two-step closure) may cause the blade to damage the tissue before complete closure of the staples. This can result in an incomplete suture.

There are no reports in the literature on treatment for pararectal hematomas. Our approach toward this type of complication comes from years of experience and from discussion with coloproctologist colleagues who believe and encourage this type of technique (what type of technique?), while continuing their efforts to overcome possible complications. It is important to differentiate between stable hematoma and active hematoma in patients who are hemodynamically unstable [21].

23.3.1.4 Stable Hematoma

This should be treated with broad-spectrum antibiotics, total parenteral nutrition, and spontaneous drainage, which is normal for a minimum suture dehiscence in the third/fourth day after surgery, with gradual drainage of the hematoma cavity. If symptoms such as abdominal pain or failure of bowel canalization persist 3–4 days after surgery, it can indicate the need to perform a minimum transanastomotical opening by the transanal route so as to permit spontaneous drainage. It is important not to drain the hematoma too early, or debride and clean the cavity by washing it with antiseptic solution. Hematomas are usually very large and come up to the rectal peritoneum, and often produce an inflammatory reaction with the appearance of free fluid in the abdomen. Emptying the cavity means risking the rectal lumen coming in contact the peritoneum, a source of bacterial contamination. The presence of air in the hematoma and in the perirectal fat is due mostly to the passage of air from the rectum to the dehiscence, and not to gas gangrene, which would result in more severe symptoms. Our advice is to put a soft drainage tube into the rectum to allow the spontaneous outflow of air.

23.3.1.5 Progressive Hematoma

In cases of progressive hematoma, wait, if possible, for stabilization of the framework through transfusions of blood and plasma. In our experience, derived from emergency surgery, the majority of retroperitoneal hematomas resolve themselves. Embolization by use of angiography is recommended and is efficient for those patients with unstable hemodynamics (Fig. 23.3). In women, it could be useful to use a gauze laparotomy packing through the vagina, associated with the positioning of the Sangstaken–Blakemore probe in the rectum. An aggressive laparotomy should be the very last resort, because, in the presence of a large hematoma, it is impossible to perform dissections that lead to selective hemostasis, and it might then be necessary to resort to a major procedure such as Hartmann's resection.

23.3.1.6 Rectovaginal Fistula

This is a technical error that should be avoided if possible.

In order to prevent the occurrence of a rectovaginal fistula, the correct positioning of a vaginal valve is necessary at the beginning of the procedure, so as to support the cervix, vaginal vault, and possible enterocele; the positioning of this valve stretches the rectum and the retrovaginal septum, which become more visible and can be checked easily with a digital maneuver.

In our opinion, it is unlikely to consider a rectovaginal fistula as being secondary to a hematoma drainage, considering the solidity of vagina wall. We think that a hematoma in this area would drain more easily through the rectal anastomosis rather than into the vagina.

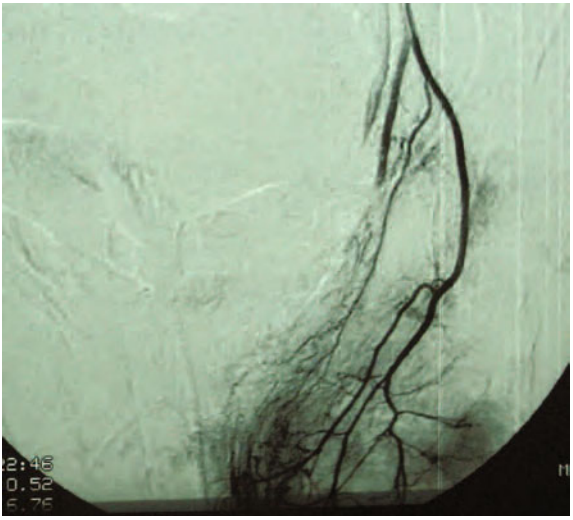

Fig. 23.3 Angiographic embolization for an unstable pelvic-perirectal hematoma

Treatment of a rectovaginal fistula is not as simple as it is reported to be in the literature. The preparation of the reconstruction usually leads to a large gap because all of the staples must be removed in the area where the rectum will be repaired. In our opinion, it is extremely difficult to be able to mobilize a rectal flap that is adequate after a STARR procedure that has resected at least 5–10 cm from the rectum. In large resections using CCS-30 (Transtar), the risk is to involve the pouch of Douglas in the suture; for this reason, during the isolation of the anastomosis there is a risk of entering the peritoneum with problems of bacterial contamination.

23.3.1.7 Rectal Necrosis or Perineal Sepsis

In cases of rectal necrosis or perineal sepsis, an aggressive approach with a stoma or resection using Hartmann's procedure is indicated, in order to avoid deterioration of the clinical state of the patient, and possibly death, as described in the literature [22].

When opening a rectum with an intraoperative dehiscence, it must be completely repaired intraoperatively without a stoma. The surgeon must be able to perform a manual transanal anastomosis. This situation can be particularly difficult to correct if it happens during the use of a CCS-30 because the resection is larger, and also there will be more intersection of the sutures. The presence of tangential vectors on the intersection of sutures increases traction on the sutures. A tear of the anastomosis may be very difficult to resolve during the use of a CCS-30 stapler.

23.3.1.8 Urgency and Fecal Incontinence

This is the main problem with which we are confronted in the postoperative period after STARR. This potential problem should be clearly explained to patients and they should be asked to sign a detailed informed consent. Strangely, literature reports indicate that preoperative incontinence improves after a STARR procedure. We believe that it is very dangerous to use STARR on a patient with incontinence, especially if is active, as it is almost certain to be worse postoperatively and at the 1 year follow-up.

In the literature, fecal urgency is said to occur in around 25.3% [23] to 34% [24] of patients who undergo STARR; however, there is a problem in actually defining the term defecatory urgency. This condition should include those patients in whom the stimulus has become more urgent, but the patient is able postpone defecation until the appropriate time and place. If this is not the case, then the patient should be considered to be incontinent.

The only currently available manometer data [25, 24] correlate the trouble with continence with a reduction in compliance. In our experience, these problems can benefit from treatment by pelvic floor rehabilitation, particularly volumetric rehabilitation or SNM [26].

23.3.2 Internal Delorme's Procedure

This is an alternative technique to STARR, and it is technically more difficult to perform. Intraoperatively, it can be difficult to keep the muscle layer intact, and there is a danger of entering the perirectal fat, with the possibility of infection. It is difficult to decide how much rectal mucosa to remove and how much to plicate, because plication of more than 8 cm of rectal muscle can seem excessive.

Bleeding and stenosis are among the possible complications that have been reported. In the literature, and incidence of complications can vary from absent to 34% [27]. Stenosis is formed at the level of the cylindrically plicated rectum and treatment involves the removal of a large fibrotic labrum, which results in the anastomosis regaining elasticity. From the point of view of defecatory and urgency incontinence, possible complications are similar to those that apply to STARR; the only difference is that with an internal Delorme's procedure there is an elongation of the anal canal, and therefore fewer potential problems, especially problems with passive incontinence (G. Naldini and C. Menconi, unpublished data).

23.3.3 Laparoscopic Ventral Mesh Rectopexy

In recent years, laparoscopic ventral mesh rectopexy (LVMR) has emerged as the preferred method for rectopexy. In the literature there are controversial results about functional evaluation of rectopexy. Some authors compare patients with external prolapse with patients with rectocele and rectal intussusception, and then evaluate the functional results and judge a positive result to be an improvement of 50% [28] in constipation [29–32]. Since constipation is the most important, if not the only, indication of rectal intussusception, we find this enthusiasm hard to share. A recent, extremely interesting, publication reports on ways to deal with complications of LVMR, in the setting of a tertiary referral center [33].

All dissections should be performed with hook diathermy. If the mesh needs to be replaced, a Teflon-coated lightweight polypropylene is recommended, and if it comes off it is best to use a new mesh anchoring it to the sacral promontory with Protacks, and suture it to the mesh previously placed. In cases where there is a lesion in the rectum, it can be sutured if it is small, or an anterior resection of the rectum with limited LVMR using a biological mesh above the anastomosis can be performed. For rectovaginal fistulas, the mesh can be removed laparoscopically, and the rectum repaired through an abdominal access if it is high, or transvaginal if it is low. All other erosions should be treated with laparoscopic removal of the mesh, by repairing the defect and by repositioning the biological mesh.

The causes of LVMR failure can be: absence of ventral dissection and mesh lying free on the pelvic brim; or the recurrence of a prolapse, in which the cause is detachment from the sacral promontory or the incorrect positioning of the staples on the top of the sacrum rather than the promontory (in most cases only two staples were found to have been used).

Complications caused by the mesh can be: stenosis of the rectum due to the attachment of the thread of the mesh to the midsacrum instead of the promontory; erosion of the rectum or vagina, which is treated by the removal of the mesh, and repair and positioning of a biological mesh; pelvic pain as a result of an excessive inflammatory response to the implant, and this can be treated by replacement of the prosthesis with Teflon-coated polypropylene, which shows good results.

Interestingly, the 2008 National Institute for Health and Care Excellence (NICE) review [34] indicates a much higher rate of erosion for synthetic meshes compared with the organic meshes; in contrast, the percentage of failures is substantially higher (23% vs. 9%) than for organic meshes. We advise using a laparoscopic approach and not a perineal approach to remove the mesh, because the perineal approach can be very difficult technically.

There are still questions for which there are no answers in the literature. (1) In cases of permanent or worsening constipation that do not show any problems of a technical nature, is there anything that can be done? (2) Are there any effects of LVMR on possible pregnancies in women of childbearing age? (3) In cases of rectal cancer (especially if it is anterior), could it be a problem to have a prosthesis between the rectum and vagina just above the pelvic floor?

23.4 Conclusions

The treatment of complications is always very difficult and they often become chronic disorders for the patient. The best approach is prevention of complications through accurate diagnosis and choice of procedure and device. Again we point out the importance of choosing the best device and in-depth knowledge of the characteristics of the device. The cause of possible problems and complications can be insufficient knowledge of the device.

Our advice is to perform surgery only if it is able to resolve the complications. We regret that we have had to underline the fact that the literature is of little helps to us in the treatment of complications; it appears to indicate that whatever procedure you perform produces good results, and this is absolutely not true.

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Surgical Treatment of Recurrent Rectal Prolapse

24

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24.1 Background

Rectal prolapse or procidentia is a condition in which the entirety of the rectal wall protrudes through the anus. Full-thickness prolapse is a distressing and socially debilitating condition that occurs in a bimodal distribution, initially before the age of 3 years equally in both genders, and after the fifth decade of life primarily in females. The latter group represents 80–90% of adult patients diagnosed [1, 2]. The severity of this condition varies; patients may present with a protruding mass that spontaneously reduces with standing or cessation of straining, or one that has already progressed to continual prolapse (Fig. 24.1). Management depends on the severity of the disease and can range from medical therapy and lifestyle modifications to surgical repair. The goal of surgery is to control prolapse, restore continence when possible, and prevent constipation and impaired evacuation [3]. These goals are typically achieved by returning the rectum to its normal position in the pelvis by fixing it to the presacral fascia. Surgical procedures may be broadly categorized by either the perineal approach or the abdominal approach, which are performed either open or in a laparoscopic fashion. Unfortunately, while there are over 130 different surgical procedures described to surgically repair this distressing condition, little consensus exists as to which one is the most beneficial.

Despite the myriad of choices for repair, recurrence rates can be as high as 47% for some of the procedures [4, 5]. Recurrence can be classified as early – likely a result of technical issues at the time of the operation – or late, often secondary to the nature of the condition, underlying patient characteristics, or habits such as chronic straining that result in prolapse. Risk factors associated

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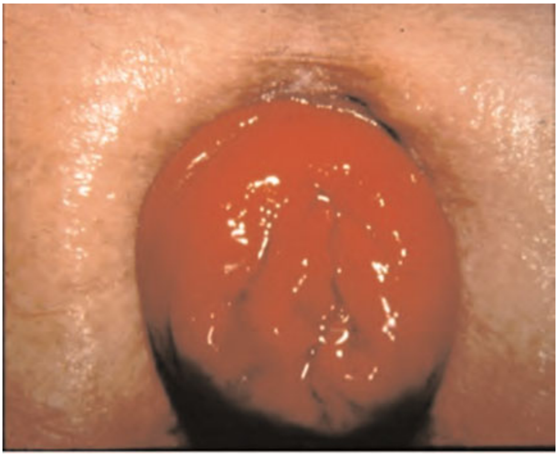

Fig. 24.1 Full-thickness rectal prolapse. (Courtesy of Justin A Maykel)

Box 24.1 Predisposing factors and anatomic correlates for recurrent rectal prolapse

- Chronic constipation
- Neurologic/infectious diseases
- Gender
- Parity
- Redundant rectosigmoid colon
- Deep pouch of Douglas
- Patulous anus
- Diastasis of the levator ani
- Loss of sacral fixation
- Technical error

with recurrence include a technical error associated with the rectopexy or rectosigmoidectomy (including improper suture placement, failure to mobilize, inadequate resection), failure to address concomitant pelvic floor defects, underlying psychiatric disease, male gender, older age, and a higher body mass index (Box 24.1) [6]. Recurrent rectal prolapse repair can and should be approached, both in the preoperative evaluation and in the operative management, in a similar fashion to primary repair, with a few small caveats. The most commonly performed procedures for primary rectal prolapse are rectopexy with use of sutures or mesh (anterior or posterior placement) for fixation, sigmoid resection with rectopexy, Altemeier perineal rectosigmoidectomy and the Delorme procedure (perineal procedure). As the details of each procedure are discussed in depth elsewhere in this textbook, this chapter will highlight the unique aspects of caring for the patient with recurrence that must be taken into consideration when encountering this situation.

24.2 Preoperative Evaluation and Patient Selection

When approaching the patient with recurrent rectal prolapse, it is important to first determine whether or not any surgery is required at all. Depending on the degree of recurrent prolapse and symptoms, observation or simple serial band ligation of mucosal prolapse has shown excellent results [7]. As with any disease process, all evaluations should begin with a thorough history and physical examination, taking into account the overall clinical condition of the patient. Special focus during history should be upon the predominant symptom associated with the recurrence (constipation or incontinence), as this answer may guide both the work-up and the preoperative counseling regarding postoperative bowel function. While this caveat is similar to primary prolapse, focus should also be on the timing of the recurrence and changes in function following the initial operation. For example, if constipation worsened following repair, this symptom could have led to increased straining and eventual recurrence. Additionally, this symptom may prompt a constipation evaluation including transit studies and defecography that may not have been required or performed at the initial evaluation. Physical examination should focus on identifying both the prolapse and concomitant pelvic floor defects, which may have contributed to the recurrence or are de novo and need to be addressed at time of recurrent repair. Necrotic or ischemic prolapse, similar to the primary repair, is readily visualized and typically requires urgent resection (Fig. 24.2). In the elective setting, a careful assessment of sphincter function is even more important for those experiencing fecal incontinence in the setting of recurrence. In certain patients, the examination may sug-

Fig. 24.2 Incarcerated rectal prolapse. (Courtesy of Isaac Felemovicious)

Box 24.2 Preoperative evaluation of recurrent rectal prolapse

History:
- Pelvic pressure
- Tenesmus
- Incomplete evacuation
- Constipation
- Incontinence

Physical examination:
- Visual exam of perianal area
- Digital rectal exam
- Sphincter tone and levator muscle assessment
- Valsalva maneuvers
- Identification of rectocele, cystocele, uterine prolapse

Adjunctive tests:
- Incontinence:
  - Manometry
  - Pudendal nerve latency
  - Defecography
  - Endorectal ultrasound
- Constipation:
  - Manometry
  - Defecography
  - Transit time study
  - Thyroid/parathyroid function tests

gest the need for ultrasound evaluation to identify any potential defect that could be addressed and improved by surgery. Furthermore, depending on the severity of the incontinence and the underlying tone/nerve function, a better option for the patient may be fecal diversion instead of another prolapse repair.

Endoscopy is recommended prior to surgical repair to exclude neoplasia in those patients at risk or with unusual symptoms. Endoscopy may also be useful to exclude conditions such as a lead point or solitary rectal ulcer, an anastomotic stricture in those patients who have had a prior resection, and to determine the level of any anastomosis that may need to be resected – especially when considering a perineal resection in a patient with a prior abdominal resection rectopexy as discussed below. Adjunctive studies such as anal manometry, electromyography, pudendal nerve motor latency testing, cinedefecography, or transit time studies should be ordered based on the patient's predominant symptoms. Additionally, they may be helpful in those patients with possible concomitant pelvic floor abnormalities such as cystocele, enterocele, or vaginal vault prolapse that may be difficult to detect on examination. Box 24.2 lists the components of a successful evaluation. Finally, it is crucial to review the prior operative note(s) to determine crucial details that may radically effect the operation, such as the use and type of mesh, extent of dissection, previous resection(s), and any technical difficulties the prior surgeon may have encountered.

24.3 Which Operative Approach for Recurrent Prolapse is Better?

Currently, there is very little reported in the literature specifically regarding the management of recurrences – with only six studies, all retrospective in nature, that directly address management of recurrent rectal prolapse (Table 24.1) [8–13]. Early studies consisted of small cohorts. Hool reported on 24 patients with recurrent rectal prolapse over a 30-year period. The time to recurrence from primary repair occurred within 2 years. The majority of these patients were treated with an abdominal approach (72% Ripsten Mesh repair). The overall re-recurrence rate for this group was 17% with 7 years follow-up. The authors noted that the majority of initial recurrences appeared as a result of a technical error, with mesh failure the most common cause [9]. Furthermore, altered preoperative bowel function, especially incontinence, was rarely altered following repair of the recurrence – an important counseling point for patients prior to recurrent repairs. Fengler et al. reported 14 patients with recurrent rectal prolapse that were treated over a 10-year period. Those authors found a slightly earlier average time to recurrence than the Hool group, at 14 months. Treatment of these patients involved either a perineal or an abdominal approach, with a follow-up of 50 months for either approach. At the end of the study, there was only one death and there was no recurrence in the remaining patients [8]. Overall, complications included one patient with mucosal sloughing that occurred between two anastomotic lines, and three patients with preoperative fecal incontinence had no resolution of symptoms. Pikarsky matched 27 cases of reoperative recurrent prolapse with an equal number of primary prolapse repair, utilizing a mixture of abdominal and perineal approaches with a mean follow-up of 24 months. The overall recurrence rate between the recurrent repair and primary repair was similar (15% vs. 11%) [10].

Table 24.1 Recurrent Rectal Prolapse: Literature Reports

Study [Reference]	No. of patients	Approach	Recurrence rate (%)
Hool et al. (1997) [9]	24	Abdominal > perineal	17
Fengler et al. (1997) [8]	14	Perineal > abdominal	0
Pikarsky et al. (2000) [10]	27	Abdominal and perineal	15
Watts and Thompson (2000) [12]	17	Perineal	NA
Steele et al. (2006) [11]	78	Perineal > abdominal	37, 15
Ding et al. (2012) [13]	23	Perineal	39

To try to determine if there was a better surgical strategy when approaching a recurrent prolapse repair, Steele and colleagues analyzed a cohort of 685 patients over a 14-year period and identified 78 recurrences that underwent surgical repair utilizing a perineal approach (n = 51) or an abdominal approach (n = 27). Overall, 29% of patients developed a second recurrence, with a statistically higher rate of re-recurrence in the perineal approach group (37% vs. 15%, $p = 0.03$). The authors noted that recurrence after primary repair occurred at an average of 33 months, which was much longer than prior studies. Moreover, the time to second recurrence occurred at an average of 9 months. The authors of that study concluded that the abdominal approach should be utilized for recurrent prolapse repairs when the patient's risk profile permitted, due to the much lower re-recurrence rate [11]. When comparing complications, rates of both major and minor postoperative morbidity were similar between perineal and abdominal approaches.

For patients unable to tolerate an abdominal approach for their recurrence repair, the perineal rectosigmoidectomy still offers a useful alternative. Although associated with worse functional results and higher recurrence rates, it is associated with lower morbidity rates, shorter hospital stays, and less postoperative pain compared with an abdominal approach. A recent retrospective study by Ding and associates evaluated the safety and efficacy of redo perineal rectosigmoidectomy in 23 patients and compared them with 113 case-matched patients undergoing primary repair over a 9-year period. The authors noted that while postoperative complications rates were similar (17.4% vs. 16.8%), the rate of recurrence was much higher in the redo repair group (39.1% vs. 17.7%, $p = 0.007$), with a shorter interval of time to recurrence compared with primary repair (16.0 months vs. 21.5 months). The authors concluded that this approach was safe and feasible in patients who would otherwise be unable to tolerate an abdominal procedure; however, the rate of recurrence would likely be considerably higher than primary repair [13].

While there is still not a consensus in the literature regarding the optimal approach for a recurrence repair, the literature suggests that the technical errors are usually, but not always, the cause of initial recurrence, time to recurrence is shorter than that of a primary repair, and abdominal repairs have lower recurrence rates compared with the perineal approach for redo recurrence repairs. The perineal approach, while having a significantly higher recurrence rate, is still a feasible alternative for patients with severe co-morbidities who are unable to undergo an abdominal approach repair. Finally, abdominal repairs can be performed via laparoscopy or traditional open routes, although only case reports currently exist for the minimally invasive approach in the setting of recurrent disease [14].

While the data may be sparse, in order to determine the ideal approach for patients with recurrence, the outcome of evaluation must be taken into account. Whether it is the complication rate, mortality, functional results, cost, or subsequent recurrences, there is a fine balance among the various surgical options for each metric. As an example, Delorme's procedure, in general, is associated with high rate of recurrence (> 50%) in the setting of recurrent disease; however, the morbidity is often < 10% and there is no anastomosis to be concerned about. Therefore, sacrificing benefits on one aspect may allow improvements in another area, and should be viewed within the context of the individual patient.

24.4 Pearls and Pitfalls

There are technical points to consider when performing surgery for recurrence. As previously discussed, pelvic floor disorders should be identified during the preoperative evaluation and dealt with during the repair, or they may lead to recurrence. Even if not addressed, these issues can be discussed with the patient during preoperative counseling – specifically regarding the potential need for future additional surgical intervention should they become symptomatic. The value of a detailed operative report from the previous initial repair cannot not be overemphasized, and allows the surgeon to determine the type of repair, if prosthetic material was utilized, and whether or not pelvic floor pathology was present, repaired, and in what manner. The unexpected discovery of mesh tightly adhered to the sacrum during an attempt to perform a laparoscopic recurrent repair may prompt quick conversion to open or excessive bleeding in either setting.

From a pure technical aspect, there remains a fine balance between attempting to mobilize or resect more bowel, with the goal of lowering recurrence rates, with that of taking too much and leading to increased anastomotic complications. Conversely, leaving behind excess bowel may ensure adequate vascularization or a tension-free anastomosis, but often leads to a higher rate of recurrence. Certain other technical considerations can also affect recurrence rates. During Altemeier repairs, failure to enter the peritoneal cavity has been associated with higher recurrence rates [15]. During performance of an abdominal approach for repair, emphasis should be placed on the preservation of the superior hemorrhoidal artery in order to maintain adequate blood supply to the new anastomosis. Additionally, extensive distal lateral dissection may decrease recurrence rates, but may worsen or cause constipation [16]. Ischemic complications can further be minimized by resecting the prior anastomosis, especially when performing perineal rectosigmoidectomy in someone with a prior perineal rectosigmoidectomy or an abdominal resection rectopexy. Failure to do so may result in an ischemic segment, which may cause mucosal sloughing, anastomotic leak, or stricture [6]. Experience is always an asset and consultation or referral to experienced center is not considered a failure, but likely an expression of good judgment.

Finally, the key factor in overall recurrence rates remains length of time from surgery. A review of 643 abdominal prolapse repair procedures was evaluated with a mean follow-up of 43 months. The 1-year, 5-year, and 10-year recurrence rates were 1%, 6.6%, and 28.9%, respectively. The authors noted that technique, method of rectopexy, or manner of intra-abdominal approach (open vs. laparoscopic) did not have an impact on recurrence, but the length of follow-up did

[17]. Furthermore, despite excellent technical success with recurrent repairs (similar to the open), the subsequent function may not improve, and may actually worsen. Accordingly, patients should be counseled very carefully regarding postoperative expectations, specifically that while a successful repair may relieve the prolapse, symptoms of constipation or incontinence are likely to remain present and that the rate of recurrence will also increase as time passes; thus emphasizing the importance of continued postoperative follow-up.

24.5 Summary

In summary, despite the paucity of large-scale trials and level-I evidence, when managing the patient with recurrent rectal prolapse, there are several conclusions that may be drawn from the existing body of reported experience. First, recurrent prolapse most commonly occurs anywhere from 1–3 years from the initial operation, although it likely increases with even longer follow-up periods. Second, a thorough work-up for these patients including adjunctive tests is required to identify factors that led to recurrence and may need to be addressed prior to or along with a subsequent repair. These factors include severe constipation or incontinence and concomitant pelvic floor disorders. A detailed review of the operative report from the initial and any prior operations is extremely useful and can identify factors that may require intraoperative evaluation and should not be repeated during surgery. Patients should be extensively counseled concerning postoperative expectations regarding associated symptoms with their recurrent prolapse, their expected higher rated recurrence regardless of approach, and the need for prolonged follow-up after the procedure. Next, technical aspects such as resection of the prior anastomosis and maintaining a fine balance between resection of redundant bowel and ensuring a tension-free anastomosis should help prevent higher rates of postoperative complications and recurrence. Finally, abdominal approaches are consistently associated with lower rates of recurrence, even following repair of recurrence. This approach should be attempted if patient risk profile permits. If an abdominal operation is not possible, then a perineal approach is still a safe and feasible procedure, albeit at a cost of a higher recurrence rate and less optimal function.

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Management of Concomitant Middle Compartment Disorders

25

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25.1 Introduction

In the traditional "vertical" segregation of the pelvic floor into anterior, middle and posterior compartments, disorders of the middle compartment (uterus, vagina and introitus) were the preserve of gynecologists. This compartmentalized view of the anatomy, assessment, and management of pelvic floor disorders led to clinicians working in isolation, with a detailed understanding of pathologies limited to their area of expertise, often to the detriment of the patient. The modern, horizontally integrated view of the pelvic floor as a whole unit has necessitated multidisciplinary team working and has led to a more detailed and broader assessment process [1]. The aim of this strategy has been to optimize patient management by avoiding repeated clinic attendance and/or operative intervention because of a failure to accurately identify dysfunction of an adjacent organ of the pelvic floor.

Multicompartmental dysfunction of the pelvic floor is common, but appreciation of this fact by practicing clinicians had been sporadic at best, despite extensive data in the literature, until the resurgence of interest in pelvic floor disorders over the past decade or so. The Cleveland Clinic in Florida did much to raise awareness in colorectal circles with their seminal publication on a survey of three groups of patients: those with fecal incontinence, those with rectal prolapse, and a control group [2]. Consistent with similar studies on "normal" populations, the control group had incidences of urinary incontinence and genital prolapse of 30% and 12.5%, respectively. Urinary incontinence was present in 53% of those who had had previous surgery for fecal incontinence and 65% in those who had had previous surgery for rectal prolapse. Genital prolapse was similarly more prevalent in the study groups than in controls, being found in 18% of patients with fecal incontinence and 34% of patients with rectal prolapse.

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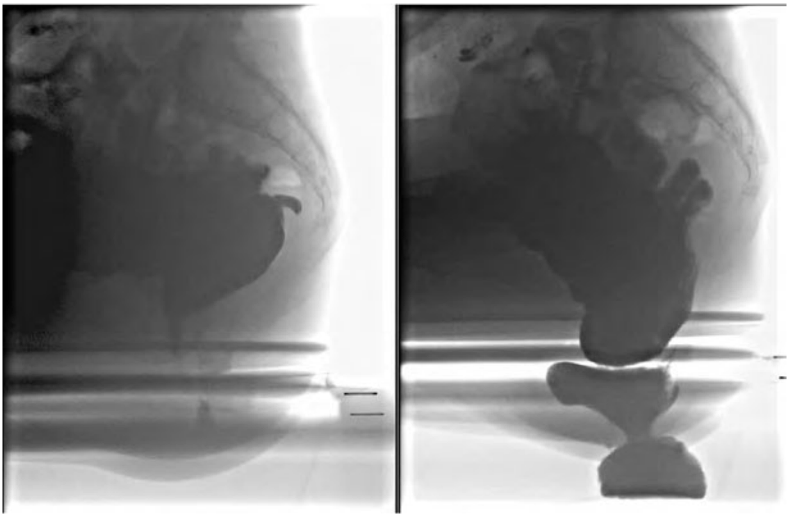

Fig. 25.1 Defecating proctogram at rest (*left*) and on evacuation (*right*). There is a normal anorectal angle at rest, with a reasonable pelvic lift and good anal canal length (*left*). There is a small anterior rectocele seen with coughing, which enlarges with evacuation and does not fully empty. There is vaginal vault prolapse and an enterocele that descends to within 4 cm of the anal canal (*right*)

The inevitable consequence of all these developments in our understanding of the basic science underlying prolapse disorders and in advances in service provision is the increased frequency of the diagnosis of multicompartmental pelvic organ prolapse. Indeed, with a greater understanding of the natural history of the disease process, multicompartmental pelvic organ prolapse may even be thought inevitable if only unicompartmental prolapse has been diagnosed at initial presentation, thus raising the prospect of prophylactic surgical measures. Ultimately, if multicompartmental prolapse repair is to be performed, the debate is between sequential and simultaneous procedures. The development of urogynecology as a subspecialty means that anterior and concomitant middle compartment prolapse is often dealt with by the same surgeon. The challenge lies when there is posterior with concomitant middle compartment prolapse, as this traditionally would have required both a colorectal surgeon and a gynecologist. With the development of pelvic floor surgery as a specialty in its own right, the prevailing view is that procedures that simultaneously correct prolapse in both compartments are to be preferred as the outcome from concomitantly performed procedures is not any worse than sequentially performed procedures, the overall time in recovery is reduced by having only one operation and there is a theoretical reduction in the rate of surgical complications. Technical considerations, such as access to the sacral promontory for rectopexy and colpopexy, also tend to favor simultaneous procedures.

The main pathological entities that will be encountered in the middle compartment are vaginal vault prolapse and uterine prolapse. These frequently coexist with posterior compartment disorders (Fig. 25.1). The management strategy for each of these concomitant disorders varies according to the operative approach intended for the posterior compartment surgery. The goals of surgery are, however, the same regardless of the operative approach, namely the restoration of normal anatomy and function of pelvic organs.

25.2 Etiology of Middle Compartment Prolapse

The high degree of concordance between pelvic floor pathologies suggests a common etiology to disorders of all three compartments, namely childbirth, particularly with increasing parity, after prolonged labor, and after instrumental deliveries. Middle compartment prolapse (vaginal vault and uterus) is caused by loss of support or weakening of the uterosacral and cardinal ligaments. Hysterectomy in particular is associated with a significantly increased risk of vaginal vault prolapse [3]. Etiological factors other than parity, such as family history, genetics, obesity, and smoking status have been implicated in the development of pelvic organ prolapse [4] and much recent work has focused on the significant role of connective tissue and extracellular matrix metabolism [5–7]. Increasing age is a significant risk factor in addition to those mentioned above, with estrogen deficiency, particularly after the menopause, the presumed main contributing factor. Hormone replacement therapy (HRT) for more than 5 years may have a protective role in the development of pelvic floor dysfunction in postmenopausal females [8], but it is uncertain whether HRT initiated at the onset of menopause can prevent such prolapse.

25.3 Epidemiology

Population estimates of prevalence and incidence of pelvic organ prolapse are difficult to derive accurately, but are conservatively estimated at a life-time risk of at least one-third of the female population as a whole [9] and possibly up to 50% of parous women. Life-time risk of having surgery for pelvic organ prolapse of any type has been estimated at 11.1%, with a high reoperation rate of 29% [10]. This high rate of reoperation may in part reflect the inadequate assessment of all compartments of the pelvic floor in the past and it is uncertain whether it is representative of modern practice.

25.4 Classification

The International Continence Society has devised a scoring system for vaginal prolapse called the pelvic organ prolapse quantification (POP-Q) system, which defines specific sites on the anterior, posterior, and apical vaginal compartments that are measured with respect to the position of the hymen [11]. An ordinal staging system is derived from the measurements ranging from 0 to 4, where stage 0 denotes no prolapse through to stage 4 denoting complete eversion. Use of this standardized system in both clinical practice and in reporting trials facilitates stratification of patients and comparison between studies of different management techniques.

25.5 Conservative Management

The most conservative option for genital prolapse is vaginal pessary use. A wide range of pessary styles and sizes are available and selection of the most appropriate device usually requires a degree of trial and error. Such an approach can be useful for the aged, highly co-morbid patient, who may have a similarly conservative approach employed for their posterior compartment prolapse. Pessaries are also indicated in those who wish to avoid surgery specifically for their genital prolapse or postoperatively after pelvic reconstructive surgery to prevent recurrence. Pessary care can optimize and facilitate safe long-term use, but may be bothersome for younger patients who often prefer definitive surgical management.

25.6 Transvaginal and Obliterative Surgical Approaches

Operative approaches to genital prolapse in general and vaginal vault prolapse in particular include transvaginal, abdominal (open, laparoscopic, or robotic), and obliterative techniques. When considering the management of vault prolapse, transvaginal approaches, such as ileococcygeus suspension, sacrospinous fixation, and uterosacral ligament suspension are useful for postmenopausal women for whom sexual activity may not be important and in whom a perineal approach for posterior compartment disorders has been selected. Sacrospinous fixation was first described in the 1980s [12] and has been the favored transvaginal approach by many, with the vaginal apex being attached to the sacrospinous ligaments by non-absorbable sutures. The posterior vaginal dissection may allow repair of concomitant enterocele, but the main limitation of this procedure is the not insignificant incidence of postoperative cystocele formation [13]. The medical literature is replete with a myriad of techniques for transvaginal placement of various mesh types for vault prolapse. The recent announcement by the Food and Drug Administration (FDA) in the USA regarding transvaginal mesh placement, whether biological or synthetic mesh, has cast doubt on whether they should be performed at all [14]. Indeed, in their review the FDA concluded “serious adverse events are NOT rare” and also “transvaginally placed mesh in POP repair does NOT conclusively improve clinical outcomes over traditional non-mesh repair”. This point of view remains controversial and is directly opposed by some authors who point out that there is good evidence to support the use of mesh augmentation and that it has a favorable risk/benefit ratio [15]. Obliterative approaches for vault prolapse such as colpectomy or colpocleisis are reserved for elderly women who are not sexually active, and have high rates of patient satisfaction [16]. Similar to the transvaginal approach, obliterative approaches are a useful adjunct to perineal approaches for posterior compartment prolapse. In view of the aging population in many westernized societies, the obliterative approaches to vault and uterine prolapse are likely to become more widespread [17].

25.7 Abdominal Operative Approaches: Open and Minimally Invasive

The abdominal approach to correction of vault or uterine prolapse was first described in the 1960s [18, 19] and involves the placement of a suspensory prosthesis, either synthetic or biologic, between the vaginal vault and the sacral promontory in the retroperitoneal plane. Abdominal approaches to correction of vault or uterine prolapse, whether open, laparoscopic, or robotic, are optimal when an abdominal approach has been selected for correction of the posterior compartment. In patients with uterine prolapse, the role of uterine preservation and suspension versus hysterectomy, either via vaginal or abdominal routes, remains contentious with no clear consensus emerging from the literature [20]. Open sacrocolpopexy has been reported to have better outcomes than transvaginal sacrospinous fixation in terms of correction of prolapse, recurrence, postoperative stress urinary incontinence, and postoperative dyspareunia. Laparoscopic sacrocolpopexy has equivalent outcomes in terms of prolapse correction when compared with open surgery, but is associated with reduced blood loss and shorter lengths of stay [21]. The laparoscopic approach has become the favored approach for many gynecologists in Europe, with over 20 years of experience behind it as a technique. Complications such as L5/S1 discitis [22] due to tack misplacement and mesh erosion [23] are well described and appropriate strategies for prevention and management now exist [24–26]. There remains debate about which mesh is optimal for this type of surgery, and this is covered in detail in Chapter 27. As laparoscopic experience has grown among the wider surgical community, other minimally invasive techniques such as single port surgery have also been described in small numbers [27], although long-term follow up is lacking.

Since the advent of the Da Vinci® system onto the market in 1999, robotic sacrocolpopexy for pelvic organ prolapse has disseminated rapidly across the USA with minimal evidence to support its use. The past 5 years has seen numerous single institution case series or retrospective cohort studies that all purport to demonstrate at least equivalent outcomes to laparoscopic sacrocolpopexy, but only two have reported long-term outcomes [28, 29]. Only one small randomized trial (from the Cleveland Clinic) is currently available and its authors concluded that "robotic-assisted sacrocolpopexy results in longer operating time and increased pain and cost compared with the conventional laparoscopic approach" [30]. Results from the multicenter ACCESS trial, which also compares laparoscopic and robotic surgery, are awaited [31]. The trial may not, however, deliver the answer many clinicians are looking for since its primary outcome measure is cost of the procedure rather than a patient-focused outcome such as rate of recurrence, complications, or severe postoperative pain.

25.8 Synchronous Approaches

Synchronous approaches to middle and posterior compartment prolapse via the abdomen have become more prevalent since the wider recognition of multicompartmental prolapse as a common phenomenon has occurred. Small, single-institution case series of open abdominal procedures with short follow-up first appeared approximately 15 years ago, mainly in the gynecological literature. Cundiff et al. [32] were among the first who reported good clinical and radiological outcomes on 19 patients with vault prolapse, perineal descent, and associated rectoceles or enteroceles who had a sacrocolpoperineopexy. This involved dissection of the rectovaginal septum to the perineal body and mesh placement in this plane, which was sutured to the perineal body, the length of the vagina, and to the sacrum. Marinkovic and Stanton [33] utilized a similar open abdominal approach for 12 patients with triple compartment prolapse, but added an anterior mesh in order treat the cystocele. Objectively assessed clinical outcome and patient satisfaction scores were reported as being good with a median of 39 months follow-up. Within the colorectal literature, detailed functional outcome after open repair in 29 patients with a median 26-month follow-up was reported by Lim et al. following sacrocolporectopexy, which involved suspension of the vaginal vault with a "Y"-shaped mesh combined with fixation of the free edges of the mesh to the rectum, which had been mobilized posteriorly [34]. Significant improvements in global pelvic floor distress inventory scores were noted postoperatively.

The open abdominal approach for concomitant middle and posterior compartment prolapse coincided with the adoption of laparoscopy by the colorectal community, several decades after gynecologists had pioneered its use. Laparoscopic approaches for rectal prolapse were first described in the early 1990s, and many subsequent studies have demonstrated benefits in comparison with open surgery, particularly in terms of reductions in perioperative morbidity and length of hospital stay. Initial reports describing the laparoscopic management of multicompartmental prolapse replicated the open technique. Sagar et al. [35] reported functional outcome on ten patients after laparoscopic sacrocolporectopexy to be improved in a similar manner to their open cohort [34]. This technique, however, necessitated posterior rectal mobilization, which had become associated with worsening constipation. D'Hoore et al. [36] had advocated anterior rectal mobilization only in their seminal paper on laparoscopic ventral rectopexy, in order to avoid this troubling complication that can often be worse than the disease being treated. Subsequently, several minor modifications of the laparoscopic ventral mesh rectopexy technique have been proposed, including mesh fixation to the posterior and/or anterior vaginal wall [37], or with concomitant posterior colporrhaphy [38] as methods for dealing with multicompartmental prolapse. The majority of authors have reported excellent outcomes in terms of prevention of prolapse recurrence, but mesh-related complications and their management remain a concern [39]. The good outcome associated with this minimally invasive approach has been demonstrated most notably in the elderly with low morbidity and recurrence rates [40].

25.9 Summary

The management of concomitant middle compartment prolapse should be tailored to the individual patient and is influenced by the approach taken to the posterior compartment. Elderly and/or comorbid patients may benefit from conservative or obliterative strategies. Patients fit enough for surgery are likely to be best managed by an abdominal approach that synchronously corrects the prolapse of both compartments by suspension to the sacral promontory. Laparoscopic techniques are associated with equivalent outcomes to open surgery in terms of recurrence, but with low rates of morbidity.

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Management of Concomitant Pelvic Disorders: The Urologic Perspective

26

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26.1 Introduction

The pelvic floor is a crossover of various complex functions, and can be considered from three aspects: urological, gynaecological, and coloproctological. The pelvic floor is at risk of damage in females because of its anatomy, since the pelvic organs are positioned in dynamic tensile structures that are subject to weakness over time. There are many factors to be considered, both intrinsic and extrinsic. Intrinsic factors induce the reduction of collagen production, which might lead to deterioration of the fibroelastic support. Extrinsic factors (i.e., constipation, cough, and physical activities) induce an increase in abdominal pressure. Two critical moments in the life of a woman are pregnancy and delivery, which can result in injury. Birth trauma may lead to muscle and neurological lesions, and damage due to stretching. Further alterations are brought about by hormonal changes in the menopause. Symptoms of damage are voiding dysfunction, incontinence, urinary retention, gynecological disorders (such as dyspareunia or vaginal prolapse), and coloproctology dysfunctions (such as constipation and fecal incontinence). An overactive pelvic floor is frequently associated with voiding difficulties of the bladder, and constipation, dyspareunia, and chronic pelvic pain. A reduced tone of the pelvic floor is associated with urinary stress incontinence and/or fecal incontinence, vaginal prolapse, and sexual problems. The most frequent urological symptom in females is stress urinary incontinence (SUI) due to sphincter deficiency, with involuntary loss of urine during activities requiring effort. If this condition is not treated, it evolves over time into mixed urinary incontinence (MUI). MUI is a combination of SUI with urinary urge incontinence (UUI). Urge incontinence is caused by an abnormal

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bladder filling function secondary to detrusor overactivity. A clinical definition of overactive bladder (OAB) syndrome is dry, urinary urgency and frequency, or wet, if patients also refer urge incontinence. In cases of pelvic organs prolapse (POP), all symptoms and dysfunctions must be identified before surgery since they are not always correlated with POP and can be cured with conservative or mini-invasive treatment. It is also necessary to perform effective patient counseling on the outcomes after surgery. The urological approach provides for the clinical assessment of the sacral area. In addition to the presence of POP, the integrity of innervation in terms of sensitivity and muscle contractile activity should be investigated. The assessment consists of a specific and general history, physical examination, and neuro-urological and examinations with instruments (such as renal pelvic ultrasound and urodynamics). First-line therapy treatments are conservative. They include perineal rehabilitation and medical treatment. In cases where these fail, percutaneous tibial neurostimulation (PTNS) and sacral neuromodulation should be considered. A more recent option is the injection of botulinum toxin (BoNT-A) into the detrusor muscle or the submucosa of the bladder wall in patients with OAB syndrome. BoNT-A injection is still under investigation; however, it is included in the International Consensus on Incontinence algorithm.

26.2 Conservative Management

Conservative management should be considered as a first-line treatment for uncomplicated lower urinary tract symptoms in women. This includes lifestyle interventions, and physical and pharmacological therapy.

26.2.1 Behavioral Techniques

Changes of lifestyle can be helpful especially in the early stages of disease, and these are generally combined with rehabilitation programs consisting of bladder re-education and pelvic floor muscle training (PFMT). Behavioral modifications include, for example, loss of weight, maintenance of regular bowel habits, quitting smoking, adjusting daily fluid intake, and even reducing or stopping the consumption of alcohol, coffee, and/or tea [1, 2].

Strategies of scheduled voiding regimens are mainly distinguished on the basis of adjustment of urinary symptoms. Bladder retraining includes a program of scheduled voiding that gradually increases over time, in order to improve OAB symptoms such as frequency, urgency, and UUI. Timed voiding consists of a fixed interval between micturition during the day (every 3–4 h). This program is usually recommended in cases of SUI or voiding dysfunction (e.g., incomplete bladder emptying) to prevent urinary leakage or retention [3].

26.2.2 Physical Therapy

Pelvic floor rehabilitation programs should be the first attempt to resolve mild or moderate urinary incontinence [3, 4]. The rationale of PFMT is to improve the quality and control of the striated pelviperineal muscles, which maintain continence by means of abdominoperineal reflexes. Furthermore, the voluntary contraction of pubococcygeous muscles provides a supplementary action for urethral sphincter function. Therefore, PFMT can be recommended not only for stress incontinence, but also as an adjunct to other treatments for mixed and UUI.

PFMT is often combined with biofeedback and functional electrical stimulation (FES) [5]. Biofeedback is usually indicated in the first stage of a rehabilitation program, to make the patient aware of the pelvic floor muscles and be able to eliminate synergies or correct dysfunctions; an example is the reverse perineal command.

The FES provides two different effects resulting from stimulation of the pudendal nerve: a trophic action by passive contraction of the pelvic floor muscles, and a reflex inhibition of detrusor contractions (pelvic–pudendal reflex). Therefore, FES should not be used in patients with urinary retention.

A more recently introduced, alternative form of electrical stimulation is percutaneous tibial nerve stimulation (PTNS) [6]. It consists of an acupuncture needle inserted few centimeters above the medial malleolus, while a surface electrode is placed on the medial calcaneus of the same leg. The needle electrode is then connected to an external pulse generator that delivers an adjustable electrical pulse that travels to the sacral plexus via the tibial nerve. This treatment is considered to be the least invasive form of neuromodulation, and it has been proven to be effective and safe in OAB syndrome. Furthermore, PTNS can be used as an option for chronic pelvic pain or nonobstructive urinary retention, to be used concomitantly with other conservative therapy [7].

26.2.3 Pharmacological Treatment

26.2.3.1 Overactive Bladder Syndrome and Urinary Urge Incontinence

Currently, muscarinic receptor antagonists are the first choice for pharmacological treatment of OAB syndrome and UUI. The rationale of these medications is based on the fact that detrusor contractions are primarily mediated via muscarinic receptors, particularly subtypes M2 and M3. Several antimuscarinic receptor antagonists have been investigated (Table 26.1). All have been documented to be efficacious in OAB syndrome, but none has been proven to be the ideal treatment when compared with the others available. It is still unclear which drugs should be chosen as first-, second-, and third-line therapy. Profiles of each drug and dosage differ, and these should be considered when making treatment choices [8–10]. Particular caution should be used when treating elderly patients, who should be put on lower dosages in order to avoid cognitive impairment [11]. Close-angle glaucoma is the main contraindication for antimuscarinic drugs.

More recently, the US Food and Drug Administration approved a new drug

Table 26.1 Formulation and dosage of muscarinic receptor antagonists

Drug	Dose	Frequency
Tolterodine	1–2 mg	TID
Tolderodine LA	2–4 mg	Once daily
Oxybutynin	2.5–5 mg	BID or TID
Oxybutynin XL	5–15 mg	Once daily
Oxybutynin transdermal patch	3.9 mg/dL	One patch BIW
Oxybutynin gel (10%)	1 mL	Once daily
Trospium	20 mg	BID or TID
Trospium XL	60 mg	Once daily or BID
Solifenacin	5–10 mg	Once daily
Fesoterodine	4–8 mg	Once daily
Darifenacin	7.5–15 mg	Once daily
Propiverine	15 mg XL 30 mg	BID or TID Once daily

BID, twice daily; *TID*, three times daily; *BIW,* twice weekly.

for OAB treatment. Mirabegron is a β-3 adrenergic receptor agonist, and the first of a new class of treatments with a different mechanism of action compared with antimuscarinic drugs. Mirabegron acts by relaxing the detrusor smooth muscle during the storage phase by activation of β-3 receptors, but with no negative effects on the voiding phase [12]. Promising Phase II studies have also been recently completed on Solabegron, a highly selective high-affinity β-3 receptor agonist, for the treatment of OAB and irritable bowel syndrome. It has been shown to produce visceral analgesia by releasing somatostatin from adipocytes. Phase II studies indicated a tolerability profile for Solabegron that was similar to placebo. Phase III trials are still underway [13, 14].

26.2.3.2 Female Stress Urinary Incontinence

Several pharmacologic therapies have been proposed for the treatment of SUI in women. These have shown varying success rates, but they rarely bring about total dryness in cases of severe or even moderate SUI.

Duloxetin, an antidepressant acting on the reuptake of serotonin, is the only drug approved in Europe for treatment of SUI. It is approved in the USA for other conditions, but not for SUI. It has weak effects on the bladder and urethral sphincter activities under normal conditions; however, under conditions of "bladder irritation" it suppresses bladder activity through central serotonin receptor mechanisms and enhances urethral sphincter activity through serotonergic and α1-adrenergic mechanisms. Despite a reported significant improvement when compared with placebo, many patients discontinue therapy because of side-effects [15].

Local estrogen treatment for incontinence may improve SUI, but there is no evidence about long-term effects. There have been a few studies on the choice of estrogen type and dose, but there is no direct evidence regarding the best route of administration. The risk of cancer related to long-term treatment with estrogen (breast, endometrial) suggests that estrogens should be used for limited periods only [16].

26.3 Surgical Treatments

26.3.1 Midurethral Sling

26.3.1.1 Midurethral Sling and Stress Urinary Incontinence

Surgical treatment is the standard approach for women with SUI who have failed conservative management strategies such as lifestyle changes, physical therapies, scheduled voiding regimens, and behavioral therapies. Minimally invasive midurethral slings are now considered the first-line surgical treatment for female SUI. In just a few years, midurethral sling (MUS) surgery has revolutionized this urologic field [17] because of a very short learning curve for the procedure, combined with high clinical efficacy and safety [18–20]. This new concept of tension-free midurethral support was introduced in the 1990s by Ulmsten and Petros [17].

The use of tension-free vaginal tape (TVT) has been shown to produce significantly higher continence rates compared with Burch colposuspension [21]. Furthermore, the TVT procedure has been shown to outperform other retropubic slings (intravaginal sling, SPARC™) (Table 26.2). As regards the long-term data, Nilsson et al. reported an objective cure rate for TVT of 84–90% with a follow-up ranging from 5 to 11 years [22].

In 2001, Delorme proposed a new device with a transobturator route of midurethral tape insertion (TOT) to reduce the risk of pelvic complications (particularly bladder injury) [23]. In controlled trials comparing MUS devices, patients randomized to retropubic or transobturator tapes yielded similar objective and subjective postoperative continence outcomes [21]. In the opinion of

Table 26.2 Type, approach, and manufacturer of commercially manufactured midurethral slings

Midurethral sling	Approach	Manufacturer
TVT™	RP: bottom to top	Ethicon
Advantage®	RP: bottom to top	Boston Scientific
SPARC™	RP: top to bottom	AMS
Lynx®	RP: top to bottom	Boston Scientific
Prefix PPS™	Pre-pubic: bottom to top	Boston Scientific
Monarc™	TOT: out to in	AMS
Obtryx®	TOT: out to in	Boston Scientific
Aris®	TOT: out to in	Coloplast
TVT-O™	TOT: in to out	Ethicon
MiniArc™	Single incision	AMS
TVT SECUR™	Single incision	Ethicon
AJUST™	Single incision	Bard
Solyx™	Single incision	Boston Scientific
Altis®	Single incision	Coloplast
Ophira®	Single incision	Promedon

RP, retropubic; *TOT*, transobturator.

Table 26.3 Cure and improvement rates for mini-slings

Mini-sling [29]	Cure rate (%)	Improvement rate (%)
TVT-O™	83	10
TVT SECUR™	67	13
MiniArc™	87	7

Table 26.4 Objective and subjective cure rates for TOT and TVT SECUR™

Procedure [30]	Cure rate (%)	
	Objective	Subjective
TOT	97.6	92
TVT SECUR™	83.5	76

O'Connor, the retropubic sling is more effective among patients with intrinsic sphincter deficiency [24]. Rechberger et al. reported that the effectiveness of transobturator tape is significantly lower with Valsalva leak point pressure (VLPP) ≤ 60 cm H_2O, while the retropubic technique is effective with VLPP ≤ 60 cm H_2O [25]. Therefore, as reported in the literature, the TOT approach should be suggested in SUI patients with VLPP > 60 cm H_2O, while in patients with VLPP ≤ 60 cm H^2O, the retrobubic approach should be considered [24].

Furthermore, regarding the two different TOT techniques, 'inside-out' and 'outside-in', it has been reported in a prospective study that both have shown similar cure rates (86% versus 92%, respectively) [26]. Moreover, fewer postsurgical complications were seen after TOT than after the retropubic approach [27, 28].

In addition to the low risks of TOT, a much less invasive MUS (placed without use of any needles, and passed either retropubically or through the groin) has been developed. Gynecare TVT SECUR™, the first mini-sling manufactured by Ethicon, Inc., a Johnson and Johnson company, was released in the USA in 2006. More recently, the MiniArc® single-incision sling has been developed by AMS, Inc. In Tables 26.3 and 26.4, the outcomes of using mini-slings compared with TOT procedures are described [29, 30]. However, due to poor efficacy, TVT SECUR has been out of production since 2012.

26.3.1.2 Midurethral Sling and Mixed Urinary Incontinence

There is conflicting evidence on the effectiveness of the MUS in MUI. While the cure rate for the urge component seems to be variable, there is good evidence that the MUS improves the stress component.

However, a few studies have reported positive results in UUI after the TVT procedure. Rezapour and Ulmsten reported that not only SUI, but also UUI, was cured in 85% of patients and significantly improved in 4% [31].

Paick et al. evaluated the outcome after TVT, SPARC, and TOT procedures in women with MUI. The cure rates in women with MUI were similar following the TVT, SPARC, and TOT approaches (for SUI: TVT 95.8%, SPARC 90.0%, TOT 94.0%; and for UUI: TVT 81.9%, SPARC 86.4%, and TOT 82.0%) [32].

However, a recent systematic review underlines the fact that specific randomized controlled trials of tapes with a long-term follow-up are needed in order to demonstrate the efficacy of retropubic and TOT techniques in women with urodynamically proven and symptomatic MUI [33].

26.3.1.3 Midurethral Sling and Voiding Dysfunction

Voiding dysfunction after sling procedures can be caused by urethral obstruction from hyperelevation of the bladder neck or an exaggerated kinking of urethra. Further voiding symptoms (e.g., hesitancy, slow stream, intermittency, incomplete bladder emptying) and obstruction can also lead to other urinary symptoms, such as pain or OAB syndrome. Voiding dysfunctions, transient or persistent, have been reported in about 3–38% of patients after MUS procedures [34]. Although there is neither an established cut-off point between normal and abnormal postvoid residual (PVR), nor evidence of a correlation between PVR and voiding symptoms, almost 90% of patients report a PVR of < 100 mL after MUS surgery [35, 36].

There is no consensus on appropriate surgical revision techniques. Tape release, urethrolysis, and sling incision can be considered options for use in voiding dysfunction after MUS.

26.3.1.4 Midurethral Sling and Recurrent/Persistent Stress Urinary Incontinence

The choice of treatment in cases of recurrent or persistent SUI after a first surgical approach is the subject of much debate. After a MUS procedure, the rate of patients re-treated for recurrent or persistent SUI is from 5% to 20% [37].

When failure occurs after a sling procedure, several treatments have been proposed for further management such as the injection of bulking agents, retropubic suspension, pubovaginal sling procedure, shortening of the preimplanted tape, artificial urethral sphincter, adjustable continence therapy or repeat MUS [37, 38]. The latter seems to be the most attractive choice in cases of early MUS failure. Recently, Stav et al. reported encouraging results in two groups of female patients who had undergone primary and repeat MUS procedures. The preoperative incidence of intrinsic sphincter deficiency was higher in patients who had had a repeat MUS (31% vs. 13%). The subjective SUI cure rate was 86% and 62% in the primary and repeat group, respectively. Repeating the retropubic approach was significantly more successful than a repetaing the transobturator approach (71% vs. 48%). De novo urgency (30% vs. 14%) and de novo urgency urinary incontinence (22% vs. 5%) were more frequent in the group undergoing a second surgery than in the primary group. In authors' opinion, although a repeat MUS procedure has a significantly lower cure rate rather than primary MUS, the retropubic approach seems to have a higher success rate compared with TOT, whether or not repeat surgery is needed [39].

26.3.2 Anterior Vaginal Wall Prolapse Surgery

Normal pelvic organ support depends on the integrity of the endopelvic fascia, i.e. connective tissue, the pelvic floor muscles, and an adequate nerve supply. Theoretically, if one of these factors fails, the others might be able to compensate to a certain degree. Epidemiological studies have also emphasized the contributing effects of aging, genetic predisposition, obesity, constipation, and hormone therapy. A single anterior defect of the vaginal wall accounts for 33.8% of the total number of POP cases; these data were published by Hendrix et al. in 2002, and include results from 27,342 women [40]. "Bladder outlet obstruction" and occult SUI may coexist and be associated with POP. Detrusor overactivity and urethral hypermobility can be correlated with the degree of POP, while detrusor underactivity and intrinsic sphincter deficiency do not appear to have any correlation with the degree of POP. In female patient with severe POP during urodynamic evaluation reduction of prolapse could be useful to determine asymptomatic and/or hidden conditions [41] (e.g. occult stress incontinence).

Vaginal or abdominal (retropubic, laparoscopic) surgical approaches have been considered as options for treatment of anterior POP. Surgical techniques result in pelvic floor reconstruction or suspension of the involved organs. Traditional surgery comprises anterior repair and paravaginal repair.

Anterior repair is recommended for central defects [42].The recurrence rate varies from 3% to 40% [43, 44]. Paravaginal repair is recommended for lateral defects. Retropubic and vaginal access show a recurrence rate of 3–14% and 7–20%, respectively. In both accesses a persistent SUI is reported in 57% of cases [45].

POP repair with absorbable and biological mesh improves the anatomical outcome as compared with traditional repair alone, and with no increase in the rate of complications. The literature reports better anatomical outcome for polypropylene mesh as compared with biological mesh. In the polypropylene mesh group, prosthesis exposure rate was significantly higher than in the biological mesh group [46]. A polypropylene prosthesis showed better anatomical and subjective results compared with traditional surgery. Apical or posterior compartment prolapse was significantly more common following use of a polypropylene mesh, and the mesh extrusion rate was 10.4%, with 6.3% undergoing surgical correction [47].

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Synthetic and Biological Meshes for Pelvic Floor Disorders

27

Gabriele Böhm

27.1 Introduction

New innovative surgical procedures will achieve general acceptance and change former standards if they have the capacity to improve clinical outcome.

An improvement in the outcome in surgery for pelvic organ prolapse (POP) was sought, as re-operation rates after traditional POP and urinary incontinence surgery were high [1], with 60% of female patients undergoing re-intervention at the same anatomical site, and 32% of females developing a hidden support defect requiring additional intervention at a different pelvic site. The recurrence rate following pelvic surgery within the anterior compartment has been shown to be 40% [2]. These recurrence rates were observed with the traditional plication-type surgical techniques, particularly for the anterior compartment. As a result, in the hope of reducing such high recurrence rates, novel techniques for POP repair were described and disseminated within the surgical community.

The idea of adding graft augmentation to the traditional plication-type technique was in agreement with the aim of tissue reinforcement and the improvement of outcomes achieved by mesh augmentation for abdominal wall hernia repair [3, 4]. Within the field of POP surgery, the use of graft reinforcement has gained wide acceptance and the burning question is now: which graft is best to use?

Biological meshes are currently very much in vogue within the surgical community. There is nothing new about 'biologicals': in the 1960s, fascia lata was used regularly as a material for hernia repair, for example to cover congenital diaphragmatic defects. It had a convincing haptic and was easy to insert. Why then, was there a powerful search for new synthetic materials?

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The main advantage of biologic mesh is its supposedly superior role within contaminated areas and resistance to infection. But is this proclaimed advantage scientifically sufficiently supported?

What are the pros and cons of biologic and synthetic mesh? There is some good new research that may lead us in the right direction. And within the context of rather extreme warnings from the US Food and Drug Administration with regard to the use of synthetics in the urogynecological field, one should read the evidence rather carefully [5, 6].

Warnings were issued about transperineal or transvaginal insertion of synthetic meshes with regard to reported rates of complications such as mesh extrusion or viscous erosion. Studies highlighted the fact that the type of surgical insertion technique (blind insertions via trocars) might have more effect on the outcome than the type of mesh used [7]. In other studies, the complication rates of extrusion or erosion were found to be similar or higher with biological mesh compared with synthetic mesh [6].

The decision for or against one particular mesh material becomes more and more difficult given the vast amount of different materials on the market. Factors influencing the decision are the biology of the patient, the anatomical location and its role for functional improvement, the anatomical insertion site, a contaminated or noncontaminated operative area, and financial considerations.

The requirements of any biomaterial for the use in humans are:

- Elasticity according to its surrounding needs
- Structural stability (e.g., form, surface, three-dimensional construction)
- Resistance to degradation by host cells for at least 1 year or longer (depending on its supposed function: e.g., permanent support material or temporary scaffold for tissue regeneration in its place)
- Biocompatibility
- Nontoxic, nonteratogenic, noninfectious, hypoallergic
- Integration within its new surrounding tissue

Additional future benefits are likely to include:

- Stimulation of tissue regeneration in its place
- Anti-adhesive toward cavities such as the abdominal or thoracic cavity
- Surface modification according to needs, e.g., pharmaceuticals, active agents influencing the inflammatory reaction, and agents promoting tissue regeneration
- Surface modification for the visualization of the inserted material

There is a plea for more preclinical research in the field of pelvic floor surgery before the launch of new mesh designs [8, 9]. We fully support this plea and support the tendency towards more physiological, mechanical, and biomolecular research of the pelvic floor. The standardization of measuring parameters is a requirement that is long overdue.

For many years, synthetic as well as biological mesh materials were inserted and studied at different hernia locations, mostly the groin and abdominal wall. Knowledge from these locations can be partially used for other applications such as hiatus hernia, diaphragmatic hernia, urogenital prolapse and rectal prolapse, or pelvic diaphragmatic insufficiencies.

When choosing the right mesh, the surgeon has to consider the following:

- Mesh material
- Required durability of the material
- Elasticity
- Adjacent organ involvement
- Movement rate and likelihood of side-effects due to friction
- Pressure necrosis
- Contact with the peritoneal cavity
- Bacterial contamination
- Surgical insertion site

Meshes can be of biological or synthetic material.

Biological mesh materials can be classified into three groups:

- Autologous material
- Allografts (human acellular cadaveric materials)
- Xenografts (animal acellular cadaveric materials).

It is important that these materials are chemically processed in different ways. First, they have to be devitalized. This can be achieved in different ways. The chemicals used might have an effect on the functional quality of the product as well as on the host that will receive the implant. For further information we refer to chemical information sites. Box 27.1 gives some examples of biological materials.

Some biomaterials are cross-linked in order to render the biomaterial less vulnerable to rapid breakdown of collagens and proteins by collagenases and other proteinases. The amount of cross-linking defines the time required for degradation of these biomaterials. For example, 100% cross-linking may render the material impenetrable by host cells and therefore not degradable. The latter goes often hand in hand with encapsulation of the material and isolation from normal tissue turnover. This is not an ideal situation.

Synthetic materials can be classified into absorbable and nonabsorbable, monofilament and multifilament, knitted or woven, microporous and macroporous, and heavyweight and lightweight meshes. Box 27.2 gives some examples of synthetic materials.

27.2 Biological Materials

Lyophilized bovine dura mater was used regularly for congenital diaphragmatic hernia repair. The surgical haptic was good, and the material was flexible enough to fit into a dome-shaped form. With the occurrence of BSE (bovine spongiform encephalopathy) and possible transmission of Creutzfeldt–Jakob disease, bovine neuron-related materials were withdrawn from the market after 1992. Despite new avitalization processes, a residual small risk of prion or viral transmission cannot be excluded. Examples of substitutes for neuron-based materials include bovine pericardium [10], porcine pericardium, bowel wall, or fascia; however, the available size of these materials is not always sufficient for repair of large hernias. Large

Box 27.1 Examples of biological materials

Autologous grafts:
- Fascia lata
- Rectus fascia

Allografts:
- Human cadaveric dermis:
  - AlloDerm (LifeCell Corporation, Branchburg, New Jersey, USA)
  - FlexHD (Ethicon, Cornelia, Georgia, USA)
- Cadaveric fascia lata:
  - Suspend Tutoplast (Mentor Corporation, Santa Barbara, California, USA)
  - FasLata (CR Bard, Covington, Georgia, USA)

Xenografts:
- Porcine dermis:
  - **Cross-linked:**
    - Permacol (Covidien, Mansfield, Massachusetts, USA)
    - Collamend (Davol, Warwick, Rhode Island, USA)
    - Pelvicol Acellular Collagen Matrix (CR Bard)
    - PelviSoft BioMesh (like the above, only with perforations) (CR Bard)
  - **Non-cross-linked:**
    - Strattice (LiefeCell Corporation)
    - XenMatrix (Davol)
- Porcine small intestinal submucosa:
  - Surgisis (Cook Surgical, Bloomington, Indiana, USA)
- Bovine dermis:
  - Xenform Soft-Tissue Repair Matrix (Boston Scientific, Natick, Massachusetts, USA)
  - SurgiMend (TEI Biosciences, Boston, Massachusetts, USA)
- Bovine pericardium:
  - Veritas (Synovis Surgical Innovation, St Paul, Minnesota, USA)
  - Tutomesh (RTI Biologics, Alachua, Florida, USA)

surface area materials, such as dermal matrix or small bowel mucosa, chemically processed and reconstituted, are used for this purpose.

27.2.1 Acellular Biological Materials

Examples of two prototypes of acellular biological materials are discussed: Surgisis® and Permacol®.

Surgisis (Cook Surgical, Bloomington, Indiana, USA) was produced following studies by Hodde et al. [11] describing the development of an extracellular

Box 27.2 Examples of synthetic meshes

Absorbable:
GORE®BIO-A® Tissue reinforcement (polyglycolic acid:trimethylene) carbonate (PGA:TMC) fibers (Gore & Associates, Inc., Newark, Delaware, USA)

Nonabsorbable:
Gynemesh (polypropylene) (Ethicon, Norderstedt, Hamburg)
Smart Mesh (polypropylene, light weight) (Coloplast, Orton, Peterborough, UK)
ePTFE (polytetrafluorethylene) (Gore & Associates, Inc., Newark, Delaware, USA)
PVDF (polyvinylidene difluoride) (Dahlhausen GmbH & FEG Textiltechnik Aachen, Germany)
Parietex Prosup (polyester, large pore, heavyweight)(Tyco Healthcare, Gosport, Hampshire, UK)

Mixed, partially absorbable:
Vypro® (polypropylene plus polyglactin) (Ethicon, Norderstedt, Hamburg)
Ultrapro® (polypropylene plus polyglecaprone-25, large pore, lightweight) (Ethicon, Norderstedt, Hamburg)

Mixed, nonabsorbable:
Dynamesh IPOM (Polypropylene plus polyvinylidinchloride at abdominal side)
(Dahlhausen GmbH & FEG Textiltechnik)

Additional surface modifications:
Proceed® (Polypropylene plus polydioxanone and cellulose)(Ethicon, Norderstedt, Hamburg)
Parietene composite: polypropylene plus collagen/polyethylenglycol/glycerol coating) (Covidien, Mansfield, Massachusetts, USA)

matrix (ECM) made from sterilized porcine small bowel mucosa with its ECM components. Related studies by Cook Surgical postulated complete new tissue regeneration, which was qualitatively similar to the surrounding tissue [12]. As yet, there have been no long-term randomized studies to prove its superior quality. Clinical results comparing Surgisis with other meshes for use in diaphragmatic hernia demonstrated a similarly high recurrence rate of 50% [13]. Our own animal studies demonstrated that 4 months after insertion Surgisis had disintegrated and had been substituted by lower-quality scar tissue, resulting in inferior mechanical quality compared with a polypropylene mesh [14–17]. No improvement of tissue tensile strength was found when comparing animals implanted with Surgisis with control animals without mesh [18]. In a rat model, animals with Surgisis had a much lower tensile strength compared with polypropylene [19].

Surgisis did not show any convincing advantage compared with synthetic materials with respect to seroma formation, adhesions, tensile strength [20], shrinkage [21], and recurrence rates following hernia repair [22].

In summary, the insufficient mechanical strength of Surgisis renders it unsuitable for any application where mechanical support is essential [23], e.g., pelvic prolapse surgery.

Permacol (acellular cross-linked porcine dermal matrix) is another type of biomaterial that is regularly inserted in different hernia locations, including parastomal hernias, and plevic prolapse surgery [24]. Within this group of cross-linked meshes, collagen molecules are covalently bound to each other following chemical processing. This protects the material to a certain degree against degradation by host tissue collagenases. In a study, Permacol showed satisfactory tensile strength over 6 months and better mechanical properties compared with other cross-linked materials [20]. Another study demonstrated a lower hernia recurrence rate with Permacol compared with polytetrafluoroethylene (PTFE) [25]; however, the follow-up time was short and patient numbers were small. In prolapse surgery, clinical short-term results were shown to be promising [26].

However, several recent studies have revealed problems with the use of biological meshes. In a long-term follow-up study using different materials for abdominal incisional hernia repair, Permacol did not show an advantage compared with synthetic meshes [25]. In a clinical study, the recurrence rate of incisional hernia at 18 months using Permacol was 15%, with a complication rate of 35% (e.g., wound infection) [27]. This is no improvement on currently used synthetic meshes. The fistula rate following the use of Permacol intra-abdominally is low, but not unheard of; equally, bowel adhesions with the need for re-intervention have been described [6].

Additionally, Permacol has shown a marked inflammatory response in rats up to 40 days postimplantation, and no ingrowth of skeletal muscle cells [28].

The cross-linked Permacol has demonstrated better mechanical qualities compared with non-cross-linked materials [20], but inferior qualities compared with synthetic meshes. Similar findings were shown in an animal study comparing Pelvicol® with Pelvisoft®, Gynemesh®, and Surgisis. The polypropylene-based Gynemesh showed the highest tensile strength and least stiffness compared with the cross-linked Pelvicol. In addition, Pelvicol showed encapsulation after 3 months insertion time, whereas Gynemesh was found to be incorporated [29]. A clinical study using Surgisis or Pelvicol for sacrocolpopexy at 2 years follow-up found the anatomical recurrence rate to be very high (70%), with a functional recurrence rate of 40% [30].

These results compare very badly with studies on prolapse surgery using synthetic meshes. On the other hand, long-term clinical follow-up results on the use of synthetic mesh for laparoscopic anterior rectopexy for rectal prolapse describe very low recurrence rates of no more than 5% [31, 32].

Additionally, the hope for superior behavior of biological materials within a contaminated area is contradicted by multiple studies. Following inoculation of meshes with bacteria, findings have indicated a possible higher tendency of infection when using biological materials [33]. Additionally, inoculation seems to weaken the tensile strength of the biological mesh [34].

In summary, biological materials have not shown convincing superiority compared with synthetic nonabsorbable meshes in hernia repair [35, 36], or in prolapse/pelvic floor surgery [37–39]. Another disadvantage with biomaterials is their inconsistent ECM composition (e.g., type and amount of collagen). Therefore, their functional outcome is not predictable, plus, this inconsistency renders them unsuitable for surface modulation.

27.3 Synthetic Meshes

Synthetic meshes are frequently used in hernia surgery, in the knowledge that they produce good long-term results. Typical qualities include good biocompatibility, reproducibility, and consistency. The concept of lightweight and heavyweight meshes is well established [40]. The basis for this concept was the finding that the host inflammatory response depends on the material density and pore size of the mesh construct. A lightweight and large-pore-size mesh is more suitable than a heavyweight and small-pore-size mesh.

However, a limited inflammatory reaction is tolerated and is required for tissue remodeling and adequate scar formation [41]. Therefore the density of the material was reduced and the pore size was enlarged, which led to optimal tissue incorporation of the mesh and avoidance of biofilm production [42–45], with no impact on the good mechanical qualities of the material [46–49].

Mesh shrinkage of synthetic meshes is in the range of 3–30%, depending on their location, textile structure, and weight [50]. In hernia surgery, this is compensated by mesh overlap.

For the intra-abdominal application of meshes, anti-adhesive materials are added to the mesh. For example, Proceed® has a cellulose cover on its abdominal side [51, 52]. Studies comparing polypropylene meshes with different covers suggest that there is room for further improvement [52, 53].

Ultrapro® (polypropylene plus polyglecaprone-25) has demonstrated superior biocompatibility in animal studies in comparison with other synthetic materials [54], and is one of the most frequently used materials in hernia surgery [55].

PTFE was known for its lack of elasticity and tendency toward encapsulation and failed tissue integration [21]. It was hoped that there would be an improvement in these properties in the expanded version of PTFE: ePTFE. In one study, it showed fewer adhesions compared with polypropylene in the intra-abdominal position, but it also showed a shrinkage rate of 30% [51].

Another advantage of synthetic meshes, is the possibility of surface modulation [56, 57].

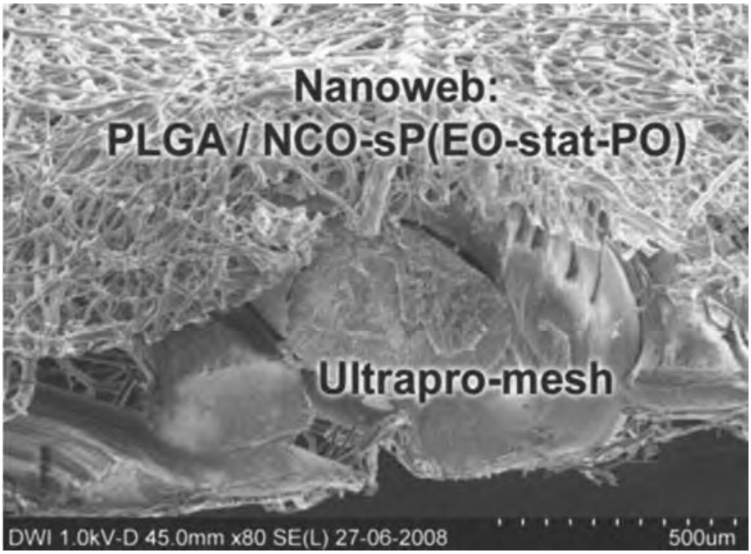

Fig. 27.1 Electronmicroscopy of a surface-modified mesh: electrospun absorbable nanoweb on Ultrapro® mesh. *PLGA* (polylactide glycolic acid) with NCO-sP(EO-stat-PO) as a possible carrier for active substances

27.3.1 Surface-modulated Meshes

The search for the ideal mesh is ongoing. The advantage of synthetic meshes is the possibility of modifying the surface of currently available commercial meshes (Fig. 27.1) [56–59]. It is possible to add active agents such as antibiotics, protein-repellent substances, and inflammatory response proteins. Also, one can configure a three-dimensional scaffold that allows cell inoculation according to the required needs. Ongoing in vitro research is attempting to establish a system in order to test cell interaction with different biomaterials [60–64]. Controlled release of active substances (e.g., antibiotics, cytokines, growth hormones) bound to the mesh is also easily achieved [65].

27.4 Summary

In summary, the individual needs of the patient, the target location and its required function, and the insertion route [66] plus its surrounding communicating tissue [67] will decide whether a biological or synthetic, absorbable or non-absorbable material, is most suitable.

The main advantage of synthetic material is its precise reproducibility, absent infectious risk, and possibility for surface modification, and addition of active agents such as inflammatory modulators or stem cell inoculation. Mechanical qualities of different synthetic meshes have been studied and the surgeon has to decide whether a stiffer or more elastic material is needed. For prolapse surgery, a more elastic mesh such as Ultrapro or smart mesh seems advisable, considering the proximity to the rather vulnerable vaginal tissue [67]. In order to avoid mesh erosion into or constriction of viscous organs (rare, but devastating for the patient when it happens) we would recommend use of as little implant material as possible, never surrounding an organ completely, and covering the material with a good amount of the patients' own tissue as a barrier. These recommendations are fulfilled, for example, in the anterior rectocolposuspension technique described by D'Hoore and Penninckx [68], using a small strip of mesh and covering it completely with peritoneum and fat.

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