Surgery: Complications, Risks and Consequences

Brendon J. Coventry *Editor*

Upper Abdominal Surgery

Springer

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This book is dedicated to my wonderful wife Christine and children Charles, Cameron, Alexander and Eloise who make me so proud, having supported me through this mammoth project; my patients, past, present and future; my numerous mentors, teachers, colleagues, friends and students, who know who they are; my parents Beryl and Lawrence; and my parents-in-law Barbara and George, all of whom have taught me and encouraged me to achieve

"Without love and understanding we have but nothing"

Brendon J. Coventry

Foreword I

This comprehensive treatise is remarkable for its breadth and scope and its authorship by global experts. Indeed, knowledge of its content is essential if we are to achieve optimal and safe outcomes for our patients. The content embodies the details of our surgical discipline and how to incorporate facts and evidence into our surgical judgment as well as recommendations to our patients.

While acknowledging that the technical aspects of surgery are its distinguishing framework of our profession, the art and judgment of surgery requires an in depth knowledge of biology, anatomy, pathophysiology, clinical science, surgical outcomes and complications that distinguishes the theme of this book. This knowledge is essential to assure us that we are we doing the right operation, at the right time, and in the right patient. In turn, that knowledge is essential to take into account how surgical treatment interfaces with the correct sequence and combination with other treatment modalities. It is also essential to assess the extent of scientific evidence from clinical trials and surgical expertise that is the underpinning of our final treatment recommendation to our patient.

Each time I sit across from a patient to make a recommendation for a surgical treatment, I am basing my recommendation on a "benefit/risk ratio" that integrates scientific evidence, and my intuition gained through experience. That is, do the potential benefits outweigh the potential risks and complications as applied to an individual patient setting? The elements of that benefit/ risk ratio that are taken into account include: the natural history of the disease, the stage/extent of disease, scientific and empirical evidence of treatment outcomes, quality of life issues (as perceived by the patient), co-morbidity that might influence surgical outcome, risks and complications inherent to the operation (errors of commission) and the risk(s) of not proceeding with an operation (errors of omission).

Thus, if we truly want to improve our surgical outcomes, then we must understand and be able to either avoid, or execute sound management of, any complications that occur (regardless of whether they are due to co-morbidity or iatrogenic causes), to get our patent safely through the operation and its post-operative course. These subjects are nicely incorporated into the content of this book.

I highly recommend this book as a practical yet comprehensive treatise for the practicing surgeon and the surgical trainee. It is well organized, written with great clarity and nicely referenced when circumstances require further information.

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Foreword II

Throughout my clinical academic career I have aspired to improve the quality and safety of my surgical and clinical practice. It is very clear, while reading this impressive collection and synthesis of high-impact clinical evidence and international expert consensus, that in this new textbook, Brendon Coventry has the ambition to innovate and advance the quality and safety of surgical discipline.

In these modern times, where we find an abundance of information that is available through the internet, and of often doubtful authenticity, it is vital that we retain a professional responsibility for the collection, analysis and dissemination of evidenced-based and accurate knowledge and guidance to benefit both clinicians and our patients.

This practical and broad-scoped compendium, which contains over 250 procedures and their related complications and associated risks, will undoubtedly become a benchmark to raise the safety and quality of surgical practice for all that read it. It also manages to succeed in providing a portal for all surgeons, at any stage of their careers, to reflect on the authors' own combined experiences and the collective insights of a strong and influential network of peers.

This text emphasizes the need to understand and appreciate our patients and the intimate relationship that their physiology, co-morbidities and underlying diagnosis can have upon their unique surgical risk with special regard to complications and adverse events.

I recognize that universally across clinical practice and our profession, the evidence base and guidance to justify our decision-making is growing, but there is also a widening gap between what we know and what we do. The variation that we see in the quality of practice throughout the world should not be tolerated.

This text makes an assertive contribution to promote quality by outlining the prerequisite foundational knowledge of surgery, science and anatomy and their complex interactions with clinical outcome that is needed for all in the field of surgery.

I thoroughly recommend this expertly constructed collection. Its breadth and quality is a testament to its authors and editor.

Professor the Lord Ara Darzi, PC, KBE, FRCS, FRS
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How to Use This Book

This book provides a resource for better understanding of surgical procedures and potential complications in general terms. The application of this material will depend on the individual patient and clinical context. It is not intended to be absolutely comprehensive for all situations or for all patients, but act as a 'guide' for understanding and prediction of complications, to assist in risk management and improvement of patient outcomes.

The design of the book is aimed at:

- Reducing Risk and better Managing Risks associated with surgery
- Providing information about 'general complications' associated with surgery
- Providing information about 'specific complications' associated with surgery
- Providing comprehensive information in one location, to assist surgeons in their explanation to the patient during the consent process

For each specific surgical procedure the text provides:

- Description and some background of the surgical procedure
- Anatomical points and possible variations
- Estimated Frequencies
- Perspective
- Major Complications

From this, a better understanding of the risks, complications and consequences associated with surgical procedures can hopefully be gained by the clinician for explanation of relevant and appropriate aspects to the patient.

The *Estimated frequency lists are not mean't to be totally comprehensive* or to contain all of the information that needs to be explained in obtaining informed consent from the patient for a surgical procedure. Indeed, *most of the information is for the surgeon* or reader only, *not designed for the patient*, however, parts should be selected by the surgeon at their discretion for appropriate explanation to the individual patient in the consent process.

Many patients would not understand or would be confused by the number of potential complications that may be associated with a specific surgical procedure, so ***some degree of selective discussion of the risks, complications and consequences would be necessary and advisable*****,** as would usually occur in clinical practice. This judgement should necessarily be left to the surgeon, surgeon-in-training or other practitioner.

Preface

Over the last decade or so we have witnessed a rapid change in the consumer demand for information by patients preparing for a surgical procedure. This is fuelled by multiple factors including the 'internet revolution', altered public consumer attitudes, professional patient advocacy, freedom of information laws, insurance issues, risk management, and medicolegal claims made through the legal system throughout the western world, so that the need has arisen for a higher, fairer and clearer standard of *'informed consent'*.

One of the my main difficulties encountered as a young intern, and later as a surgical resident, registrar and consultant surgeon, was obtaining information for use for the pre-operative consenting of patients, and for managing patients on the ward after surgical operations. I watched others struggle with the same problem too. The literature contained many useful facts and clinical studies, but it was unwieldy and very time-consuming to access, and the information that was obtained seemed specific to well-defined studies of highly specific groups of patients. These patient studies, while useful, often did not address my particular patient under treatment in the clinic, operating theatre or ward. Often the studies came from centres with vast experience of a particular condition treated with one type of surgical procedure, constituting a series or trial.

What I wanted to know was:

- The **main complications** associated with a surgical procedure;
- **Information that could be provided** during the consent process, and
- How to **reduce the relative risks** of a complication, where possible

This information was difficult to find in one place!

As a young surgeon, on a very long flight from Adelaide to London, with much time to think and fuelled by some very pleasant champagne, I started making some notes about how I might tackle this problem. My first draft was idle scribble, as I listed the ways surgical complications could be classified. After finding over 10 different classification systems for listing complications, the task became much larger and more complex. I then realized why someone had not taken on this job before!

After a brief in-flight sleep and another glass, the task became far less daunting and suddenly much clearer – the champagne was very good, and there was little else to do in any case!

It was then that I decided to speak with as many of my respected colleagues as I could from around the globe, to get their opinions and advice. The perspectives that emerged were remarkable, as many of them had faced the same dilemmas in their own practices and hospitals, also without a satisfactory solution.

What developed was a composite documentation of information (i) from the published literature and (ii) from the opinions of many experienced surgical practitioners in the field – to provide a text to supply information on **Complications, Risks and Consequences of Surgery** for surgical and other clinical practitioners to use at the bedside and in the clinic.

This work represents the culmination of more than 10 years work with the support and help of colleagues from around the world, for the benefit of their students, junior surgical colleagues, peers, and patients. To them, I owe much gratitude for their cooperation, advice, intellect, experience, wise counsel, friendship and help, for their time, and for their continued encouragement in this rather long-term and complex project. I have already used the text material myself with good effect and it has helped me enormously in my surgical practice.

The text aims to provide health professionals with useful information, which can be selectively used to better inform patients of the potential surgical complications, risks and consequences. I sincerely hope it fulfils this role.

Adelaide, SA, Australia

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I wish to thank:

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Over the last decade, numerous clinicians have discussed and generously contributed their experience to the validation of the range and relative frequency of complications associated with the wide spectrum of surgical procedures. These clinicians include:

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New York, USA: Professor Murray Brennan; Dr David Jacques; Prof L Blumgart; Dr Dan Coit; Dr Mary Sue Brady (Surgeons, Department of Surgery, Memorial Sloan-Kettering Cancer Centre, New York);
Oxford, UK: Dr Linda Hands, Vascular Surgeon; Dr Jack Collin, Vascular Surgeon; Professor Peter Friend, Transplant and Vascular Surgeon; Dr Nick Maynard, Upper Gastrointestinal Surgeon; Dr Mike Greenall, Breast Surgeon; Dr Jane Clark, Breast Surgeon; Professor Derek Gray, Vascular/Pancreatic Surgeon; Dr Julian Britton, Hepato-Biliary Surgeon; Dr Greg Sadler, Endocrine Surgeon; Dr Christopher Cunningham, Colorectal Surgeon; Professor Neil Mortensen, Colorectal Surgeon; Dr Bruce George, Colorectal Surgeon; Dr Chris Glynn, Anaesthetist (National Health Service (NHS), Oxford, UK).
Bristol, UK: Professor Derek Alderson.
Adelaide, Australia: Professor Guy Ludbrook, Anesthetist; Dr Elizabeth Tam, Anesthetist.

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The support of the University of Adelaide, especially the Department of Surgery, and Royal Adelaide Hospital has been invaluable in allowing the sabbatical time to engineer the collaborations necessary for this project to progress. I thank Professors Glyn Jamieson and Guy Maddern for their support in this regard.

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Adelaide, SA, Australia

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Chapter 1
Introduction

Brendon J. Coventry

This volume deals with complications, risks, and consequences related to a range of procedures under the broad headings of general abdominal (laparotomy), esophageal surgery, gastric surgery, obesity surgery, small bowel surgery, biliary and duodenal surgery, liver surgery, and pancreatic surgery.

Important Note
It should be emphasized that the risks and frequencies that are given here *represent derived figures*. These *figures are best estimates of relative frequencies across most institutions*, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities and different surgeons. In addition, the risks of complications in lower or higher risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient, staff, or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedures or surgical approaches. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

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Individual clinical judgement should always be exercised, of course, when applying the general information contained in these documents to individual patients in a clinical setting.

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Chapter 2
General Abdominal Surgery

Brendon J. Coventry and Bruce Waxman

General Perspective and Overview

The relative risks and complications increase proportionately according to the type of surgery, nature of the pathology, site of the abdominal problem, extent of procedure performed, technique, the complexity of the problem, and lesion size. Extensive or complex surgery usually carries higher risks of bleeding and infection than smaller procedures, in general terms. Similarly, risk is relatively higher for recurrent and complex abdominal problems, for associated lymph node dissections, and especially for those closer to or involving major vascular or neural structures (e.g., aorta, vena cava, renal vessels, or lumbar plexus). Complex procedures are typically associated with a higher frequency and greater range of complications compared to simpler procedures. This is principally related to the surgical accessibility and risk of organ/tissue/vascular/nerve/lymphatic injury. Of course, with diagnostic laparotomy or laparoscopy, or even when the cause is determined, the findings may be unexpected and necessitate surgery that is different from that which has been anticipated. For example, the possibility of a colostomy or ileostomy might be broached with the patient preoperatively, where appropriate, perhaps noting that this is a very small risk, if this may occur.

In general, for many abdominal operations, the complications are similar in type and frequency. Laparoscopic approaches carry specific risks of gas embolism and trochar injury, but open procedures often carry risk of more direct tissue injury and

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longer convalescence. Knowledge of the anatomy and the variations commonly seen is helpful in minimizing nerve, vessel, and organ injury. Surgeons argue the benefits of one approach over the other, but there is somewhat variable tangible data to demonstrate differences in terms of the observed or reported complications. Other surgeons will argue that the use of drains adds to the complication rates, but this needs to be balanced with the extent and risks of bleeding and lymphatic leakage.

Possible reduction in the risk of misunderstandings over complications or consequences from abdominal surgery might be achieved by:

- Good explanation of the risks, aims, benefits, and limitations of the procedure(s)
- Useful planning considering the anatomy, approach, alternatives, and method
- Avoiding likely associated vessels and nerves
- Adequate clinical follow-up

Multisystem failure, systemic sepsis, and **death** are uncommon after abdominal surgery, even with extensive resection, but are reported and remain a risk. However, the nature of the underlying problem and comorbidities remain the major determinants of morbidity and mortality.

Positioning on the operating table has been associated with increased risk of **deep venous thrombosis** and **nerve palsies**, especially in prolonged procedures.

The **use of specialized units with standardized preoperative assessment, multidisciplinary input, and high-quality postoperative care** is essential to the overall success of complex abdominal surgery and can significantly reduce the risk of complications or aid early detection, prompt intervention, and cost.

With these factors and facts in mind, the information given in this chapter must be appropriately and discernibly interpreted and used.

Important Note

It should be emphasized that the risks and frequencies that are given here *represent derived figures*. These *figures are best estimates of relative frequencies across most institutions*, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities and different surgeons. In addition, the risks of complications in lower or higher risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient, staff, or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedures or surgical approaches. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

For diagnostic fine or core needle biopsy complications, see Chap. 2 of Volume 2; for lymph node surgery, Chap. 5 of Volume 3; or for specific abdominal, pediatric, or vascular procedures, see the relevant volume(s).

General Exploratory Laparotomy +/– Biopsy

Description

General anesthesia is used almost exclusively, except for rare occasions when spinal or epidural anesthesia may be utilized for lower abdominal approaches. The modified Lloyd-Davies position may be useful when the pathology is in the pelvis and access to the perineum may be needed.

The aim is to inspect the abdominal cavity thoroughly, which may include a biopsy or other procedure. Generally, a midline approach is the most common. This can be upper, central or lower abdominal, or a full laparotomy, from xiphoid process to pubis. Other incisions include transverse, oblique, subcostal, paramedian, pfannenstiel, thoracoabdominal, and combinations of these. During laparotomy a systematic inspection of the abdominal wall and components is conducted and a variety of approaches can be used (e.g., clockwise or anticlockwise examination and palpation of the organs), so as not to miss any abnormality. Tissue biopsies can be taken if required. Primary "mass"-type closure of the abdominal wall is usual, and the skin is separately closed primarily, or delayed, depending on the degree of contamination and the risk of infection.

Anatomical Points

Apart from situs inversus, which is exceedingly rare, malrotations can occur but are also infrequent. The abdominal organs are usually relatively fixed in their location and most can be inspected relatively easily, either by palpation or by visualization. The organs that classically present some difficulty in examination are the duodenum (which may require a Kocher's type mobilization for inspection); the diaphragm; the kidneys, adrenals, pancreas, and aorta (that are retroperitoneal); the posterior/superior aspects of the spleen and liver; and the posterior aspects of the colon, including the appendix when retrocecal. These usually require special attention to adequately exclude pathology. Congenital fibrous bands may also occur.

Perspective

See Table 2.1. The initial pathology for which the procedure is being performed largely determines the spectrum or risks and complications. Infection is the most serious complication and is associated with contamination, often from preexisting viscus perforation. Iatrogenic injury to the bowel may also occur, especially during division of adhesions. Established infection may lead to multisystem organ failure and requirement for intensive care in susceptible individuals. The presence of distal

Table 2.1 General (exploratory) laparotomy +/− biopsy: estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	1–5 %
Wound	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Rare significant/serious problems	
Small bowel obstruction (early or late)[a,b] [Anastomotic stenosis/adhesion formation]	0.1–1 %
Colostomy/ileostomy[a,b]	0.1–1 %
Enterocutaneous fistula	<0.1 %
Deep venous thrombosis/pulmonary embolism	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness (rib or wound pain)	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	50–80 %
Incisional hernia[a] (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique and preferences
[b]Higher with pelvic surgery

tube obstruction, in many situations, increases the risk of infection due to stasis and bacterial overgrowth. Postoperative leakage from an anastomosis or viscus repair may be catastrophic, leading to localized or generalized peritonitis or intra-abdominal abscess(es). Bleeding is usually not commonplace, if good operative technique is used. Occasionally, ileostomy or colostomy is required for safe management. Wound infection, small bowel obstruction, enterocutaneous fistula, and incisional hernia are significant, but fortunately uncommon complications or consequences.

Major Complications

The type of laparotomy, procedure, and patient characteristics largely dictate the risks and complications. **Infection** is potentially the most serious complication, and in the most severe form can lead to **peritonitis, multisystem failure,** and risk of **death. Organ injury and bleeding** can be significant and may require **blood**

transfusion, although this is not common for most laparotomies. Occasionally, **splenectomy** is required for splenic injury, especially with left upper abdominal procedures. **Deep venous thrombosis** and **pulmonary embolism** is uncommon, but a higher risk is associated with pelvic surgery. **Colostomy or ileostomy** are significant consequences, which occasionally are necessary for bowel pathology, and may occur unexpectedly, which the patient should ideally be warned about for completeness. **Wound infection, small bowel obstruction, enterocutaneous fistula, and incisional hernia** are significant complications and consequences that should also be mentioned, but the less common nature of these can be emphasized to the patient.

Consent and Risk Reduction

Main Points to Explain

- GA risk
- Bleeding/hematoma
- Infection (local/systemic)
- Pain/discomfort/neuralgia
- Possible tumor recurrence*
- Other abdominal organ injury
- Possible stoma
- Respiratory complications
- Venous thromboembolism
- Possible blood transfusion
- Renal impairment
- Risks without surgery

*Dependent on pathology and type of surgery performed

Diagnostic Laparoscopy +/– Biopsy

Description

General anesthesia is used. The modified Lloyd-Davies position may be useful when the pathology is in the pelvis and access to the perineum may be needed. The aim is to inspect the abdominal cavity thoroughly, using the laparoscopic approach, which may include a biopsy or other procedure. Generally, insertion of an umbilical and several other ports with the patient supine is the most common approach. Ports can be inserted in the upper, central, or lower abdomen depending on the desired procedure, but a central insertion of the laparoscope can usually afford good vision of the entire abdominal cavity. During laparoscopy a systematic inspection of the abdominal wall and components is conducted and a variety of approaches can be used (e.g., clockwise or anticlockwise examination of the organs), so as not to miss

any abnormality. Tissue biopsies can be taken if required. Primary closure of the abdominal wall port-site holes is usual, and the skin is separately closed primarily or may be occasionally delayed, depending on the degree of contamination and the risk of infection. The laparoscopic approach is generally less traumatic than open laparotomy, with quicker recovery, but open laparotomy allows better palpation and perhaps inspection of organs. Ideally, the patient should be forewarned of the risk of conversion from laparoscopic to open surgery. Surgeons should never hesitate to convert to an open incision if the safety of the operation is jeopardized through increased risk of injury, if progress is poor, or if vision is inadequate.

Anatomical Points

Apart from situs inversus, which is exceedingly rare, malrotations can occur but are also infrequent. The abdominal organs are usually relatively fixed in their location and most can be inspected relatively easily, either by palpation or by visualization. The organs that classically present some difficulty in examination are the duodenum (which may require a Kocher's type mobilization for inspection); the diaphragm; the kidneys, adrenals, pancreas, and aorta (that are retroperitoneal); the posterior/superior aspects of the spleen and liver, and the posterior aspects of the colon, including the appendix when retrocecal. These usually require special attention to adequately exclude pathology. Adhesions or pathology may make laparoscopic inspection difficult or impossible. Congenital fibrous bands may also occur.

Perspective

See Table 2.2. The initial pathology for which the procedure is being performed largely determines the spectrum or risks and complications. Infection is the most serious complication and is associated with contamination, often from preexisting viscus perforation. Adequate exposure, good port placement, preoperative prophylactic antibiotics, and copious lavage of the abdominal cavity and the wounds with large volumes of warm saline may also assist, if perforation or infection is present. Iatrogenic injury to bowel may also occur, especially during insertion of ports or division of adhesions. Established infection may lead to multisystem organ failure and requirement for intensive care in susceptible individuals and even mortality. The presence of distal tube obstruction, in many situations, increases the risk of infection due to stasis and bacterial overgrowth. Postoperative leakage from an anastomosis or viscus repair may be catastrophic, leading to localized or generalized peritonitis or intra-abdominal abscess(es). Bleeding is usually not

Table 2.2 Diagnostic laparoscopy +/− biopsy: estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	1–5 %
Wound/port site	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Conversion to open operation[a]	1–5 %
Rare significant/serious problems	
Injury to the bowel or blood vessels (trochar or diathermy)	0.1–1 %
Duodenal/gastric/small bowel/colonic	
Gas embolus	0.1–1 %
Small bowel obstruction (early or late)[a,b] [Anastomotic stenosis/ adhesion formation]	0.1–1 %
Colostomy/ileostomy[a,b]	0.1–1 %
Enterocutaneous fistula	<0.1 %
Deep venous thrombosis/pulmonary embolism	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib or wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	50–80 %
Nerve paresthesia	0.1–1 %
Iliohypogastric/ilioinguinal nerve	
Port-site hernia formation	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences
[b]Higher with pelvic surgery

commonplace, if good operative technique is used. Occasionally, ileostomy or colostomy is required for safe management. Wound infection, small bowel obstruction, enterocutaneous fistula, and incisional hernia are significant, but fortunately uncommon complications or consequences. Gas embolism is associated with Veress needle insertion, which can be virtually eliminated by open cutdown methods. Similarly, injury to bowel or vessels during port insertion can usually be avoided by open cutdown insertion methods. Pneumothorax is a rare, idiosyncratic complication, probably from diaphragmatic leakage of gas.

Major Complications

The type of laparoscopy, procedure, and patient characteristics largely dictate the risks and complications. **Infection** is potentially the most serious complication causing **peritonitis, abscess formation**, **fistula** or **sinus formation**, and **systemic sepsis**, and in the most severe form can lead to **multisystem failure** and risk of **death. Preexisting comorbidities** including age, established generalized peritonitis, and immunosuppression can increase risk of infection greatly. **Organ injury and bleeding** can be significant and may require **blood transfusion**, although this is not common for most laparotomies. Occasionally, **splenectomy** is required for splenic injury, especially with left upper abdominal procedures. **Ureteric injury** or iliac **arterial injury** is exceedingly rare but can be catastrophic. **Deep venous thrombosis** and **pulmonary embolism** is uncommon, but a higher risk is associated with pelvic surgery. **Wound infection, small bowel obstruction, enterocutaneous fistula, and incisional hernia** are significant complications and consequences that should also be mentioned, but the less common nature of these can be emphasized to the patient. **Prolonged ileus** and, later (even decades later), small bowel obstruction can occur but are surprisingly uncommon even with extensive adhesions. The possibility of an **open laparotomy** and even a **colostomy or ileostomy** are significant consequences which occasionally are necessary for bowel pathology and may occur unexpectedly, which the patient should ideally be warned about for completeness if other pathology is found, although uncommon. **Nerve injury**, either at surgery or later scar adhesions, can cause severe discomfort and rarely chronic pain problems. **Gas embolism** is a very rare but catastrophic complication.

Consent and Risk Reduction

Main Points to Explain

- GA risk
- Bleeding/hematoma
- Infection (local/systemic)
- Pain/discomfort
- Possible tumor recurrence*
- Other abdominal organ injury
- Possible stoma
- Respiratory complications
- Venous thromboembolism
- Possible blood transfusion
- Gas embolism
- Renal impairment
- Possible open operation
- Risks without surgery

*Dependent on pathology and type of surgery performed

Further Reading, References, and Resources

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Chapter 3
Esophageal Surgery

Glyn G. Jamieson and Brendon J. Coventry

General Perspective and Overview

Esophagogastric surgery has changed somewhat over the last two or three decades with the advent of endoscopic techniques for more accurate diagnosis and laparoscopic approaches. However, the basic approaches to esophageal carcinoma and esophagectomy have advanced in a more measured way.

Complex esophageal problems in older patients with higher comorbidities for open surgery have become more commonplace, as have the refinements in investigation and assessment of esophageal disease (e.g., CT, MRI, and PET scans), such that patient selection has become more refined.

This chapter needs to be read with these changes in mind, because much of the literature has been based upon previous data from previous eras, with differing groups of patients to those who currently present for surgery.

The main complications from esophagogastric surgery are related to infection and leakage, especially from anastomoses and stomas. Bleeding is usually controllable at the time of surgery. Other complications relate to altered anatomy and function, especially of feeding, causing a range of symptoms related to meal size and tolerance.

With these factors and facts in mind, the information given in this chapter must be appropriately and discernibly interpreted and used.

The **use of specialized units with standardized preoperative assessment, multidisciplinary input, and high-quality postoperative care** is essential to the overall success of complex esophagogastric surgery and can significantly reduce risk of complications or aid early detection, prompt intervention, and cost.

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Important Note
It should be emphasized that the risks and frequencies that are given here *represent derived figures*. These *figures are best estimates of relative frequencies across most institutions*, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities and different surgeons. In addition, the risks of complications in lower or higher risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient, staff, or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedures or surgical approaches. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

For diagnostic fine or core needle biopsy complications, see Volume 2; for lymph node surgery, Volume 3; or for thoracotomy, Volume 6.

Esophagoscopy

Description

Local anesthetic spray or gel and a sedative agent are usually used. Usually a flexible scope is used; however, a rigid scope is sometimes used, especially for extraction of foreign material. The aim is to pass an endoscope via the oral cavity into the pharynx, esophagus, and usually into the stomach and duodenum in order to inspect the mucosa of these organs. The view of the oral cavity and pharynx is usually less satisfactory with a rigid or fiber optic pharyngo- or laryngoscope. However, the view of the esophagus is usually excellent and endoscopic procedures can be performed, for example, tissue biopsies, esophageal balloon dilatations, or esophageal stent placement. Endoscopic phototherapy is also used in some centers.

Anatomical Points

The anatomy is usually very straightforward and relatively constant. However, the presence of pharyngeal pouches, an esophageal diverticulum, an esophageal stenotic lesion, or a tumor mass of the gastric cardia; severe ulceration; esophageal or extrinsic tumors; or a reconstruction from previous surgery can alter the anatomy

Table 3.1 Esophagoscopy: estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Injury to mouth, teeth, pharynx, or larynx[a]	1–5 %
Rare significant/serious problems	
Bleeding/hematoma formation[a]	0.1–1 %
Perforation[a]	0.1–1 %
Infection	0.1–1 %
Failure to visualize parts of stomach or duodenum[a]	0.1–1 %
Failure to adequately biopsy[a]	0.1–1 %
Aspiration pneumonitis[a]	0.1–1 %
Respiratory depression[a]	<0.1 %
Less serious complications	
Gas bloating (transient)	5–20 %
Discomfort, sore throat	5–20 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

significantly and even render endoscopic inspection impossible. Jaw limitation, spinal kyphosis, or anterior bony osteophytes of the spine can limit entry, alter anatomy, and predispose to esophageal injury.

Perspective

See Table 3.1. The risks and the incidence of complications of upper GI endoscopic procedures, even including multiple tissue biopsies, are very low. However, the patient should ideally be made aware of the few serious complications in the unlikely event that these should occur, because the consequences may be serious and even require open surgery. Minor consequences such as gas bloating are more of an inconvenience value for the patient; however, occasionally, these may be significant. Failure to adequately biopsy a lesion of note may occur and the patient should also be warned of this possibility and the need for a further procedure(s). The risks associated with therapeutic procedures are greater and include esophageal perforation associated with dilatation of strictures, stent insertion and perforation, and necrosis which can complicate the treatment of bleeding ulcers.

Major Complications

Although rare, the major complications of endoscopy are **perforation** of the esophagus, and less frequently of the stomach or duodenum. This can be serious, even if detected immediately, and can lead to mediastinitis and sepsis, organ failure, intensive care management, and death. If perforation is suspected a contrast study must be

performed to define the site and size of perforation and the degree of contamination. Open surgery to repair the defect may be performed immediately after waking and discussion with the patient. Later detection carries a greater and more serious risk of adverse outcomes. Most instrumental perforations are small and managed conservatively. Open surgery is occasionally required to drain the area of contamination or to repair the defect. Delayed and unrecognized perforation carries a greater and more serious risk of adverse outcomes. **Aspiration pneumonitis** is less common in the partially awake and fasted patient. However, when it occurs it may be very serious and lead to ARDS and secondary infection causing lobar- or bronchopneumonia, sepsis, organ failure, intensive care support, and sometimes death. Aspiration pneumonitis is usually more serious after emergency endoscopy in the unprepared, unfasted patient, although less desirably and commonly performed in this group. **Significant respiratory depression** is a potentially serious complication of sedation and endoscopy and can lead to brain injury and even death, although now virtually abolished as a complication by good oximetric monitoring and anesthetic care during endoscopy. **Failure to visualize or biopsy** pathology may lead to failure to diagnose or more commonly repeat endoscopy +/− biopsy. **Injury to teeth or the oral cavity** is relatively rare if care is exercised, but major injury can still occur and may have major significance for the patient. Injury to the cervical spine is possible, but exceedingly rare.

Consent and Risk Reduction

Main Points to Explain

- Discomfort and gas bloating
- Injury to mouth and teeth
- Bleeding
- Problems with sedation
- Failure to visualize parts of upper GI
- Perforation
- Infection
- Further surgery; laparotomy

Esophageal Manometry

Description

Local anesthetic topical spray or gel is usually used. The aim is to pass a catheter with pressure censoring openings or a sleeve device through the esophagus into the stomach for measuring pressures in the body of the esophagus and lower esophageal

Table 3.2 Esophageal manometry: estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Discomfort	>80 %
Dysphagia (transient)[a]	>80 %
Nasal/pharyngeal trauma	
Minor	20–50 %
Major	0.1–1 %
Dislodgement[a]	1–5 %
Rare significant/serious problems	
Bleeding	0.1–1 %
Perforation	<0.1 %
Aspiration pneumonitis	<0.1 %
Less serious complications	
Failure to detect reflux/abnormal motility when present[a]	0.1–1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

sphincter region. The catheter is perfused with low volumes of water, and the patient is given 2 mL boluses of water to swallow at greater than 15-s intervals. Usually 5–10 "wet swallows" and a number of "dry swallows" are recorded. The procedure usually takes about 20 min.

Anatomical Points

The anatomy of the esophagus is relatively constant; however, the presence of pharyngeal or esophageal diverticula, webs, or an excessively short or long esophagus may cause technical difficulties. These may be evident on prior endoscopy, which is often performed.

Perspective

See Table 3.2. Esophageal manometry is a relatively safe procedure used to diagnose patients with gastroesophageal reflux disease or motility disturbances, such as spasm or achalasia. Reflux and motility disorders may coexist. Esophageal manometry may usefully identify an adynamic esophagus prior to anti-reflux surgery. Although it remains controversial, most surgeons avoid a total fundoplication in the presence of a totally adynamic esophagus. However, not all surgeons utilize esophageal manometry. Major complications are rare, and minor complications are more of a nuisance for the patient, and settle rapidly within a day or so.

Major Complications

Complications associated with esophageal manometry are rare and usually minor in nature, such as **nasal bleeding**, technical problems with equipment, failure to cannulate, **vomiting,** and **discomfort** from a **sore throat**. **Dislodgement or malpositioning** may require reinsertion or repeating the procedure. Pain is rarely sequelae. Essentially, there are no major complications with this procedure. Since the patient is alert, the airway is usually sufficiently protected to prevent **aspiration pneumonitis**. **Perforation** is an exceedingly rare, but significant complication.

Consent and Risk Reduction

Main Points to Explain

- Discomfort/sore throat
- Bleeding
- Vomiting
- Injury to mouth and teeth
- Failure to diagnose reflux
- Perforation

Pharyngeal Pouch Surgery (Cricopharyngeal Myotomy)

Description

General anesthesia is usually used. Two approaches can be used:

A. Open Approach**:** Usually, general anesthesia is used; however, in high-risk patients the procedure can be done under local anesthesia. The aim is to divide the constrictive cricopharyngeus muscle. The myotomy is usually carried out posteriorly and is taken from the esophagus below to the pharynx above to be sure that all of the cricopharyngeus muscle is divided. This is sufficient for a *small* pouch of less than 2 cm in diameter. In *medium-sized* pouches (2–5 cm) the pouch can be removed or hitched cephalad to the pretracheal fascia. For *larger* pouches, after performing the myotomy, removal is undertaken using a transverse anastomotic stapling device or sutures. The approach is usually anterior to the carotid sheath and posterior to the strap muscles with the exception of the superior belly of the omohyoid muscle, which is divided. Typically the pouch is dissected free and divided using a TA stapling device.

B. Endoscopic Approach**:** The procedure is similar to a rigid endoscopy with a modified esophagoscope known as a "**Weerda** diverticuloscope" being used. One limb of the esophagoscope goes into the pouch and the other into the esophagus so that the common wall between the two is on view. Using an endoscopic camera, an endo-GIA stapler is then placed to divide the common wall, thus carrying out a cricopharyngeal myotomy at the same time as a "pouch to esophagus" anastomosis.

Table 3.3 Pharyngeal pouch surgery (open and endoscopic): estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	1–5 %
Subcutaneous	1–5 %
Cervical	0.1–1 %
Mediastinitis	0.1–1 %
Systemic	<0.1 %
Bleeding/hematoma formation[a]	1–5 %
Esophageal/pharyngeal perforation/leakage[a]	1–5 %
Cervical plexus injury	1–5 %
Rare significant/serious problems	
Injury to mouth, teeth, pharynx, or larynx[a]	0.1–1 %
Pleural/lung infection	0.1–1 %
Recurrent laryngeal nerve palsy	0.1–1 %
Facial pain	0.1–1 %
Recurrent pouch formation/cricopharyngeal spasm	0.1–1 %
Cervical fistula	<0.1 %
Aspiration pneumonitis	0.1–1 %
Lymphatic leak/thoracic duct leakage/lymphocele	0.1–1 %
Pleural effusion	<0.1 %
Multisystem organ failure[a]	<0.1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	50–80 %
Chronic (>12 weeks)	1–5 %
Nasogastric tube[a]	0.1–1 %
Wound scarring (poor cosmesis)	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

Anatomical Points

Variations occur in the tightness of the cricopharyngeal muscle and the size and orientation of the pouch. Most pharyngeal pouches are left sided. Adhesions may be appreciable, especially in those which are long-standing.

Perspective

See Table 3.3. In recent years the endoscopic approach has been increasingly used since patients can usually be discharged on the same or the next day after the procedure. The endoscopic approach is not suitable for pouches less than 2 cm in diameter, but it is an ideal approach for patients who are having recurrent pouch surgery. Although both of the procedures are relatively minor procedures, the patients having them are often elderly

and/or infirm, so that due to comorbidities, risks and complications from the procedure are higher than would otherwise be the case. However, significant risks may also exist from reflux and/or aspiration of food material from the pouch if surgery is avoided.

Major Complications

Most major complications are related to the comorbidities of the elderly patient rather than the specific procedure per se. **Anastomotic leakage** is a potentially serious but rare complication leading to **infection**, which may rarely cause **multisystem organ failure** and **death**, in the usually elderly patients having this procedure. Although rare events, **recurrent laryngeal nerve injury** may cause a hoarse voice; **thoracic duct injury** may cause a lymphatic sinus or lymphocele, which often settles spontaneously; significant **chronic pain or numbness** may occur; **pouch reformation** and **aspiration pneumonitis** or spontaneous **lung infections** may occur.

Consent and Risk Reduction

Main Points to Explain

- Discomfort/sore throat
- Bleeding
- Dysphagia
- Perforation/leakage
- Infection
- Injury to mouth and teeth
- Failure to correct defect
- Recurrence

Open Esophageal (Heller's) Myotomy (Abdominal Approach)

Description

General anesthesia is used. The aim is to divide the circular muscle of the lower esophageal sphincter. This is done by first removing the fat pad at the gastroesophageal junction on the anterior surface of the junction. A combination of sharp and then blunt dissection is used to disrupt the longitudinal muscle fibers and then the circular muscle fibers, usually anteriorly on the esophagus. This is done by developing a plane between the muscle and the mucosa and then dividing the muscle longitudinally with diathermy or scissors. The myotomy is usually taken proximally,

until the thickened region of the lower esophageal sphincter muscle starts to thin out (superior, lower 1/3 of esophagus), and distally, until the stomach is reached, where the plane between the muscle and the mucosa is more difficult to establish and where more bleeding is usually associated with the muscle division. The approach utilized may be open or laparoscopic.

Anatomical Points

The trunk of the anterior vagus nerve usually sweeps across this operative field but is variable in its oblique course from the left to the right side of the lower esophagus. It is usually identified, isolated, and tractioned safely out of the way for the myotomy to be performed.

Perspective

See Table 3.4. This procedure is almost always undertaken via the laparoscope today because of the superior view obtained and the reduced morbidity compared to

Table 3.4 Open esophageal long myotomy (Heller's myotomy): estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	1–5 %
Subcutaneous	1–5 %
Intra-abdominal	0.1–1 %
Mediastinitis	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Rare significant/serious problems	
Recurrent achalasia/esophageal spasm	0.1–1 %
Esophageal/gastric perforation	0.1–1 %
Diaphragmatic injury/hernia	0.1–1 %
Mucosal hernia formation (large; inadequate distal myotomy)	0.1–1 %
Bowel injury (stomach, duodenum, small bowel, colon)	0.1–1 %
Pleural/lung infection/effusion	0.1–1 %
Pneumothorax	0.1–1 %
Subphrenic abscess	0.1–1 %
Gastroesophageal reflux	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Lymphocele/seroma formation	0.1–1 %

(continued)

Table 3.4 (continued)

Complications, risks, and consequences	Estimated frequency
Splenectomy	<0.1 %
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	<0.1 %
Multisystem organ failure[a]	<0.1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	50–80 %
Chronic (>12 weeks)	1–5 %
Surgical emphysema	0.1–1 %
Incisional hernia formation delayed heavy lifting/straining	0.1–1 %
Wound scarring (poor cosmesis)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

Note: If thoracic approach used include complications of thoracotomy or thoracoscopy
[a]Dependent on underlying pathology, anatomy, surgical technique and preferences

open surgery. If the patient has previously had a bag dilatation of the lower esophageal sphincter or botulinum injection, then occasionally the plane between the mucosa and the muscle is obliterated making perforation of the mucosa more likely. Most surgeons undertake some form of fundoplication in association with the myotomy (see section on fundoplication), such as an anterior fundoplication as a Dor patch.

Major Complications

Perforation of the mucosa is the main complication and this is nearly always visible at surgery and should be repaired with a 5-0-monofilament suture. **Infection** from an unrecognized perforation or failed repair may occur. Patients may have a dilated esophagus and so aspiration during anesthesia, leading to **aspiration pneumonitis**, is also a possible major complication. Not extending the myotomy far enough is a technical problem that may lead to **failure to alleviate symptoms** using surgery. **Repeat surgery** may then be required. **Pneumothorax** is rare and small if it occurs, usually spontaneously resorbing. **Injury to other organs** and **splenectomy** are rare events. Thoracic approaches are associated with the need for a chest drain tube, and a relatively higher risk of chest wall and **lung complications** (see thoracotomy), but less abdominal complications. **Multisystem organ failure** and **death** are very rare and almost always associated with infection and/or cardiorespiratory events.

Consent and Risk Reduction

Main Points to Explain

- Discomfort
- Bleeding
- Dysphagia
- Perforation/leakage
- Infection
- Pneumothorax
- Failure to correct defect
- Recurrence

Laparoscopic Esophageal Myotomy (Abdominal Approach)

Description

General anesthesia is used. Laparoscopic entry, insufflation of gas, and placement of ports is performed. The aim is to divide the circular muscle of the lower esophageal sphincter. This is done by first removing the fat pad at the gastroesophageal junction on the anterior surface of the junction. A combination of sharp and then blunt dissection is used to disrupt the longitudinal muscle fibers and then the circular muscle fibers, usually anteriorly on the esophagus. This is done by developing a plane between the muscle and the mucosa and then dividing the muscle longitudinally with diathermy or scissors. The myotomy is usually taken proximally, until the thickened region of the lower esophageal sphincter muscle starts to thin out (superior, lower 1/3 of esophagus), and distally, until the stomach is reached, where the plane between the muscle and the mucosa is more difficult to establish and where more bleeding is usually associated with the muscle division.

Anatomical Points

The trunk of the anterior vagus nerve usually sweeps across this operative field but is variable in its oblique course from the left to the right side of the lower esophagus. It is usually identified, isolated, and tractioned safely out of the way for the myotomy to be performed.

Perspective

See Table 3.5. Laparoscopic methods usually provide a superior view and reduced morbidity, compared to open surgery. However, previous surgery and adhesions may make an open approach wiser in some cases. If the patient has previously had

Table 3.5 Laparoscopic esophageal long myotomy: estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Port site	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Conversion to open operation	1–5 %
Rare significant/serious problems	
Gas embolus	0.1–1 %
Deep venous thrombosis	0.1–1 %
Mucosal hernia formation (large; inadequate distal myotomy)	0.1–1 %
Pleural/lung infection/effusion	0.1–1 %
Pneumothorax	0.1–1 %
Subphrenic abscess	0.1–1 %
Recurrent achalasia/esophageal spasm	0.1–1 %
Gastroesophageal reflux	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Esophageal/gastric perforation	0.1–1 %
Diaphragmatic injury/hernia	0.1–1 %
Injury to the bowel or blood vessels (trochar or diathermy)	0.1–1 %
Duodenal/gastric/small bowel/colonic	
Liver injury	0.1–1 %
Lymphocele/seroma formation	0.1–1 %
Splenectomy	<0.1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	<0.1 %
Multisystem organ failure[a]	<0.1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	50–80 %
Chronic (>12 weeks)	1–5 %

Table 3.5 (continued)

Complications, risks, and consequences	Estimated frequency
Paralytic ileus[a]	50–80 %
Surgical emphysema	0.1–1 %
Wound dehiscence	0.1–1 %
Port-site hernia formation	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

Note: If thoracic approach used include complications of thoracotomy or thoracoscopy
[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

a bag dilatation of the lower esophageal sphincter or botulinum injection, then occasionally the plane between the mucosa and the muscle is obliterated making perforation of the mucosa more likely. Most surgeons undertake some form of fundoplication in association with the myotomy (see section on fundoplication), such as an anterior fundoplication as a Dor patch.

Major Complications

Perforation of the mucosa is the main complication and this is nearly always visible at surgery and should be repaired with a 5-0-monofilament suture. **Infection** from an unrecognized perforation or failed repair may occur. Patients may have a dilated esophagus and so aspiration during anesthesia, leading to **aspiration pneumonitis**, is also a possible major complication. Not extending the myotomy far enough is a technical problem that may lead to **failure to alleviate symptoms** using surgery. **Repeat surgery** may then be required. **Pneumothorax** is rare and small if it occurs, usually spontaneously resorbing. **Injury to other organs** and **splenectomy** are rare events. **Bleeding** is rarely a problem. The main risk is from the gastric and esophageal vessels adjacent to the operation site. Injury to abdominal wall vessels and rarely deeper large vessels is rare. Direct or aortic inferior vena cava puncture with catastrophic bleeding from a trocar is reduced significantly using open access (cutdown) approaches for abdominal entry. **Injury to organs** such as the colon, small bowel, liver, antrum of the stomach, or spleen is rare but may be serious. Immediate primary repair, depending on the size and extent of injury, is indicated if this occurs. Occasionally colostomy or ileostomy is required. Entry of gas into the vascular system (i.e., **gas embolus)** is rare and often catastrophic, usually due to direct puncture and insufflation of CO_2 with the Veress needle approach when establishing the pneumoperitoneum. Open peritoneal access approaches almost abolish this risk. **Multisystem organ failure** and **death** are very rare and almost always associated with infection and/or cardiorespiratory events.

Consent and Risk Reduction

Main Points to Explain

- Discomfort
- Bleeding
- Dysphagia
- Perforation/leakage
- Infection
- Pneumothorax
- Failure to correct defect
- Recurrence

Esophageal Perforation Repair

Description

General anesthesia is used. Esophageal perforation can occur at any point along the esophageal length; however, the most common site of perforation is in the lower esophagus. The cause may be trauma from a foreign body (e.g., chicken bone) or spontaneous rupture (Borhaave's disease). The rupture is almost always an *emergency* procedure and the risks of surgery need to be balanced against the risk of not operating, the natural history of which is often infection and death. The aim is to repair the esophageal defect within the chest. Early repair is usually associated with a better outcome. Direct closure is usual, but occasionally esophageal resection and gastroesophageal anastomosis, an omental patch, or esophageal bypass may be required. Access is often via a right or left lateral thoracotomy, undertaken through the fourth or fifth intercostal space. The lung is retracted and usually collapsed and the esophagus exposed to reveal the site of perforation. If esophageal resection is required, the distal esophageal portion is brought into the abdomen and the stomach is stapled and divided through the proximal portion of the stomach, then removed. The remaining stapled stomach is then brought into the chest and the anterior wall of stomach is anastomosed with the end of the esophagus. The anastomosis is sometimes covered with a wrap of the stomach, as a "fundoplication." The procedure can also be performed with the patient supine. Alternatively, a left thoracolaparotomy can be used, with the patient on the right side. In this case, the azygos vein is not usually divided during mobilization of the esophagus.

Anatomical Points

The anatomy is relatively constant, being most influenced by the location of the perforation. The recurrent laryngeal nerve is most at risk on the right side, while the

thoracic duct is at risk on the left. The heart and hila of both lungs are close to the esophagus and are at risk of injury. The stomach anatomy is slightly variable, determining the ease of traction into the chest of the stomach tube, if esophageal reconstruction is used. The overall stomach size and arrangement of the vascular supply are the main variables. In general, the stomach can be extended through the chest up to the cervical region, with mobilization, in most cases. The duration and extent of the perforation, the degree of leakage, and the intensity of the surrounding inflammation/infection can distort the anatomy and dictate the type of surgery required.

Perspective

See Table 3.6. The risk from esophageal rupture is significant, especially if this is not detected soon after the time of rupture, if leakage has occurred or if infection has become established. The risk of death from no surgery is typically high, and the

Table 3.6 Esophageal perforation repair: estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Wound/subcutaneous	1–5 %
Intra-abdominal (including subphrenic abscess)	1–5 %
Intrathoracic (pneumonia; pleural)	1–5 %
Mediastinitis	1–5 %
Systemic	1–5 %
Late – postsplenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	5–20 %
Pulmonary infection	20–50 %
Pulmonary abscess/empyema	1–5 %
Recurrent laryngeal nerve injury	1–5 %
Pneumothorax	20–50 %
Cardiac arrhythmias	20–50 %
Pericardial effusion	1–5 %
Myocardial injury/cardiac failure/myocardial infarction (hypotension)[a]	1–5 %
Pulmonary injury (direct or inferior pulmonary vein injury)	1–5 %
Anastomotic breakdown	1–5 %
Diaphragmatic injury/paresis/hernia	1–5 %
Thoracic duct injury (chylous leak, lymphocele, fistula)	5–20 %
Deep venous thrombosis	1–5 %
Anastomotic stenosis/esophageal obstruction (early or late)[a]	1–5 %
Multisystem failure (renal, pulmonary, cardiac failure)[a]	5–20 %
Death[a]	1–5 %

(continued)

Table 3.6 (continued)

Complications, risks, and consequences	Estimated frequency
Rare significant/serious problems	
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	0.1–1 %
Organ injury (pancreatic injury/cyst/leakage/fistula/pancreatitis Liver/biliary/bowel injury (stomach, duodenum, small bowel, colon))	0.1–1 %
Splenic injury	0.1–1 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Gastro- or esophago-cutaneous fistula	0.1–1 %
Gastro- or esophago-pleural/bronchial fistula	0.1–1 %
Osteomyelitis of ribs	0.1–1 %
Paraplegia	<0.1 %
Less serious complications	
Pain/tenderness [rib pain, wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Surgical emphysema	20–50 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8/52)	>80 %
Nasogastric tube[a]	50–80 %
Chest drain tube(s)	>80 %
Wound drain tube(s)	>80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

risks from surgery need to be placed in this context. The site of the perforation may also dictate the operative approach and range of potential risks and complications. Open surgery is usually preferred, with minimally invasive techniques currently not yet being used by the majority of surgeons for this procedure.

Major Complications

The major complication following repair of a mid or distal esophageal rupture is **anastomotic leakage**, which occurs in 5–10 % of patients and is associated with approximately 50 % mortality rate. **Infection** and **abscess formation** may occur, and **multisystem organ failure** and **death** are closely associated with severe infection and/or comorbidities such as diabetes and **cardiorespiratory compromise**. The other major complication is **respiratory failure**. The development of ARDS occurs in 5–25 % of patients depending on their general level of preoperative fitness and, in particular, their smoking history. Providing no other organ failure occurs, it is usually reversible with prolonged endotracheal intubation and ventilation.

Laparoscopic approaches, partial or full, are associated with additional/alternative risks of trochar insertion and gas insufflation, including vascular injury, bowel injury, conversion to open surgery, and gas embolism. **Necrosis of the gastric tube** is a risk if reconstruction is used but is a less frequent complication and may be more prevalent in heavy smokers.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Perforation/leakage
- Bleeding
- Pneumothorax
- Chest infection
- Chest tubes
- ICU admission
- Ventilation
- Death

Mid and Distal Esophagectomy

Description

General anesthesia is used. The procedure is usually carried out to excise cancer. The aim is to remove the greater part of the esophagus with an anastomosis within the chest. The stomach is usually mobilized as for a total gastrectomy (see relevant section) through a midline laparotomy. In the classical Ivor-Lewis approach, the patient is then turned onto the left side and a right lateral thoracotomy is undertaken through the fourth or fifth intercostal space. The lung is retracted (and usually collapsed) and the azygos vein is identified and divided with suture ligation. The pleura overlying the esophagus is then incised and the esophagus is dissected from its bed, being usually divided at or above the level of the azygos vein. The distal esophageal portion is brought into the abdomen and the stomach is stapled and divided through the proximal portion of the stomach, then removed. The remaining stapled stomach is then brought into the chest and the anterior wall of the stomach is anastomosed with the end of the esophagus. The anastomosis is sometimes covered with a wrap of the stomach, as a "fundoplication." The procedure can also be performed with the patient supine. Alternatively, a left thoracolaparotomy can be used, with the patient on the right side. In this case the azygos vein is not usually divided during mobilization of the esophagus.

Anatomical Points

The anatomy is relatively constant, being most influenced by the location and any anatomic distortion from the tumor. The recurrent laryngeal nerve is most at risk on the right side, while the thoracic duct is at risk on the left. The heart and hila of both lungs are close to the esophagus and are at risk of injury. The stomach anatomy is slightly variable, determining the ease of traction into the chest of the stomach tube used for esophageal reconstruction. The overall stomach size and arrangement of the vascular supply are the main variables. In general, the stomach can be extended through the chest up to the cervical region, with mobilization in most cases.

Perspective

See Table 3.7. Irrespective of the positioning of the patient, the thoracic and abdominal components of the procedure can be performed either synchronously (two surgeons) or sequentially. In patients selected for use of neoadjuvant therapy (preoperative

Table 3.7 Mid and distal esophagectomy: estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Wound/subcutaneous	1–5 %
Intra-abdominal (including subphrenic abscess)	1–5 %
Intrathoracic (pneumonia; pleural)	1–5 %
Mediastinitis	1–5 %
Systemic	1–5 %
Late – postsplenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	5–20 %
Unresectability of malignancy/involved resection margins[a]	5–20 %
Recurrence/progressive disease[a]	5–20 %
Anastomotic breakdown	1–5 %
Recurrent laryngeal nerve injury	1–5 %
Tracheal injury	1–5 %
Pneumothorax	20–50 %
Cardiac arrhythmias	20–50 %
Pericardial effusion	1–5 %
Myocardial injury/cardiac failure/myocardial infarction (hypotension)[a]	1–5 %
Pulmonary injury (direct or inferior pulmonary vein injury)	1–5 %
Pulmonary infection	20–50 %
Pulmonary abscess/empyema	1–5 %
Diaphragmatic injury/paresis/hernia	1–5 %
Thoracic duct injury (chylous leak, fistula)	5–20 %

Table 3.7 (continued)

Complications, risks, and consequences	Estimated frequency
Deep venous thrombosis	1–5 %
Splenic injury	1–5 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Dysphagia	1–5 %
Reflux esophagitis/pharyngitis	5–20 %
Delayed gastric emptying	5–20 %
Bilious vomiting	1–5 %
Dumping syndrome	5–20 %
Early dumping (vasomotor)	
Late dumping (osmotic; insulin surge)	
Intolerance of large meals (necessity for small frequent meals)	5–20 %
Diarrhea	5–20 %
Nutritional deficiency – anemia, B12 malabsorption	5–20 %
Feeding jejunostomy leakage/abscess/inflammation	1–5 %
Lymphocele/seroma formation	5–20 %
Aspiration pneumonitis	1–5 %
Anastomotic stenosis/esophageal obstruction (early or late)[a]	1–5 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	5–20 %
Death[a]	1–5 %
Rare significant/serious problems	
Organ injury (pancreatic injury/cyst/leakage/fistula/pancreatitis)	0.1–1 %
Liver/biliary/bowel injury (stomach, duodenum, small bowel, colon)	
Gastric ischemia devascularization/necrosis (gastric arterial injury)	<0.1 %
Gastro- or esophago-cutaneous fistula	0.1–1 %
Gastro- or esophago-pleural/bronchial fistula	0.1–1 %
Colonic ischemia (middle colic arterial injury)	0.1–1 %
Colonic fistula	0.1–1 %
Renal/adrenal injury[a]	<0.1 %
Osteomyelitis of ribs	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
(Anastomotic stenosis/adhesion formation)	
Paraplegia	<0.1 %
Less serious complications	
Pain/tenderness (rib pain, wound pain)	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Surgical emphysema	20–50 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8 weeks)	>80 %
Nasogastric tube[a]	50–80 %
Chest drain tube(s)	>80 %
Wound drain tube(s)	>80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

chemotherapy and radiotherapy), it is very unusual for cancers to be unresectable. There is some division of opinion concerning radical lymphadenectomy associated with this procedure. Japanese surgeons particularly perform radical lymphadenectomy with esophagectomy, while most surgeons in the West remove only paraesophageal lymph nodes with the esophagus. Sentinel node tracing has been used to identify and resect the main draining lymph node(s). The extent of surgery may therefore dictate the consequent risk of complications. Laparoscopic and thoracoscopic methods are being increasingly used to perform mid or distal esophagectomy either assisting laparotomy or for the entire procedure. Minimally invasive techniques are currently not yet being used by the majority of surgeons for these procedures.

Major Complications

The major complication following mid or distal esophagectomy is **anastomotic leakage**, which occurs in 5–10 % of patients and is associated with approximately 50 % mortality rate. **Necrosis of the gastric tube** is a less frequent complication and may be more prevalent in heavy smokers. **Delayed gastric emptying** is also relatively common but perhaps less so when a pyloroplasty or some other form of drainage procedure is carried out. For this reason most surgeons advocate such a procedure following esophagectomy. The other major complication is **respiratory failure**. The development of ARDS occurs in from 5 % to 25 % of patients depending on their general level of preoperative fitness and, in particular, their smoking history. Providing no other organ failure occurs, it is usually reversible with **prolonged endotracheal intubation, ventilation,** and **ICU support**. If **multisystem organ failure** supervenes, **death** may result, especially if comorbidities are present. Laparoscopic approaches, partial or full, are associated with the additional/alternative risks of trochar insertion and gas insufflation, including vascular injury, bowel injury, **conversion to open surgery,** and **gas embolism**.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Perforation/leakage
- Bleeding
- Pneumothorax
- Chest infection
- Chest tubes
- ICU admission
- Ventilation
- Death

Total Esophagectomy

Description

General anesthesia is used. Total esophagectomy is almost always used for resection of malignancy. The aim is to remove almost all of the esophagus except for the proximal 1–2 cm which is left for anastomosis to a gastric tube. The abdominal and thoracic parts of the procedure are similar to those for a subtotal esophagectomy. The approach to the cervical esophagus is usually through a left-sided incision in front of the sternocleidomastoid with the incision passing between the carotid sheath posteriorly and the strap muscles anteriorly. The esophagus is mobilized and divided 1–2 cm distal to the cricopharyngeus muscle. It is then anastomosed end to side to the anterior wall of the raised stapled gastric tube. The above procedure is considered here. Occasionally, colon or small intestine segments are utilized as alternative sources for the neo-esophageal conduit reconstruction, particularly if the stomach is unable to be used or bypassing of the chest is necessary. On occasions, bowel conduits have been tunnelled pre- or retrosternally for palliative esophageal bypass. Free flap skin conduits have also been utilized in special situations.

Anatomical Points

The anatomy is relatively constant, being most influenced by the location and any anatomic distortion from the tumor. The recurrent laryngeal nerves are at risk bilaterally, while the thoracic duct is at risk on the left. The heart and hila of both lungs are close to the esophagus and are at risk of injury. The stomach anatomy is slightly variable, determining the ease of traction into the chest of the stomach tube used for esophageal reconstruction. The overall stomach size and arrangement of the vascular supply are the main variables. In general, the stomach can be extended through the chest up to the cervical region, with mobilization in most cases.

Perspective

See Table 3.8. Irrespective of the positioning of the patient, the cervical, thoracic, and abdominal components of the procedure can be performed either synchronously (two surgeons) or sequentially. In patients selected for use of neoadjuvant therapy (preoperative chemotherapy and radiotherapy), it is very unusual for cancers to be unresectable. There is some division of opinion concerning radical lymphadenectomy associated with this procedure. Japanese surgeons particularly perform radical lymphadenectomy with esophagectomy, while most surgeons in the West remove

Table 3.8 Total esophagectomy: estimated frequency of complications, risks, and consequences

Complications, risks and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Wound/ subcutaneous	1–5 %
Intra-abdominal (including subphrenic abscess)	1–5 %
Intrathoracic (pneumonia; pleural)	1–5 %
Mediastinitis	1–5 %
Systemic	1–5 %
Late – postsplenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	5–20 %
Anastomotic breakdown	5–20 %
Cervical fistula	1–5 %
Anastomotic stenosis/esophageal obstruction (early or late)[a]	1–5 %
Unresectability of malignancy/involved resection margins[a]	5–20 %
Recurrence/progressive disease[a]	5–20 %
Recurrent laryngeal nerve injury	1–5 %
Tracheal injury	1–5 %
Pneumothorax	20–50 %
Cardiac arrhythmias	20–50 %
Pericardial effusion	1–5 %
Myocardial injury/cardiac failure/myocardial infarction (hypotension)[a]	1–5 %
Pulmonary injury (direct or inferior pulmonary vein injury)	1–5 %
Pulmonary infection	20–50 %
Pulmonary abscess/empyema	1–5 %
Diaphragmatic injury/paresis/hernia	1–5 %
Thoracic duct injury (chylous leak, fistula/lymphocele)	5–20 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	5–20 %
Deep venous thrombosis	1–5 %
Splenic injury	1–5 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Dysphagia	1–5 %
Reflux esophagitis/pharyngitis	5–20 %
Delayed gastric emptying	5–20 %
Bilious vomiting	1–5 %
Dumping syndrome	5–20 %
Early dumping (vasomotor)	
Late dumping (osmotic; insulin surge)	
Intolerance of large meals (necessity for small frequent meals)	5–20 %
Diarrhea	5–20 %
Nutritional deficiency – anemia, B12 malabsorption	5–20 %
Feeding jejunostomy leakage/abscess/inflammation	1–5 %
Aspiration pneumonitis	1–5 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	5–20 %
Death[a]	1–5 %

Table 3.8 (continued)

Complications, risks and consequences	Estimated frequency
Rare significant/serious problems	
Organ injury (pancreatic injury/cyst/leakage/fistula/pancreatitis)	0.1–1 %
Liver/biliary/bowel injury (stomach, duodenum, small bowel, colon)	
Gastro- or esophago-cutaneous fistula	0.1–1 %
Gastro- or esophago-pleural/bronchial fistula	0.1–1 %
Colonic ischemia (middle colic arterial injury)	0.1–1 %
Colonic fistula	0.1–1 %
Osteomyelitis of ribs	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
(Anastomotic stenosis/adhesion formation)	
Necrosis of conduit	0.1–1 %
Renal/adrenal injury[a]	<0.1 %
Paraplegia	<0.1 %
Less serious complications	
Pain/tenderness [rib pain, wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Surgical emphysema	20–50 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8 weeks)	>80 %
Nasogastric tube[a]	50–80 %
Chest drain tube(s)	>80 %
Drain tube(s)[a]	>80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

only paraesophageal lymph nodes with the esophagus. Sentinel node tracing has been used to identify and resect the main draining lymph node(s). The extent of surgery may therefore dictate the consequent risk of complications. The anastomotic leakage rate is higher with this procedure than for subtotal esophagectomy, presumably because of the extra length that the stomach has to span, additional mobilization of the stomach and perhaps inadvertent associated tensioning of the tissues. The consequences of a leak at the cervical region may be less threatening than an intrathoracic leak. Nevertheless, some cervical leaks still pass into the mediastinum and chest rather than out through the cervical wound. The incidence of structuring/stenosis following the procedure is also higher with this procedure than with an intrathoracic anastomosis. Mobilization of the upper esophagus makes recurrent laryngeal nerve damage and thoracic duct injury more frequent. Laparoscopic and thoracoscopic methods are being increasingly used to perform total esophagectomy either assisting laparotomy or for the entire procedure. Minimally invasive techniques are currently not embraced by the majority of surgeons for these procedures.

Major Complications

These are essentially similar to that of subtotal esophagectomy, that is, **anastomotic leak**, gastric necrosis and ARDS, **multisystem failure,** and **death**, but are more common. The major complication following total esophagectomy is anastomotic leakage which occurs in >10 % of patients and is associated with approximately 50 % mortality rate. **Necrosis of the gastric tube** is a less frequent complication and may be more prevalent in heavy smokers. **Delayed gastric emptying** is also relatively common but perhaps less so when a pyloroplasty or some other form of drainage procedure is carried out. For this reason most surgeons advocate such a procedure following esophagectomy. The other major complication is **respiratory failure**. The development of ARDS occurs in 5–25 % of patients depending on their general level of preoperative fitness and, in particular, their smoking history. **Lung infection**, **pleural effusions,** and **cardiac arrhythmias** are not uncommon. Providing no other organ failure occurs, it is usually reversible with **prolonged endotracheal intubation and ventilation**. If **multisystem organ failure** supervenes, **death** may result, especially if comorbidities are present. Risk of **recurrent laryngeal nerve injury** and **thoracic duct lymphatic leakage** is greater with total esophagectomy.

Laparoscopic approaches, partial or full, are associated with the additional/alternative risks of trochar insertion and gas insufflation, including **vascular injury, bowel injury**, **conversion to open surgery,** and **gas embolism**.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Perforation/leakage
- Bleeding
- Pneumothorax
- Chest infection
- Chest tubes
- ICU admission
- Ventilation
- Death

Further Reading, References, and Resources

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Chapter 4
Gastric Surgery

Glyn G. Jamieson, Peter Devitt, and Brendon J. Coventry

General Perspective and Overview

Gastroduodenal surgery has changed remarkably over the last two decades with the advent of better pharmaceutical and operative therapies. The discovery of ***Helicobacter pylori*** **and proton pump inhibitors** and a better understanding of acid control have reduced the incidence of clinically significant peptic ulceration to low levels, and all but removed the need for operations such as highly selective vagotomy and truncal vagotomy and pyloroplasty. Some 20 or more years ago, a surgical trainee in a large teaching hospital would often need to surgically deal with at least one peptic perforation per day on average, using a range of techniques. This has become a relatively rare event today. **Laparoscopic and endoscopic techniques** have also altered the way we diagnose, access, and treat many esophagogastric and duodenal conditions.

Endoscopic percutaneous gastrostomy has almost replaced open gastrostomy for venting and/or feeding purposes.

Bleeding peptic ulcers are now almost universally treated with a trial of **endoscopic injection therapy**, and the need for open surgery for underrunning of the bleeding point(s) is reserved for the most resistant or precarious situations.

With these changes to less invasive surgery and treatments have come changes in the range and incidence of complications and consequences of surgery. Indeed, some of the complications of the open surgery have increased, not through worsening of surgical standards but from the selection of the more difficult, complex, and older patients with higher comorbidities for open surgery.

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This chapter needs to be read with these changes in mind, because much of the literature has been based upon previous data from previous eras, with differing groups of patients to those who currently present for surgery.

The main complications from gastric surgery are related to infection and leakage, especially from anastomoses and stomas. Bleeding is usually able to be controlled at the time of surgery. Other complications relate to altered anatomy and function, especially of gastric emptying, causing a range of symptoms related to meal size and tolerance.

With these factors and facts in mind, the information given in this chapter must be appropriately and discernibly interpreted and used.

The **use of specialized units with standardized preoperative assessment, multidisciplinary input, and high-quality postoperative care** is essential to the success of complex gastric surgery overall and can significantly reduce risk of complications or aid early detection, prompt intervention and cost.

Important Note
It should be emphasized that the risks and frequencies that are given here *represent derived figures*. These *figures are best estimates of relative frequencies across most institutions*, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities and different surgeons. In addition, the risks of complications in lower or higher risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient, staff, or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedures or surgical approaches. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

Upper Gastrointestinal Endoscopy

Description

Local anesthetic spray or gel and a sedative agent are usually used. The aim is to pass an endoscope via the oral cavity into the pharynx, esophagus, stomach, and into the duodenum in order to examine the upper digestive tract. The view of the oral cavity and pharynx is usually less satisfactory than with a rigid or fiber-optic pharyngo- or laryngoscope. However, the view of the esophagus, stomach, and duodenum (usually no further than the second part) is usually excellent. Apart from its diagnostic facility (combined with biopsy), therapeutic maneuvers such as injection

Table 4.1 Upper gastrointestinal endoscopy estimated frequency of complications, risks and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Injury to mouth, teeth, pharynx or larynx[a]	1–5 %
Rare significant/serious problems	
Bleeding/hematoma formation[a]	0.1–1 %
Perforation[a]	0.1–1 %
Infection	0.1–1 %
Failure to visualize parts of stomach or duodenum[a]	0.1–1 %
Failure to adequately biopsy[a]	0.1–1 %
Aspiration pneumonitis[a]	0.1–1 %
Respiratory depression[a]	<0.1 %
Less serious complications	
Gas bloating (transient)	5–20 %
Discomfort, sore throat	5–20 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

of bleeding peptic ulcers and insertion of gastrostomy tubes and esophageal stents can also be performed.

Anatomical Points

The anatomy is usually straightforward and relatively constant; however, the presence of a pharyngeal pouch, an esophageal diverticulum, a duodenal diverticulum, gastric scarring/ulceration, duodenal scarring/ulceration, and tumors or a reconstruction from previous surgery can increase the technical difficulties of the procedure.

Perspective

See Table 4.1. The risks and the incidence of complications of upper GI endoscopic diagnostic procedures, even including multiple tissue biopsies, are very low. However, the patient should ideally be made aware of the few serious complications in the unlikely event that these should occur, because the consequences may be serious and even require open surgery. Minor consequences such as gas bloating are more of inconvenience value for the patient; however, occasionally these may be significant. Failure to adequately biopsy a lesion of note may occur, and the patient should also be warned of this possibility and the need for a further procedure(s). The risks associated with therapeutic procedures are greater and include esophageal perforation associated with dilatation of strictures, stent insertion, and perforation and necrosis, which can complicate the treatment of bleeding ulcers.

Major Complications

Although rare, the major complications of endoscopy are **perforation** of the esophagus and less frequently still the stomach or duodenum. This can be serious, even if detected immediately, and can lead to mediastinitis and sepsis, organ failure, intensive care management, and death. If instrumental perforation occurs it may not be recognized immediately but should be suspected if the patient complains of pain. The presence of surgical emphysema would be virtually diagnostic of esophageal perforation. If perforation is suspected, a contrast study must be performed to define the site and size of perforation and the degree of contamination. Most instrumental perforations are small and managed conservatively. Open surgery is occasionally required to drain the area of contamination or to repair the defect. Delayed and unrecognized perforation carries a greater and more serious risk of adverse outcomes. **Aspiration pneumonitis** is less common in the partially awake and fasted patient. The risk of inhalation is increased in the patient with obstruction (achalasia, pyloric stenosis) or who has hematemesis. In such circumstances it may be prudent to protect the airway and perform the procedure with anesthesia and endotracheal intubation. Aspiration may be complicated by ARDS and/or secondary infection causing lobar or bronchopneumonia which sometimes progress to generalized sepsis, organ failure, intensive care support, and sometimes death. Aspiration pneumonitis is usually more serious after emergency endoscopy in the unprepared, unfasted patient or in patients with chronic upper gastrointestinal problems such as achalasia and gastric outlet obstruction. **Significant respiratory depression** is a potentially serious complication of sedation and endoscopy, and can lead to brain injury and even death, although now virtually abolished as a complication by good oximetric monitoring and anesthetic care during endoscopy. **Failure to visualize or biopsy** pathology is a risk of any endoscopic procedure, but in the elective setting, upper gastrointestinal tract endoscopy has high diagnostic yield. Disease processes (e.g., site and cause of acute hemorrhage) are more likely to be missed in emergency procedures or those where there has been difficulty achieving satisfactory sedation or airway control. **Injury to teeth** is uncommon and additional care will be required in the presence of crowns or bridgework. Patients with extensive dental caries must be warned of the risks of breakage of a decayed tooth.

Consent and Risk Reduction

Main Points to Explain

- Discomfort and gas bloating
- Injury to mouth and teeth
- Bleeding
- Problems with sedation
- Failure to visualize parts of upper GI
- Perforation
- Infection
- Further surgery; laparotomy

Percutaneous Endoscopic Gastrostomy

Indications

This therapeutic procedure is undertaken either for feeding or relief of obstruction ("venting gastrostomy"). When used for feeding a percutaneous endoscopic gastrostomy (PEG) may be temporary or permanent. Temporary placement is often used in patients about to undergo treatment for head and neck cancers. Permanent PEG insertion can be considered in patients with problems of deglutition (e.g., after stroke). Venting gastrostomies are sometimes used in as part of the management of the terminally ill with malignancy intestinal obstruction and persistent vomiting.

Description

Sedation and local anesthesia (spray or gargle) may be used, especially in high-risk patients, but general anesthesia is also acceptable. The aim is to establish a portal to the stomach from the exterior. With the patient lying supine, the endoscope is turned anteriorly inside the stomach so that the light is visible through the anterior abdominal wall where a needle is used to infiltrate local anesthetic over an area well away from the costal margin where the endoscope light can be seen clearly. The needle is pushed on down into the stomach. When it has been seen clearly by the endoscopist, the needle is removed, a small stab incision is made at the site of entry and a wide bore passed into the stomach. Under direct view, a guide wire is passed through this needle, grasped by the endoscopist and drawn through the anterior wall, into the stomach and pulled out through the mouth. A large-bore (20–24 FrG) catheter can now be passed through the mouth over the guide wire and brought out through the anterior abdominal wall. The gastrostomy tube is held in position by means of a plastic collar lying over the skin.

Anatomical Points

The colon, small bowel, liver, and omentum may overlie the stomach and make access more difficult. Perforation or transfixion of the transverse colon is a well-documented risk. Gastrostomy insertion can be more challenging in the obese and those who have had previous upper abdominal surgery. The procedure should be avoided or used with caution in those patients with massive ascites.

Perspective

See Table 4.2. Gastrostomy is used for drainage, feeding or both. Percutaneous endoscopic gastrostomy (PEG) is almost exclusively used for gastric access, where

Table 4.2 Percutaneous endoscopic gastrostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection	
Wound[a]	5–20 %
Subcutaneous cellulitis; abscess	1–5 %
Intraperitoneal	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation	1–5 %
Paralytic ileus	1–5 %
Gastric leakage[a]	1–5 %
Gastric fistula[a]	1–5 %
Discharging abscess sinus[a]	1–5 %
Pneumoperitoneum	5–20 %
Free esophageal/gastric perforation[a]	1–5 %
Tube dislodgement (internalization or extraction)[a]	5–20 %
Gas bloating (transient)	5–20 %
Gastroesophageal reflux	5–20 %
Aspiration pneumonitis	1–5 %
Injury to mouth, teeth, pharynx or larynx	1–5 %
Rare significant/serious problems	
Failure to perform endoscopically	0.1–1 %
Conversion to open operation (early or late)	0.1–1 %
Less serious complications	
Hernia formation (incisional)	0.1–1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

an endoscopy can be performed. Complications are few, but skin infection and irritation are common. Renewal of the gastrostomy catheter is often required for these complications or as a routine for catheter maintenance. Endoscopy may be required for this if the button on the end of the catheter has become rigid and inflexible.

Major Complications

These relate either to insertion of the tube or leakage or migration. Although PEG insertion is usually easy and safe, **esophageal perforation** or **teeth injury** can occur. Rarely, the catheter may migrate distally and could lead to **stomach outlet obstruction**. Separation of the stomach from the anterior abdominal wall is a more serious complication and may result in **intraperitoneal leakage** of stomach contents and peritonitis, with or without abscess formation or generalized sepsis. Occasionally the tube will migrate outwards, with accumulation of feed in the subcutaneous tissues or peritoneal cavity. **Pressure necrosis** of the stomach against the catheter balloon and free

perforation is rare. The most frequent complication however, occurs around the exit of the catheter where **minor infection and excoriation** is very common. Associated **abscess formation** is not uncommon. **Systemic sepsis** is infrequent but may be severe, often related to the underlying condition(s), and can rarely lead to death.

Consent and Risk Reduction

Main Points to Explain

- Discomfort and gas bloating
- Injury to mouth and teeth
- Bleeding
- Problems with sedation
- Failure to insert PEG
- Perforation
- Infection
- Long-term PEG problems
- Further surgery; laparotomy
- Risks without surgery

Open Gastrostomy

Description

General anesthesia is usually used, but in high-risk patients local anesthesia infiltration may be satisfactorily used. The aim is to establish a portal to the stomach from the exterior. Older methods where a tube of stomach was constructed and brought out through the anterior abdominal wall are almost never used today. The commonest procedure today is to make a small upper midline incision and identify the anterior wall of the stomach where it is mobile enough to reach the anterior abdominal wall. The procedure can also be done laparoscopically. A large-bore (20–24 FrG) Foley balloon catheter is inserted through a separate abdominal wall incision several centimeters lateral to the midline incision. A nonabsorbable purse-string suture is inserted into the anterior wall of the stomach, and the Foley catheter is inserted into the stomach through a stab wound in the middle of the purse string. The balloon is inflated with about 10–20 ml of saline. The purse string is tightened and tied around the Foley catheter. The anterior wall of the stomach is brought into apposition with the inside of the anterior abdominal wall by gentle traction on the Foley catheter. Sutures are then placed to hold the stomach to the exit point of the catheter on the inside of the abdominal wall and the Foley catheter is secured into position against the skin.

Table 4.3 Open gastrostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection	
Wound	5–20 %
Subcutaneous cellulitis; abscess	1–5 %
Intraperitoneal	0.1–1 %
Systemic[a]	0.1–1 %
Bleeding/hematoma formation	1–5 %
Paralytic ileus	1–5 %
Gastric leakage[a]	1–5 %
Gastric fistula	1–5 %
Discharging abscess sinus	1–5 %
Tube dislodgement (internalization or extraction)	5–20 %
Gastroesophageal reflux[a]	5–20 %
Aspiration pneumonitis	1–5 %
Less serious complications	
Hernia formation (incisional)	0.1–1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

Anatomical Points

The colon, small bowel, liver, and omentum may overlie the stomach and make access difficult. Although these organs are at risk, generally these can be displaced to enable the procedure to be performed. The procedure is more difficult in the obese and those who have had previous upper abdominal surgery.

Perspective

See Table 4.3. Open gastrostomy is used for drainage, feeding or anchoring the stomach to the anterior abdominal wall (e.g., as part of a hiatal hernia reduction and repair procedure). The procedure is performed infrequently and has almost completely been replaced by the endoscopic and radiological approaches. When used today, the open gastrostomy is usually part of a decompression procedure and may be used as an alternative to nasogastric intubation. An example of its use is to reduce the risk of reflux of gastric contents in patients with an esophageal rupture.

Major Complications

Occasionally, the balloon of a Foley catheter may migrate distally and can lead to **stomach outlet obstruction**. Separation of the stomach from the anterior abdominal wall may result in **intraperitoneal leakage** of stomach contents and peritonitis, with or without abscess formation or generalized sepsis. **Pressure necrosis** of the stomach against the catheter balloon and free **perforation** is rare. The most frequent

complication, however, occurs around the exit of the catheter where **minor infection and excoriation** are very common. Associated **abscess formation** may occur but common. **Systemic sepsis** is infrequent, but may be severe, often related to the underlying condition(s), and can rarely lead to death.

Consent and Risk Reduction

Main Points to Explain

- Discomfort and gas bloating
- Bleeding
- Problems with sedation/GA
- Leakage
- Infection (incl. peritonitis)
- Long-term gastrostomy problems
- Further surgery; laparotomy
- Risks without surgery

Gastrectomy (Partial Gastrectomy; Billroth I; Billroth II; Roux-En-Y)

Description

General anesthesia is used. The aim is to remove part of the stomach with reconstitution of gastrointestinal continuity. These procedures are designed for lesions of the lower 2/3 of stomach. The amount of stomach removed is contingent upon the nature (benign or malignant), anatomy, and site of the pathology. The basic operation is mobilization of the distal stomach, with division of the left gastric and right gastroepiploic vessels. If a tumor is close to the pylorus, usually a Roux-en-Y procedure is preferred with the gastric remnant being anastomosed to the Y limb of a Roux-en-Y reconstruction. In benign situations or tumors with lower malignant potential (e.g., gastrointestinal stromal tumors), a Billroth I reconstruction where the gastric stump is joined to the duodenum can be undertaken but is associated with a greater degree of troublesome bile reflux. In the Billroth II reconstruction, the duodenal stump is closed and a loop enterostomy is anastomosed to the gastric remnant.

Anatomical Points

Vascular anomalies of the left gastric, gastroduodenal, and short gastric vessels may occur but are usually detected and dealt with at operation without difficulty. Massive left lobe of liver enlargement may restrict access. There are few other variations of any consequence for this procedure.

Perspective

See Table 4.4. The main controversies surrounding partial gastrectomy for gastric malignancy have been whether a splenectomy should be performed and also how many lymph nodes should be removed. The situation with regard to

Table 4.4 Partial gastrectomy (including Billroth I, Billroth II, and Roux-en-Y) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal	0.1–1 %
Intrathoracic (pneumonia; pleural)	1–5 %
Mediastinitis	0.1–1 %
Systemic	0.1–1 %
Late—post splenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	1–5 %
Intolerance of large meals (necessity for small frequent meals)	50–80 %
Paralytic ileus	20–50 %
Diarrhea	20–50 %
Unresectability of malignancy/involved resection margins[a]	5–20 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Delayed neo-gastric emptying	1–5 %
Bilious vomiting/bile reflux[b]	1–5 %
Dumping syndrome[a]	1–5 %
Dumping (vasomotor)	
Late dumping (osmotic; insulin surge)	
Splenic injury[a]	1–5 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy (may be part of procedure, i.e., 100 %)	
Rare significant/serious problems	
Stomal/anastomotic stenosis	0.1–1 %
Stomal/anastomotic ulceration	0.1–1 %
Common bile duct injury	0.1–1 %
Biliary fistula	0.1–1 %
Liver injury	0.1–1 %
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)	0.1–1 %
Dysphagia	0.1–1 %
Duodenal stump leak/fistula[a]	0.1–1 %
Gastric ischemia (devascularization)/gastric-cutaneous fistula[a]	0.1–1 %
Anastomotic breakdown	0.1–1 %
Colonic ischemia (middle colic arterial injury)/fistula[a]	0.1–1 %
Renal/adrenal injury	0.1–1 %

Table 4.4 (continued)

Complications, risks, and consequences	Estimated frequency
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/ adhesion formation]	0.1–1 %
Seroma formation	0.1–1 %
Subphrenic abscess	0.1–1 %
Deep venous thrombosis	0.1–1 %
Thoracic duct injury (chylous leak, fistula)[a]	<0.1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8/52)	0.1–1 %
Nutritional deficiency—anemia, B12 malabsorption	5–20 %
Nasogastric tube[a]	50–80 %
Drain tube(s)[a]	>80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences
[b]Incidence varies with type of reconstruction

splenectomy appears to have been resolved, and it is now accepted that the spleen should be preserved, if possible. The extent of lymph node resection remains controversial, with most Western surgeons not practicing extended lymphadenectomy, as developed and popularized by Japanese surgeons as part of a radical partial gastrectomy. Sentinel node tracing and biopsy is used in some centers.

Major Complications

As with most upper gastrointestinal operations, the most serious potential complication is **anastomotic leakage**. In Billroth II and Roux-en-Y reconstructions, such leakage is often as much from the **duodenal stump**, as it is from the anastomosis, and for this reason, a drain is often placed to the region of (or through) the duodenal stump. This does not to reduce the risk of leakage but does facilitate control of any leak. **Infection and multisystem failure** may then ensue, and this is the main cause of **death**, although a rare outcome. **Bleeding** is rarely severe and usually controlled at surgery. In the longer term, **bile reflux** has always bedeviled partial gastrectomy procedures of the Billroth I or Billroth II type. For this reason many surgeons use a Roux-en-Y procedure with a long limb (>50 cm) to try to prevent biliary reflux.

Consent and Risk Reduction

Main Points to Explain

- Infection (incl. peritonitis)
- Bleeding
- Problems with sedation/GA
- Anastomotic leakage
- Long-term gastrectomy problems
- Further surgery; laparotomy
- Risks without surgery

Total Gastrectomy

Description

General anesthesia is used. The aim is to remove all of the stomach, including the gastroesophageal junction. This is usually carried out via a midline laparotomy incision, although in revisional cases, or when other difficulties are encountered, it may be necessary to extend the incision into the left thorax as a thoracoabdominal incision.

Anatomical Points

Vascular anomalies of the left gastric, gastroduodenal, and short gastric vessels may occur but are usually detected and dealt with at operation without difficulty. Obesity and massive left lobe of liver enlargement may restrict access, as can a narrow costal angle. The presence of small bowel adhesions, short mesentery, previous surgery, a hiatus hernia, and/or short esophagus may impede ease. There are few other variations of any consequence for this procedure.

Perspective

See Table 4.5. Total gastrectomy tends to be used in all proximal gastric tumors, including those close to the cardia. Esophagogastrectomy is usually used for any tumor which involves the cardia. Various substitute gastric pouches have been advocated as gastric replacements, following total gastrectomy, but none has really established a place over a simple Roux-en-Y interposition. There are some

Table 4.5 Total gastrectomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal	0.1–1 %
Intrathoracic (pneumonia; pleural)	1–5 %
Mediastinitis	0.1–1 %
Systemic	0.1–1 %
Late—post splenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	1–5 %
Paralytic ileus	20–50 %
Unresectability of malignancy/involved resection margins[a]	5–20 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Delayed neo-gastric emptying	1–5 %
Bilious vomiting/bile reflux	1–5 %
Dumping syndrome	1–5 %
Early dumping (vasomotor)	
Late dumping (osmotic; insulin surge)	
Intolerance of large meals (necessity for small frequent meals)	50–80 %
Stomal/anastomotic stenosis	1–5 %
Diarrhea	20–50 %
Splenic injury[a]	1–5 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy (may be part of procedure, i.e. 100 %)	
Rare significant/serious problems	
Common bile duct injury	0.1–1 %
Biliary fistula	0.1–1 %
Liver injury	0.1–1 %
Duodenal stump leak[a]	0.1–1 %
Duodenal fistula[a]	0.1–1 %
Gastric ischemia (devascularization)/gastric-cutaneous fistula[a]	0.1–1 %
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)	0.1–1 %
Dysphagia	0.1–1 %
Anastomotic breakdown	0.1–1 %
Colonic ischemia (middle colic arterial injury)/colonic fistula[a]	0.1–1 %
Renal/adrenal injury	0.1–1 %
Diaphragmatic injury/hernia	0.1–1 %
Pulmonary injury (direct or inferior pulmonary vein injury)	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	0.1–1 %
Seroma formation	0.1–1 %
Subphrenic abscess	0.1–1 %

(continued)

Table 4.5 (continued)

Complications, risks, and consequences	Estimated frequency
Paraplegia[a]	<0.1 %
Thoracic duct injury (chylous leak, fistula)[a]	<0.1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8/52)	0.1–1 %
Nutritional deficiency—anaemia, B12 malabsorption	5–20 %
Nasogastric tube[a]	50–80 %
Drain tube(s)[a]	>80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

long-term reports suggesting that patients with a pouch do have superior nutrition to those without. As with partial gastrectomy, most Western surgeons do not practice extensive lymphadenectomy with total gastrectomy. Sentinel node tracing and biopsy is used in some centers. Splenectomy is often performed; however, some surgeons aim to retain the spleen. The duodenal stump is stapled or oversewn and the esophagus is anastomosed to a Roux-en-Y limb of jejunum for gastrointestinal reconstruction.

Major Complications

As with partial gastrectomy, **anastomotic leakage** is the major complication. And again, this includes **duodenal blow-out**. Foley catheter drainage of the stump may reduce this risk, but this practice is rarely followed. The major challenge of total gastrectomy is the esophago-jejunal anastomosis. Various maneuvers, including oral passage of the anvil of the stapling device, are used to reduce the difficulties associated with retraction of the cut end of the esophagus into the mediastinum. **Mediastinitis** from leakage into the mediastinum is often a more catastrophic event than when a gastrojejunal anastomotic leak occurs into the abdomen. **Infection and multisystem failure** may then ensue, and this is the main cause of **mortality**, when it occurs. **Bleeding** is rarely severe and usually controlled at surgery. **Anastomotic stricture** is not infrequent, as is the need for adjustment of food intake from the lack of a stomach. These can occasionally be major complications for the patient. A feeding jejunostomy is often performed as part of the operation of total gastrectomy—to allow enteral feeding during the immediate postoperative phase and to facilitate feeding in the unfortunate development of an anastomotic leak.

Consent and Risk Reduction

Main Points to Explain

- Infection (incl. peritonitis)
- Bleeding
- Problems with GA
- Anastomotic leakage
- Long-term gastrectomy problems
- Further surgery; laparotomy
- Risks without surgery

Gastroenterostomy

Description

General anesthesia is used. The aim is to join the stomach to a proximal small bowel loop. The gastroenterostomy can be joined either to the anterior or posterior wall of the stomach, and the small bowel can be placed either in front of or behind the transverse colon. A GIA stapler or equivalent is commonly used for the anastomosis with manual suture closure of the holes created for the limbs of the stapling device. The procedure is often performed laparoscopically. A gastroenterostomy differs from a Billroth II because the stomach and duodenum remain intact.

Anatomical Points

There are essentially no variations that are of major influence in this procedure, except perhaps for adhesions or shortening of the mesentery, limiting the raising of the small bowel loop.

Perspective

See Table 4.6. Gastroenterostomy is nearly always used as a palliative bypass procedure most frequently for carcinoma of the head of the pancreas or for distal gastric or duodenal malignancy. It is unusual for a gastroenterostomy to be fashioned for benign disease today. The procedure is often straightforward and the complication rate is often determined by the underlying disease(s). With the developing of endoscopic stenting devices, there may be reduced need for surgical bypass of these malignant obstructions.

Table 4.6 Gastroenterostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal	0.1–1 %
Intrathoracic (pneumonia; pleural)	1–5 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Paralytic ileus	20–50 %
Stomal ulceration	1–5 %
Stomal stenosis	1–5 %
Unresectability of malignancy/involved resection margins[a]	5–20 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Delayed gastric emptying	1–5 %
Bilious vomiting	1–5 %
Dumping syndrome	1–5 %
Early dumping (vasomotor)	
Late dumping (osmotic; insulin surge)	
Intolerance of large meals (necessity for small frequent meals)	5–20 %
Diarrhea	20–50 %
Rare significant/serious problems	
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)	0.1–1 %
Liver injury	0.1–1 %
Gastric ischemia (devascularization)[a]	0.1–1 %
Anastomotic breakdown	0.1–1 %
Gastric-cutaneous fistula	0.1–1 %
Colonic ischemia (middle colic arterial injury)[a]	0.1–1 %
Colonic fistula[a]	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	0.1–1 %
Seroma formation	0.1–1 %
Subphrenic abscess	0.1–1 %
Less serious complications	
Pain/tenderness [wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8/52)	0.1–1 %
Nasogastric tube[a]	50–80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

Major Complications

The major complication occurring after gastroenterostomy is **failure to function**. Occasionally mechanical obstruction from malpositioning, kinking, improper stapling or an insufficient stoma opening size may exist. Once mechanical obstruction has been excluded, it is usually just a matter of time—in some cases weeks—before the stoma functions. Gastric prokinetic agents, such as the erythromycins, may be helpful. **Anastomotic stenosis** can occur and refashioning may be required. **Anastomotic leakage** is unusual but can be catastrophic if considerable or undetected. **Infection and multisystem failure** may then ensue, and this is the main cause of **mortality**, when it occurs, although the underlying disease may determine this. **Bleeding** is rarely severe and usually controlled at surgery.

Consent and Risk Reduction

Main Points to Explain

- Infection (incl. peritonitis)
- Bleeding
- Problems with sedation/GA
- Anastomotic leakage
- Long-term stomal problems
- Further surgery; laparotomy
- Risks without surgery

Truncal Vagotomy and Pyloroplasty

Description

General anesthesia is used. The aim is to divide both the anterior and posterior trunks of the vagus (X) nerve to destroy the pyloric tone, thereby aiding gastric emptying. The anterior vagus nerve usually traverses the anterior wall of the esophagus, often seemingly lying within its substance and passing from the left side above to the right side below. The posterior trunk of the vagus nerve usually lies behind and to the right of the esophagus and it is usually the larger of the two trunks. Both trunks have a small, but not insignificant, vessel running with them, which often bleeds if the divided ends are not either ligated or diathermied. The pyloroplasty is fashioned for drainage, by incising longitudinally through the wall of the stomach about 3 cm proximal to the pylorus, through the pylorus and then about 3 cm distal to the pylorus into the duodenum. This longitudinal incision is then closed transversely, either with an interrupted or a running suture.

Anatomical Points

There are many variations to the pattern of the vagi as they come through the esophageal hiatus. The commonest is virtual absence of the anterior trunk of the vagus with the dominant posterior trunk taking the full supply to the stomach. The reverse situation is extremely rare. Left lobe of liver enlargement or a large, deep chest cavity may impede access to the esophagus. Vascular anomalies are of little consequence for this surgery.

Perspective

See Table 4.7. With the identification of *Helicobacter pylori* as the important etiologic agent for peptic ulcer disease and the development of first the H_2-receptor antagonists and then the proton pump inhibitors, vagotomy is now virtually

Table 4.7 Truncal vagotomy and pyloroplasty estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal	0.1–1 %
Mediastinitis	<0.1 %
Intrathoracic (pneumonia; pleural)	1–5 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Delayed gastric emptying	1–5 %
Bilious vomiting	1–5 %
Dumping syndrome	20–50 %
Early dumping (hypovolemia)	
Late dumping (insulin surge)	
Intolerance of large meals (necessity for small frequent meals)	5–20 %
Diarrhea	5–20 %
Rare significant/serious problems	
Liver injury	0.1–1 %
Anastomotic (duodenotomy) breakdown	0.1–1 %
Duodeno- or gastro-cutaneous fistula	0.1–1 %
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)	0.1–1 %
Failed acid reduction (including late recurrence)	0.1–1 %
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	0.1–1 %
Subphrenic abscess	0.1–1 %

Table 4.7 (continued)

Complications, risks, and consequences	Estimated frequency
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Paralytic ileus	20–50 %
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8 weeks)	>80 %
Nasogastric tube[a]	50–80 %
Drain tube(s)[a]	>80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

confined to the realms of surgical history. Surgery for peptic ulcer disease is now usually confined to the treatment of complications (perforation, bleeding), and in these cases the aim is to deal with the complication (closure, underrunning) and leave the definitive ulcer treatment (*H. pylori* eradication, acid suppression) to medical therapy.

Major Complications

The important complications of vagotomy include recurrent ulceration, dumping, diarrhea, and bilious vomiting. **Anastomotic leakage** is very unusual but can be catastrophic, if considerable or undetected. **Gastric dysmotility** and **dysphagia** or **vomiting** due to functional or **pyloric obstruction** can occur but usually settle as function returns and pyloric edema abates. **Infection and multisystem organ failure** may then ensue, and these are the main cause for **death** when it occurs. **Bleeding** is rare and is usually controlled at surgery.

Consent and Risk Reduction

Main Points to Explain

- Infection (incl. peritonitis)
- Bleeding
- Problems with sedation/GA
- Anastomotic leakage
- Long-term stomal problems
- Further surgery; laparotomy
- Risks without surgery

Highly Selective Vagotomy

Description

General anesthesia is used. The aim is to dissect the anterior nerve of Latarjet and the posterior nerve of Latarjet away from the esophagus and lesser curve of the stomach down to the incisura. This maintains innervation to the antrum and pylorus of the stomach and therefore preserves relatively normal gastric emptying. Most surgeons begin the dissection in the region of the "crow's foot" of the vagus nerves near the incisura and gradually work proximally all the time pushing the trunks of the nerves away to the right and superiorly from the lesser curve. This is carried out until the trunks have been separated from the proximal stomach and the distal esophagus for a length of at least 5 cm above the anatomic gastro-esophageal junction.

Anatomical Points

The stomach and esophagus anatomy is relatively constant; however, the vagus nerve is highly variable in its fine anatomy, in particular relating to the "crow's foot" region at the termination of the vagus on the stomach wall. Fine branches of the vagus also communicate with the distal esophagus and upper stomach and these transmurally innervate the proximal acid-producing area of the stomach. For this reason the vagus must be cleared away from the stomach above the incisura and crow's foot, all the way onto the distal esophagus for about 5 cm, to completely divide the vagal fibers stimulating acid secretion. The anterior and posterior vagus must be dissected free from the stomach and esophagus to ensure this. The vascularity of the stomach is usually excellent transmurally, so that division of the lesser curve branches supplying the stomach wall rarely causes any ischemia, but watershed areas can exist and where these are present can lead to necrosis of the stomach wall.

Perspective

See Table 4.8. When surgical treatment of peptic ulcer disease was common, a lot of time and effort went into establishing the best operation for lowering acid secretion to heal both duodenal and gastric ulcers. During the 1970s, highly selective (or proximal gastric) vagotomy without a drainage procedure was probably the most popular operation performed. HSV was also "highly surgeon variable" being dependent on experience and technique. This operation was being refined at about the

Table 4.8 Highly selective vagotomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal	0.1–1 %
Mediastinitis	<0.1 %
Intrathoracic (pneumonia; pleural)	1–5 %
Systemic	0.1–1 %
Late—post splenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Delayed gastric emptying	1–5 %
Bilious vomiting	1–5 %
Intolerance of large meals (necessity for small frequent meals)	1–5 %
Diarrhea	5–20 %
Rare significant/serious problems	
Recurrent ulceration (early or late failure)—requiring chronic acid inhibitors	
(Failed acid reduction)	0.1–1 %
Gastric/esophageal ischemia (devascularization)/perforation[a]	0.1–1 %
Gastro- or esophago-cutaneous fistula	0.1–1 %
Splenic injury	0.1–1 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)	0.1–1 %
Dumping syndrome	0.1–1 %
Early dumping (hypovolemia)	
Late dumping (insulin surge)	
Liver injury	0.1–1 %
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	0.1–1 %
Subphrenic abscess	0.1–1 %
Later drainage procedure (e.g., pyloroplasty)	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Paralytic ileus	20–50 %
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8 weeks)	0.1–1 %
Nasogastric tube[a]	50–80 %
Drain tube(s)[a]	>80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

same time as the H_2-receptor antagonists appeared. These powerful agents, combined with the understanding of the role of *Helicobacter pylori* in the pathogenesis of peptic ulcer disease, rapidly rendered HSV and its related operations redundant. If there is any role for any form of vagotomy today, it is for the rare instances of ulcer disease resistant to medical therapy or as part of the management of gastrinoma.

Major Complications

There is a very small incidence of **lesser curve necrosis**, probably of the order of less than 1 in a 1,000 cases. When the operation was combined with a fundoplication the incidence of lesser curve necrosis was higher, perhaps of the order of 2 %. **Perforation, peritonitis and sepsis** with **abscess formation** were the main problems. **Infection and multisystem organ failure** may then ensue, and these were the main causes for **mortality**, when this occurs. **Bleeding** is rare and is usually controlled at surgery. **Poor gastric emptying** can occur despite attempts to preserve the terminal nerves to the pylorus. Occasionally, **dysphagia** occurred, which usually took several weeks to resolve.

Consent and Risk Reduction

Main Points to Explain

- Infection (incl. peritonitis)
- Bleeding
- Problems with GA
- Perforation and leakage
- Recurrent ulceration
- Further surgery; laparotomy
- Risks without surgery

Oversewing of Bleeding Peptic Ulcer

Description

General anesthesia is used. The aim is to localize the ulcer and ligate the bleeding point. Endoscopy will usually have localized the site of the ulcer. A gastrotomy can then be placed close to a gastric ulcer, or a duodenotomy adjacent to a duodenal ulcer, avoiding directly cutting through the ulcer itself. If endoscopy is not used or the ulcer is unable to be visualized, then a longitudinal anterior gastrotomy, or duodenotomy immediately distal to the pylorus, can be performed to locate the ulcer.

Induration or scarring around the ulcer may be palpable to assist localization. Rarely (~1 %) perforation or penetration occurs with bleeding. The bleeding point in the ulcer base is defined and underrun using a stout needle. A firm bite of tissue (through scar) is obtained usually in two directions at right angles to each other, as a part of a cross-stitch to secure hemostasis. Closure of the longitudinal duodenotomy is best undertaken transversely to avoid any narrowing of the lumen.

Anatomical Points

The gastroduodenal artery can vary slightly in position and may be the main source of ulcer related bleeding. Occasionally the ulcer can lie very close to the common bile duct, which may then be at risk of inadvertent ligation during underrunning. Occasionally, the bleeding is from a Dieulafoy's malformation, a bare "bristle-like" end artery, rather than an ulcer, typically in the upper stomach.

Perspective

See Table 4.9. Simple oversewing of the bleeding point in a peptic ulcer is the surgical treatment of choice today since the introduction of effective acid-suppressant agents. In the past it was common to carry out acid-suppression surgery such as a truncal vagotomy and pyloroplasty for duodenal ulcers and a Billroth I gastrectomy for gastric ulcers. Highly selective vagotomy was also advocated by some surgeons

Table 4.9 Oversewing of bleeding peptic ulcer estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal	0.1–1 %
Intrathoracic (pneumonia; pleural)	1–5 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Rare significant/serious problems	
Inability to control bleeding/recurrent hemorrhage[a]	0.1–1 %
Recurrent ulceration (early or late failure)—requiring chronic acid inhibitors	
(Failed acid reduction)	0.1–1 %
Gastro-cutaneous fistula	0.1–1 %
Common bile duct injury[a]	0.1–1 %
Perforation	0.1–1 %
Splenic injury[a]	0.1–1 %

(continued)

Table 4.9 (continued)

Complications, risks, and consequences	Estimated frequency
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)[a]	0.1–1 %
Liver injury	0.1–1 %
Anastomotic (suture line breakdown duodenotomy) breakdown[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
(Anastomotic stenosis/adhesion formation)	
Seroma formation	0.1–1 %
Subphrenic abscess	0.1–1 %
Deep venous thrombosis	0.1–1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Paralytic ileus	5–20 %
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8 weeks)	0.1–1 %
Nasogastric tube[a]	5–20 %
Drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

proficient in the technique. Endoscopic control of bleeding (injection, coagulation, clipping) is first-line treatment for bleeding peptic ulcers with surgery reserved for the small percentage (<5 %) of cases not thus controlled. Angiography and embolization may be considered for failures of endoscopic therapy, particularly in high-risk patients. Surgical oversewing is usually advocated for torrential bleeding in the hemodynamically unstable patient or for the patient who rebleeds after several attempts at endoscopic control. Usually simple oversewing is followed by few complications and is a very effective treatment to stop bleeding especially when coupled with acid-suppression therapy. Recurrent bleeding, either early or late, is the main problem following oversewing, but leakage of gastroduodenal contents, infection and systemic sepsis are serious problems, especially where other comorbidities are present.

Major Complications

Rebleeding is the major problem which occurs in probably less than one percent of cases, depending on pathology. Cutting through of sutures during surgery, due to the friable inflamed tissues at the ulcer edge, is often frustrating and can lead to further bleeding and extended operative time. **Leakage** from the duodenotomy or

gastrotomy is unusual. **Peritonitis, sepsis, abscess formation** or **fistula formation** may develop if leakage occurs. **Injury to the biliary system** and **biliary obstruction** from a deep posterior suture is possible. **Multisystem organ failure** can occur, which may be related to the underlying disease process (e.g., blood loss, coagulopathy, age), and can lead to **death**.

Consent and Risk Reduction

Main Points to Explain

- Infection (incl. peritonitis)
- Bleeding
- Problems with GA
- Further bleeding
- Further surgery; laparotomy
- Risks without surgery

Oversewing of Perforated Peptic Ulcer

Description

General anesthesia is used. The aim is to define the perforation, washout any material that has leaked, and repair the defect. A duodenal ulcer may be repaired using interrupted monofilament sutures, with or without an omental plug. It is essential to biopsy a gastric ulcer to exclude malignancy, and it is either closed directly (in the first instance) or resected with a form of gastric reconstruction. The decision to resect is based on several factors including the degree of peritoneal contamination and infection. Rarely, bleeding or penetration occurs with perforation. Occasionally posterior perforation and penetration must be dealt through an anterior duodenotomy by underrunning with a stout suture and needle. Closure of the longitudinal duodenotomy should be undertaken transversely to avoid narrowing the lumen. Treatment with an acid-blocking agent is usual after repair of a duodenal ulcer.

Anatomical Points

The perforation site can vary considerably in position and may even close over, sealing the defect. Posterior perforations into the lesser sac may be initially concealed. Occasionally the ulcer can lie very close to the common bile duct, which may then be at risk of inadvertent ligation during underrunning. Occasionally, a blood vessel associated with the perforated ulcer may cause bleeding.

Table 4.10 Oversewing of perforated peptic ulcer estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	5–20 %
Intra-abdominal	5–20 %
Intrathoracic (pneumonia; pleural)	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Rare significant/serious problems	
Re-perforation	0.1–1 %
Recurrent ulceration (early or late failure)—chronic acid inhibitors	
(Failed acid reduction)	0.1–1 %
Gastro-cutaneous fistula	0.1–1 %
Ulcer bleeding	0.1–1 %
Common bile duct injury	0.1–1 %
Splenic injury	0.1–1 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)	0.1–1 %
Liver injury	0.1–1 %
Anastomotic breakdown (duodenotomy suture line breakdown)	0.1–1 %
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	0.1–1 %
Subphrenic abscess	0.1–1 %
Deep venous thrombosis	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Paralytic ileus	5–20 %
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8/52)	0.1–1 %
Nasogastric tube[a]	5–20 %
Drain tube(s)[a]	5–20 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

Perspective

See Table 4.10. Simple oversewing of perforated peptic ulcers with or without a plug of omentum is the treatment of choice since the introduction of effective

acid-suppressant agents. In the past, it was common to carry out acid-suppression surgery such as a truncal vagotomy and pyloroplasty for duodenal ulcers and a Billroth I gastrectomy for gastric ulcers. A small percentage of patients have a localized (sealed-off) perforation and can be managed conservatively. The complications of surgery are determined by the effectiveness of achieving longer-term closure and healing and by the underlying comorbidities. Re-perforation is not uncommon but has been lessened with the concurrent use of acid-suppressant agents. Peritoneal sepsis is not uncommon and relates particularly to the timing of perforation before diagnosis and surgery. Systemic sepsis and the underlying comorbidities are powerful determinants of further morbidity and mortality. There is a move towards laparoscopic repair for perforated peptic ulcer, but there is no conclusive evidence that there is any reduction in complications using this approach.

Major Complications

Ongoing **peritoneal sepsis** is an important but uncommon problem postoperatively and may lead to **abscess** formation or **systemic sepsis**, possibly leading to **multisystem organ failure** and **death**. **Wound infection** due to contamination is higher when established infection from perforation has occurred. **Incisional hernia** formation is also higher after infection. **Re-perforation** is not uncommon and may lead to failure to improve after initial operative repair. **Cutting through of sutures** at the ulcer edge during surgery is often frustrating and can lead to **further bleeding** and extended operative time. For this reason an omental plug may be used to seal the defect and reduce tension. **Leakage** from the duodenotomy or gastrotomy is unusual but may occur in the presence of peritoneal infection. **Injury to the biliary system** from a deep superior or posterior suture is possible.

Consent and Risk Reduction

Main Points to Explain

- Infection (incl. peritonitis)
- Bleeding
- Problems with GA
- Further leakage
- Further surgery; laparotomy
- Risks without surgery

Open Nissen Fundoplication

Description

General anesthesia is used. The aim is to wrap the upper stomach around the lower esophagus with the stomach being sutured to itself to hold it in position, in order to create a cuffed area of increased pressure to "re-form" the lower esophageal sphincter. There are many variations to the fundoplication operation, which may also be partial or total. The major three types of total fundoplications vary in the point used for the wrap and are as follows, with the first two being those actually described by Nissen himself:

1. ***Nissen posterior wall***—Taking the posterior stomach wall and bringing it to the right side of the esophagus to sew it to the anterior stomach wall in front.
2. ***Nissen anterior wall***—Taking the anterior wall of the stomach and sliding it up and around behind the esophagus and then sewing it to itself in front of the esophagus.

Neither of the above two operations requires division of the short gastric vessels.

3. ***Both walls***—Division of the short gastric vessels and turning the upper greater curve of the stomach wall around behind the esophagus and sewing it to the anterior wall of the stomach in front of the esophagus. It is not always necessary to divide short gastric vessels for a total fundoplication.

An essential component of any fundoplication procedure is to ensure the hiatus is sufficiently narrowed. This is particularly important when the procedure is undertaken laparoscopically—as is usually the case.

Most surgeons use a large bougie (36–44 FrG) within the esophageal lumen while the wrap is being undertaken to try to prevent making the wrap too tight.

Anatomical Points

Very infrequently, the anterior wall of the stomach is not generous enough to be taken around behind the esophagus without division of the short gastric vessels. The short gastric vessels may extend very high on the greater curvature of the stomach or be tightly applied to the spleen. The abdominal esophagus may be very short. Adhesions to the spleen, diaphragm or colon may exist. Liver or splenic enlargement may reduce access to the stomach. Obesity and a deep chest physique can make access difficult. Rare anomalies of the vascular supply to the stomach may render the stomach fundus susceptible to ischemia upon division of the short gastric vessels, especially with tensioning of the stomach.

Perspective

See Table 4.11. Many types of fundoplication exist. Controversy persists as to whether short gastrics should or should not be divided in total fundoplications. A double fundoplication with two rows of sutures is sometimes carried out. Various

Table 4.11 Open Nissen fundoplication estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal	0.1–1 %
Mediastinitis	<0.1 %
Intrathoracic (pneumonia; pleural)	1–5 %
Subphrenic abscess	0.1–1 %
Systemic	0.1–1 %
Late—post splenectomy sepsis	<0.1 %
Bleeding/hematoma formation[a]	1–5 %
Paralytic ileus	5–20 %
Transient dysphagia	5–20 %
Persistent gastroesophageal reflux	1–5 %
Gas bloat syndrome	1–5 %
Abdominal distention (acute or chronic)	1–5 %
Inability to vomit or belch[a]	1–5 %
Excessive flatus[a]	1–5 %
Surgical emphysema	1–5 %
Diaphragmatic injury	1–5 %
Breakdown of fundoplication[a]	1–5 %
Delayed gastric emptying	1–5 %
Transient early satiety	50–80 %
Diarrhea	0.1–1 %
Splenic injury[a]	0.1–1 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Rare significant/serious problems	
Pseudoachalasia[a]	0.1–1 %
Wrap herniation	0.1–1 %
Paraesophageal herniation[a]	0.1–1 %
Diaphragmatic hernia	0.1–1 %
Pneumothorax	0.1–1 %
Myocardial ischemia/infarction	0.1–1 %
Ulceration esophageal/gastric/duodenal (early or late)	0.1–1 %
Gastric/esophageal ischemia (devascularization)/perforation	0.1–1 %
Gastro- or esophago-cutaneous fistula	0.1–1 %

(continued)

Table 4.11 (continued)

Complications, risks, and consequences	Estimated frequency
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)	0.1–1 %
Liver injury	0.1–1 %
Small bowel obstruction (early or late)[a] [anastomotic stenosis/ adhesion formation]	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8 weeks)	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	0.1–1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

extra fixation sutures are placed between the fundoplication and the diaphragm, or the esophagus, or the median arcuate ligament of the aorta. Partial fundoplications are variously described with the wrap only encircling the posterior 180–270° of the esophagus and similarly anterior partial fundoplications encircling part of the anterior part of the esophagus. All of the fundoplications tend to produce a one-way valve and/or higher-pressure zone at the gastro-esophageal junction region, and so all are associated with some degree of inability to belch and vomit, causing gastric distension or excessive flatus. Early after surgery, difficulty in swallowing is also very common—in a proportion, this persists. Open fundoplications have been largely replaced by laparoscopic approaches. Complications are usually few and minor when they occur, but major complications are well reported and may be serious with associated significant morbidity and very rarely mortality.

Major Complications

Splenectomy may be necessary from injury during retraction in somewhere between 1 % and 5 % of cases. The other major complication is **aphagia**, or very severe **dysphagia**, which can occasionally require **early reoperation**. Acute **para-esophageal herniation** seems to occur very much less frequently after open fundoplication than is the case with laparoscopic fundoplication. **Esophageal or gastric perforation** is a major complication, but this occurs very infrequently indeed in primary anti-reflux surgery. **Infection and multisystem organ failure** may then ensue, and this is the principal cause of **mortality** when it occurs. **Bleeding** is rare and is usually controlled at surgery.

Consent and Risk Reduction

Main Points to Explain

- Infection (incl. peritonitis)
- Bleeding
- Problems with GA
- Dysphagia
- Long-term stomal problems
- Possible reoperation
- Risks without surgery

Laparoscopic Nissen Fundoplication

Description

General anesthesia is used. The aim of production of a one-way valve between the esophagus and stomach is identical to that for open fundoplication, by creating a wrap of the upper stomach around the lower esophagus with the stomach being sutured to itself to hold it in position. This forms a cuffed area of increased pressure to "re-form" the lower esophageal sphincter. Most surgeons use five ports in this procedure, where the epigastric port is used for retraction of the liver, sometimes with a "Nathanson Hook" retractor. As with open fundoplication, it is contentious whether the short gastrics should be divided or not. The usual practice in North America is to divide short gastrics, while elsewhere practice is more evenly divided between short gastric division or not. The mobilization of the anterior wall of the stomach and the esophagus is similar to that carried out in open fundoplication with the exception that dissection behind the esophagus and exposure of the pillars of the hiatus is more frequently carried out during laparoscopic fundoplication. This is because it is necessary to create a clear window behind the esophagus to safely and more easily draw the stomach through behind the esophagus. For this reason almost all surgeons today practice narrowing of the hiatus posteriorly with one, two, or more sutures. The options for laparoscopic fundoplication are essentially analogous to those for open fundoplication (Fig. 4.1).

Anatomical Points

The chief variation of practical importance in laparoscopic fundoplication relates to the size of the left lobe of the liver. When this is large and bulky, it can obscure vision of the hiatus. Previous surgery can be problematic from altering anatomy. Very rarely, abnormal blood supply of the stomach fundus may cause ischemia after short gastric vessel division.

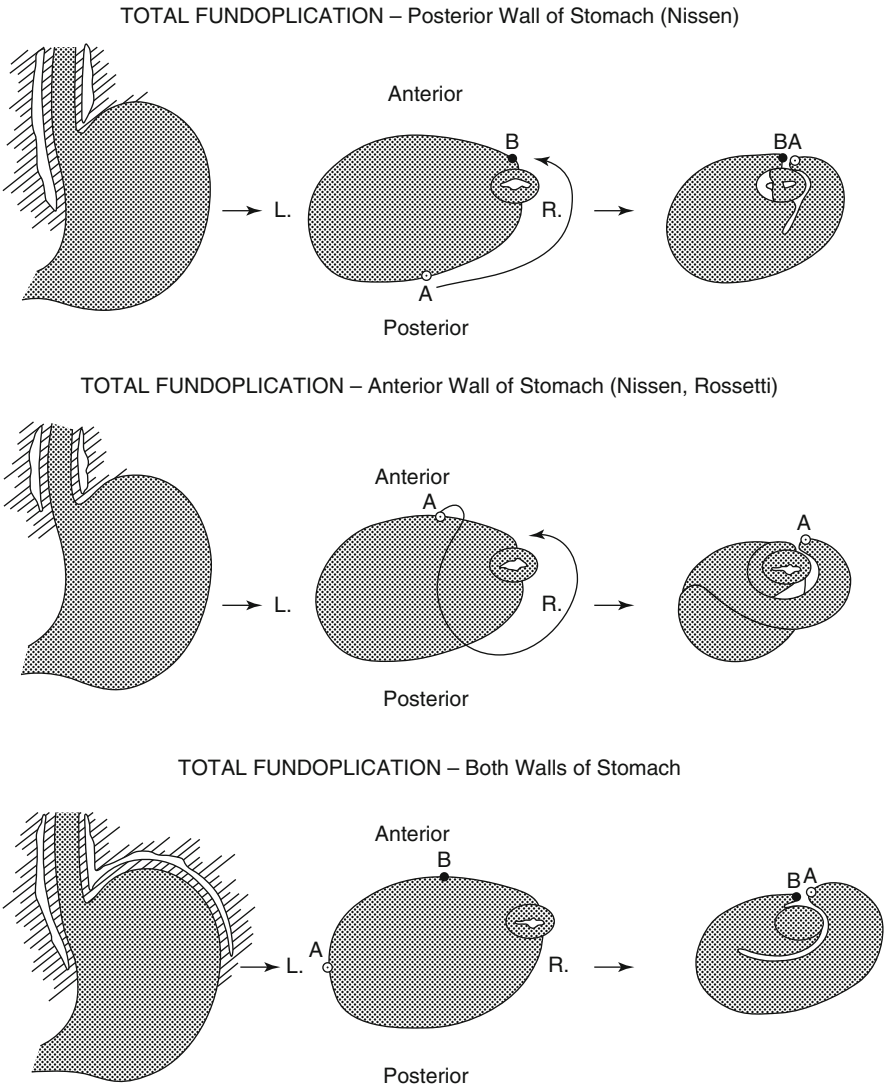

Fig. 4.1 Types of Nissen and modified Nissen fundoplications (Adapted from Jamieson and Duranceau (1984) with permission)

Perspective

See Table 4.12. Most of the comments made for open fundoplication pertain to laparoscopic fundoplication. It is unquestionable that laparoscopic surgery has largely replaced open surgery for primary anti-reflux surgery. It is also true that laparoscopic anti-reflux surgery has largely replaced thoracic surgery for this condition, so much so that some thoracic surgeons are now learning the technique of laparoscopic fundoplication. Typically, few complications arise

Table 4.12 Laparoscopic Nissen Fundoplication estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal	0.1–1 %
Mediastinitis	<0.1 %
Intrathoracic (pneumonia; pleural)	1–5 %
Subphrenic abscess	0.1–1 %
Systemic	0.1–1 %
Late—post splenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	1–5 %
Conversion to open operation	1–5 %
Transient dysphagia	5–20 %
Persistent gastroesophageal reflux	1–5 %
Gas bloat syndrome	1–5 %
Abdominal distention (acute or chronic)	1–5 %
Inability to vomit or belch[a]	1–5 %
Excessive flatus[a]	1–5 %
Surgical emphysema	1–5 %
Diaphragmatic injury	1–5 %
Paraesophageal herniation[a]	0.1–1 %
Breakdown of fundoplication[a]	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Transient early satiety	50–80 %
Diarrhea	0.1–1 %
Rare significant/serious problems	
Gas embolus	0.1–1 %
Pneumothorax	0.1–1 %
Diaphragmatic hernia	0.1–1 %
Wrap herniation	0.1–1 %
Pseudoachalasia	0.1–1 %
Ulceration esophageal/gastric/duodenal (early or late)	0.1–1 %
Gastric/esophageal ischemia (devascularization)/perforation	0.1–1 %
Gastro- or oesophago-cutaneous fistula	0.1–1 %
Myocardial ischemia/infarction	0.1–1 %
Pancreatitis/pancreatic injury/cyst/leakage/fistula	0.1–1 %
Bowel injury (duodenum, small bowel, colon)	0.1–1 %
Liver injury	0.1–1 %
Splenic injury	<0.1 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Small bowel obstruction (early or late)[a] [Anastomotic stenosis/adhesion formation]	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	<0.1 %

(continued)

Table 4.12 (continued)

Complications, risks, and consequences	Estimated frequency
Less serious complications	
Paralytic ileus	0.1–1 %
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	0.1–1 %
Chronic (>12 weeks)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Port site hernia	0.1–1 %
Incisional hernia (delayed heavy lifting/straining for 8 weeks)	1–5 %
Nasogastric tube[a]	0.1–1 %
Wound drain tube(s)[a]	0.1–1 %

[a]Dependent on underlying pathology, anatomy, surgical technique and preferences

and if they occur, most are minor in nature. However, major catastrophic complications are reported including gas embolism and direct injury to bowel and major vessels. Conversion to open surgery is a potentially significant aspect that can be associated with delayed recovery and a different potential range of risks.

Major Complications

The major complication following laparoscopic fundoplication is probably early **severe dysphagia**, even **aphagia**. This occurs infrequently and is usually best dealt with by **reoperation** in the first days after surgery and readjustment under endoscopic control. Often, this is more simply achieved at an early postoperative stage. **Splenic injury** occurs far less frequently in laparoscopic surgery than in open surgery, so that incidental splenectomy has almost disappeared as a complication of (laparoscopic) fundoplication surgery. **Esophageal perforation** occurs infrequently, while **stomach ischemia** and **gastric perforation** are serious, but rare, events. **Infection and multisystem failure** may then ensue, and this may rarely lead to **mortality**. **Major bleeding** from aberrant vessels is rare and is usually controllable at surgery. **Gas embolus** and **major vascular injury** are additional serious, although very rare, complications of the laparoscopic approach.

Consent and Risk Reduction

Main Points to Explain

- Infection (including peritonitis)
- Bleeding
- Problems with GA
- Dysphagia
- Laparoscopic problems
- Conversion to open surgery
- Possible reoperation
- Risks without surgery

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Chapter 5
Obesity (Bariatric) Surgery

Justin Bessell and Brendon J. Coventry

Overview

Obesity is a major problem, which is increasing at an alarming rate in western societies arising principally from an overabundance of high carbohydrate and fat content food and sedentary lifestyles. Numerous studies have associated obesity with excess mortality and significant morbidities, such as cardiovascular disease, diabetes, and joint disease. However, significant social and psychiatric morbidity is also frequently reported to be associated with obesity. Weight loss is often a difficult process and obesity surgery offers a range of means by which weight control can be improved and alleviation of obesity can be achieved. Bariatric or weight loss surgery has been shown to be effective in significantly reducing morbidity and mortality associated with obesity. A recent (2007) study of over 15,000 obese people, of which 7,925 who had gastric bypass and 7,925 nonoperative matched controls, demonstrated an age-adjusted 40 % decrease in death rate in the operative group compared to controls, after a follow-up period of 7 years. Similarly, decreases of 56 % for coronary artery disease, 92 % for diabetes, and 60 % for cancer were observed in those after a gastric bypass compared with the controls. Accidents and suicides were, however, reported to be 58 % higher in the operative group, which was unexplained. This latter finding may suggest a higher incidence of presurgical mood disorders amongst those seeking surgery, or postsurgical psychological morbidity, although quality of life has been shown to improve after gastric bypass surgery.

Some 80 % of the bariatric surgery performed in the USA has been gastric bypass surgery; other western countries have tended to use gastric banding more frequently.

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Laparoscopic methods for performing gastric bypass surgery are being used more frequently; however, many surgeons still prefer open bypass techniques. The initial open gastric banding procedures have now largely been replaced by laparoscopic banding methods, most commonly adjustable gastric banding techniques. Open (vertical) gastric banding has therefore not been separately described in this chapter.

Acute complications are often related to the degree of obesity and the risks of surgery in obese patients, which include wound infection, bleeding, respiratory infection, and venous thromboembolism. Longer-term complications associated with obesity surgery are primarily infective or related to the pouch and limitation to food flow, for implantable laparoscopic adjustable gastric banding (LAGB), while gastric bypass complications are chiefly infective and nutritional in nature. However, a range of complications and consequences of surgery are reported.

The need for surgery and the relative risk of surgery must always be balanced against the risks associated with ongoing obesity in the longer term. Quality of life issues, together with full psychological and sometimes psychiatric assessment, are also essential to evaluate before and after surgery. Psychological support can improve compliance and outcomes in most situations. The cost, quality of life improvements, and survival benefits provide a strong argument for use of these procedures in managing severe obesity, especially when associated with diabetes and cardiovascular disease. Although the optimal strategy remains debated, relatively greater weight loss is associated with procedures with both a restrictive and absorptive component.

With these factors and facts in mind, the information given in these chapters must be appropriately and discernibly interpreted and used.

The *use of specialized units* with standardized preoperative assessment, multidisciplinary input, and high-quality postoperative care is essential to the success of complex obesity surgery overall and can significantly reduce risk of complications or aid early detection, prompt intervention, and cost.

Important Note

It should be emphasized that the risks and frequencies that are given here *represent derived figures*. These *figures are best estimates of relative frequencies across most institutions*, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities and different surgeons. In addition, the risks of complications in lower or higher risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient and staff or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedures or surgical approaches. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

Laparoscopic Adjustable Gastric Banding

Description

General anesthesia is used. Laparoscopic adjustable gastric banding (LAGB) is used for treatment of morbid obesity. The aim is to provide a smaller gastric pouch for food in the stomach, thereby promoting early satiety, reduction of calorie intake, and weight loss. Using laparoscopic techniques, the procedure utilizes a silicone band to create a small proximal gastric pouch. Laparoscopic gastric banding typically places an inflatable cuff device around the upper stomach, connected to an implantable reservoir on the abdominal wall for in(de-)flation. Other methods of laparoscopic gastric banding are described but are very rarely used now. Patient selection and support by a multidisciplinary allied health-care team is especially important for the success of obesity surgery. The skin wounds are usually closed with absorbable suture, staples, or tape.

Anatomical Points

The anatomy is essentially fairly constant; however, the obese physique both inside and outside of the abdominal muscle wall can make accessibility problematic. Inadvertent injury during cannulation is possible unless laparoscopic entry under direct vision is practiced. Adhesions to the spleen can increase risk of splenic injury. The colon, small bowel, and omentum may overlie the stomach and make access more difficult. Although these organs are at risk, generally these can be readily displaced using reverse Trendelenburg positioning to enable the procedure to be performed. Commonly, the left lobe of the liver is large and bulky and can obscure vision. Fatty infiltration of the liver also makes the swollen liver friable and prone to injury during retraction. Previous surgery can alter anatomy and be problematic.

Perspective

See Table 5.1. Laparoscopic adjustable gastric banding is an elective procedure almost exclusively used for treating morbid obesity. The procedure is often technically straightforward, if somewhat challenging, and the complication rate is often determined by the degree of obesity and coexistence of other underlying risk factors such as smoking, diabetes, pulmonary disease, and cardiovascular disease. The success in reducing obesity is well established, with the majority of patients maintaining >60 % excess weight loss (EWL) for 5 years or longer. Both the success and the complication rates are closely related to patient selection. Major problems include wound infection of port sites or the implanted reservoir, atelectasis and pneumonia,

Table 5.1 Laparoscopic adjustable gastric banding complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	1–5 %
Intra-abdominal (including subphrenic abscess)	0.1–1 %
Intrathoracic (pneumonia, pleural, mediastinitis)	0.1–1 %
Systemic	0.1–1 %
Late – postsplenectomy sepsis (vaccination)	<0.1 %
Bleeding and hematoma formation[a]	1–5 %
Conversion to open operation	1–5 %
Diarrhea	1–5 %
Symmetrical pouch dilatation	
Adults	1–5 %
Adolescents	5–20 %
Band slippage	1–5 %
Port complications (leakage, migration, tube kink)	1–5 %
Bolus obstruction (serious, requiring removal)	1–5 %
Dysphagia or pseudo-achalasia	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Failure of suture/staple line/band	1–5 %
Failure to control excessive weight	1–5 %
Delayed gastric (distal) emptying	1–5 %
Inability to vomit or belch	1–5 %
Gas bloat syndrome	1–5 %
Repeated vomiting	1–5 %
Rare significant/serious problems	
Pneumothorax	0.1–1 %
Myocardial ischemia/infarction	0.1–1 %
Gas embolus	0.1–1 %
Diaphragmatic injury/hernia	0.1–1 %
Ulceration stomal/esophageal/gastric/duodenal (early or late)	0.1–1 %
Gastric/esophageal/bowel injury or ischemia (devascularization)/perforation	0.1–1 %
Gastric erosion	0.1–1 %
Pancreatic/liver injury	0.1–1 %
Gastro-cutaneous fistula	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
[Adhesion formation]	
Deep venous thrombosis and pulmonary embolism	0.1–1 %
Splenic injury[a]	0.1–1 %
Conservation (consequent limitation to activity, late rupture)	
Splenectomy	
Extrusion of band +/− ulceration	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption	0.1–1 %
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %

Table 5.1 (continued)

Complications, risks, and consequences	Estimated frequency
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	0.1–1 %
Abdominal distention (acute or chronic)/excessive flatus	1–5 %
Intolerance of large meals (necessity for small meals)[a]	>80 %
Surgical emphysema	1–5 %
Seroma formation	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	0.1–1 %
Port site herniae	0.1–1 %

[a]Dependent on underlying pathology, anatomy, patient selection, surgical technique, and preferences

injury to other abdominal organs, conversion to open operation, venous thromboembolism, band erosion and slippage, stomal ulceration and bleeding, bolus obstruction or stomal stenosis, dysphagia, and inability to eat.

Major Complications/Consequences

The major complications occurring after laparoscopic gastric banding are symmetrical pouch dilatation (more commonly in adolescents than adults), band slippage, and port complications (leakage, migration, tube kinking). Gastric erosion from the band is rare. Wound infection of port sites or implanted reservoir, chest infection, or intra-abdominal infection are relatively rare but can be serious. Gastric or esophageal perforation and leakage is very unusual and is usually diagnosed on routine contrast radiography on the first postoperative day. Systemic infection and multisystem organ failure may then ensue and is the major cause of mortality when it occurs. Possible conversion to open operation is important to warn the patient about. Bleeding is rarely severe and usually controlled at surgery. Failure of "stomal" function can occur. Occasionally mechanical obstruction needs to be excluded from edema, malpositioning, kinking, or insufficient stoma opening size due to cuff overinflation or symmetrical pouch dilatation patient overeating. Usually, improved function of the proximal pouch occurs after a period of weeks following band deflation and can be shown on subsequent contrast swallow. If it persists, however, laparoscopic repositioning or replacement of the band into a more proximal position is required. Bolus obstruction is not uncommon, with or without stomal stenosis, but usually responds to band deflation, but rarely may require endoscopy for removal of the bolus material. Stomal ulceration may occasionally cause bleeding. Erosion of the band material through the stomach wall is reported but is rarely serious, and the eroded band can be removed endoscopically, if the buckle lies intragastrically, or otherwise dealt with laparoscopically. Reservoir displacement or malfunction, tube kinkage, or

leakage from the band or port may require revisional surgery. Splenectomy may be necessary from injury in <1 % of cases. Gas embolus or major vascular or bowel injury are additional serious, although very rare, complications of the laparoscopic approach. Venous thromboembolism is a serious and potentially lethal complication, which is related to obesity and surgery, but appears to be no more common in patients having laparoscopic band surgery than any other form of laparoscopic surgery.

Consent and Risk Reduction

Main Points to Explain

- Infection (including peritonitis)
- Bleeding
- Respiratory infection
- Laparoscopic complications
- Conversion to open surgery
- Long-term banding problems
- Band may require removal
- Further surgery
- Risks without surgery

Open Gastric Bypass

Description

General anesthesia is used. Open gastric bypass surgery is principally for elective reduction of weight in the morbidly obese patient. A midline incision is usually used. The aim of open gastric bypass surgery is to provide a smaller gastric pouch for food in the stomach, promoting early satiety, and to provide a bypass for food from the stomach directly to the more distal small bowel. The absorptive capacity for nutrients (predominantly fat malabsorption) causes steatorrhea which, in addition to weight loss, further discourages intake of fatty foods. The procedure utilizes a linear stapler to create a small proximal gastric pouch (or more recently a divided gastroplasty), to which a Roux-en-Y reconstruction is anastomosed, bypassing the distal stomach, duodenum, and upper small bowel, leaving biliary and pancreatic drainage unchanged. Open gastric bypass is gradually being replaced by laparoscopic methods (see below) in many centers. Patient selection and support is especially important for the success of obesity surgery. The abdominal wall is mass-closed, the subcutaneous tissues closed with absorbable interrupted sutures and the skin closed using continuous subcuticular sutures. Wound drain tubes are used according to surgical preference.

Anatomical Points

The anatomy is essentially fairly constant; however, the obese physique both inside and outside of the abdominal muscle wall can make accessibility problematic. Occasionally, the presence of a shorter mesentery or adhesions may make it difficult for the Roux limb to reach the proximal gastric pouch. When the left lobe of the liver is large and bulky, it can obscure vision. Previous surgery can make further surgery difficult from adhesions or altered anatomy. Redoing open gastric bypass surgery can be challenging. The colon, small bowel, and omentum may overlie the stomach and make access more difficult. Splenic adhesions may restrict mobilization of the stomach and increase risk of splenic injury. Although these organs are at risk, generally these can be readily displaced to enable the procedure to be performed safely. The most dangerous stage of the procedure is creation of the posterior gastric window, as damage and leakage to the proximal stomach, cardia, or esophagus can be difficult to repair and possibly only dealt with by drainage.

Perspective

See Table 5.2. Gastric bypass is an elective procedure almost exclusively for treating morbid obesity. The procedure is often technically straightforward, if somewhat challenging, and the complication rate is usually determined by the degree of

Table 5.2 Open gastric bypass complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	5–20 %
Intra-abdominal (including subphrenic abscess)	1–5 %
Intrathoracic (pneumonia, pleural, mediastinitis)	5–20 %
Systemic	0.1–1 %
Late – postsplenectomy sepsis (vaccination)	<0.1 %
Bleeding and hematoma formation[a]	1–5 %
Diarrhea	20–50 %
Bolus obstruction (serious, requiring removal)	1–5 %
Dysphagia or pseudo-achalasia	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Failure of suture/staple line/small bowel anastomotic leakage	1–5 %
Failure to control excessive weight	1–5 %
Delayed neo-gastric emptying	20–50 %
Inability to vomit or belch	5–20 %
Gas bloat syndrome	1–5 %
Repeated vomiting	1–5 %

(continued)

Table 5.2 (continued)

Complications, risks, and consequences	Estimated frequency
Nutritional deficiency – anemia, B12 malabsorption	1–5 %
Dumping syndrome	1–5 %
Early dumping (vasomotor)	
Late dumping (osmotic, insulin surge)	
Stomal stenosis	5–20 %
Stomal dilatation (widening)	5–20 %
Pouch gastritis	1–5 %
Pouch dilatation	1–5 %
Rare significant/serious problems	
Stomal ulceration	0.1–1 %
Pneumothorax	0.1–1 %
Myocardial ischemia/infarction	0.1–1 %
Diaphragmatic injury/hernia	0.1–1 %
Gastric/esophageal/bowel injury or ischemia (devascularization)/perforation	0.1–1 %
Pancreatic/liver injury	0.1–1 %
Gastro-cutaneous fistula	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
[Adhesion formation]	
Deep venous thrombosis and pulmonary embolism	0.1–1 %
Splenic injury[a]	0.1–1 %
Conservation (consequent limitation to activity, late rupture)	
Splenectomy	
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Complications with extensive (massive diversion) bypass procedures	
Electrolyte imbalance	1–5 %
Bypass enteritis	1–5 %
Nephrolithiasis	1–5 %
Abnormal liver function tests	5–20 %
Hepatic failure	0.1–1 %
Transient hair loss	50–80 %
Postural hypotension	20–50 %
Migratory polyarthritis	5–20 %
Bone disease	5–20 %
Cholelithiasis	20–50 %
Sensitivity to cold	5–20 %
Anemia	1–5 %
Mild malnutrition (vitamin, protein, calorie, fatty acid)	5–20 %
Severe malnutrition (including encephalopathy)	1–5 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Abdominal distention (acute or chronic)/excessive flatus	1–5 %

Table 5.2 (continued)

Complications, risks, and consequences	Estimated frequency
Intolerance of large meals (necessity for small meals)[a]	>80
Seroma formation	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia (delayed heavy lifting/straining for 8/52)	0.1–1 %
Nasogastric tube[a]	50–80 %
Wound drain tube(s)[a]	>80

[a]Dependent on underlying pathology, anatomy, patient selection, surgical technique, and preferences

obesity and any and coexistence of other underlying risk factors, such as smoking, diabetes, pulmonary disease, and cardiovascular disease. The success in reducing obesity is variable, and failure rates are well reported. Both the success and the complication rates are closely related to patient selection. The incidence of nutritionally related complications increases proportionally with the amount of the small bowel that is bypassed. For instance, hepatic dysfunction, renal and biliary calculi, and malnutrition are more common with more extensive small intestinal bypass. Major problems include wound infection and dehiscence, atelectasis and pneumonia, injury to other abdominal organs, anastomotic leakage and intra-abdominal infection, venous thromboembolism, stomal ulceration and bleeding, bolus obstruction or stomal stenosis, pouch or stomal dilatation, dysphagia, and inability to eat and rarely systemic infection, multisystem failure, and death.

Major Complications/Consequences

The major complications occurring after open gastric bypass are wound infection, chest infection, or intra-abdominal infection. These can be serious. Anastomotic leakage occurs in up to 5 % of cases but is usually recognized on the ubiquitous postoperative contrast follow-through – provided the radiologist examines both the gastrojejunostomy and the enteroenterostomy more distally. Leakage may be dealt with in many instances using the drains inserted at the time of initial surgery; however, re-laparotomy is required for unremitting sepsis. Small bowel obstruction occurs in about 1–5 % of cases. If this occurs early, it is generally at the enteroenterostomy; if late, it is generally a distal SBO. Bleeding is rarely severe and usually controlled at surgery. Failure of stomal function can occur. Occasionally mechanical obstruction needs to be excluded from edema, malpositioning, kinking, improper stapling, or insufficient stoma opening size. Usually, improved stomal function occurs after a period of days but can occasionally take weeks. Anastomotic stenosis can occur (early or late) and dilatation or refashioning may be required. Bolus obstruction is not uncommon, early or later, with or without stomal stenosis, and may require endoscopy or rarely further surgery for removal of the bolus material. Stomal ulceration may occasionally cause very significant bleeding. Stomal dilatation or pouch dilatation can occur and can reduce the effectiveness of the procedure. Depending on the method, erosion of any

Consent and Risk Reduction

Main Points to Explain

- Infection (including peritonitis)
- Bleeding
- Respiratory infection
- Anastomotic leakage
- Long-term bypass problems
- Further surgery
- Risks without surgery

permanent sutures or other foreign material can occur. Nutritional abnormalities may be significant due to the induced malabsorption, and longer-term monitoring for these is usually required. Splenectomy may be necessary from injury during retraction in somewhere <1 % of cases. Venous thromboembolism is a serious and potentially lethal complication, which is more common in obese patients having surgery.

Laparoscopic Gastric Bypass

Description

Laparoscopic gastric bypass surgery is principally for elective reduction of weight in the morbidly obese patient. The patient is usually positioned supine and the number and sites of ports are placed according to surgical preference and accessibility. The aim of laparoscopic gastric bypass surgery is to provide a smaller gastric pouch for food in the stomach, thereby promoting early satiety, and to provide a bypass for food from the stomach directly to the more distal small bowel, reducing the capacity for absorption of nutrients, causing weight loss. The procedure utilizes a linear stapler to create a small pouch in (or divide) the upper stomach fundus, to which a small bowel loop or Roux-en-Y reconstruction tube is anastomosed, bypassing the distal stomach, duodenum, and upper small bowel, leaving biliary and pancreatic drainage unchanged. Patient selection and support is especially important for the success of obesity surgery. The port sites are closed using deep muscle sutures where required and skin sutures, staples, or tape.

Anatomical Points

The anatomy is essentially fairly constant; however, the obese physique both inside and outside of the abdominal muscle wall can make accessibility problematic.

The laparoscopic approach is perhaps less affected by limitations posed by obese tissues. Occasionally, the presence of a shorter mesentery or adhesions may make the raising of the small bowel more difficult. When the left lobe of the liver is large and bulky, it can obscure vision. Previous surgery can make further surgery difficult from adhesions or altered anatomy. Repeat laparoscopic gastric bypass surgery can be challenging. The colon, small bowel, and omentum may overlie the stomach and make access more difficult. Splenic adhesions may restrict mobilization of the stomach and increase risk of splenic injury. Although these organs are at risk, generally these can be readily displaced to enable the procedure to be performed safely.

Perspective

See Table 5.3. Laparoscopic surgery is being increasingly utilized to replace open surgery for primary gastric bypass surgery. Clearly, there are advantages

Table 5.3 Laparoscopic gastric bypass complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Subcutaneous/wound	5–20 %
Intra-abdominal (including subphrenic abscess)	1–5 %
Intrathoracic (pneumonia, pleural, mediastinitis)	5–20 %
Systemic	0.1–1 %
Late – postsplenectomy sepsis (vaccination)	<0.1 %
Bleeding and hematoma formation[a]	1–5 %
Conversion to open operation	1–5 %
Diarrhea	20–50 %
Bolus obstruction (serious, requiring removal)	1–5 %
Dysphagia or pseudo-achalasia	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Failure of suture/staple line/small bowel anastomotic leakage	1–5 %
Failure to control excessive weight	1–5 %
Delayed neo-gastric emptying	20–50 %
Inability to vomit or belch	5–20 %
Gas bloat syndrome	1–5 %
Repeated vomiting	1–5 %
Nutritional deficiency – anemia, B12 malabsorption	1–5 %
Dumping syndrome	1–5 %
Early dumping (vasomotor)	
Late dumping (osmotic, insulin surge)	
Stomal stenosis	5–20 %
Stomal dilatation (widening)	5–20 %
Pouch gastritis	1–5 %
Pouch dilatation	1–5 %
Excessive flatus	1–5 %

(continued)

Table 5.3 (continued)

Complications, risks, and consequences	Estimated frequency
Rare significant/serious problems	
Stomal ulceration	0.1–1 %
Pneumothorax	0.1–1 %
Myocardial ischemia/infarction	0.1–1 %
Gas embolus	0.1–1 %
Diaphragmatic injury/hernia	0.1–1 %
Gastric/esophageal/bowel injury or ischemia (devascularization)/perforation	0.1–1 %
Pancreatic/liver injury	0.1–1 %
Gastro-cutaneous fistula	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
[Adhesion formation]	
Deep venous thrombosis and pulmonary embolism	0.1–1 %
Splenic injury[a]	0.1–1 %
Conservation (consequent limitation to activity, late rupture)	
Splenectomy	
Multisystem failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Complications with extensive (massive diversion) bypass procedures	
Electrolyte imbalance	1–5 %
Bypass enteritis	1–5 %
Nephrolithiasis	1–5 %
Abnormal liver function tests	5–20 %
Hepatic failure	0.1–1 %
Transient hair loss	50–80 %
Postural hypotension	20–50 %
Migratory polyarthritis	5–20 %
Bone disease	5–20 %
Cholelithiasis	20–50 %
Sensitivity to cold	5–20 %
Anemia	1–5 %
Mild malnutrition (vitamin, protein, calorie, fatty acid)	5–20 %
Severe malnutrition (including encephalopathy)	1–5 %
Less serious complications	
Pain/tenderness (rib pain (sternal retractor), wound pain)	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Surgical emphysema	1–5 %
Abdominal distention (acute or chronic)/excessive flatus	1–5 %
Intolerance of large meals (necessity for small meals)[a]	>80 %
Seroma formation	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Port site herniae	0.1–1 %
Nasogastric tube[a]	50–80 %
Wound drain tube(s)[a]	>80 %

[a]Dependent on underlying pathology, anatomy, patient selection, surgical technique, and preferences

in the laparoscopic over the open approach but also the specific risks of laparoscopy. Laparoscopic gastric bypass is an elective procedure almost exclusively for treating morbid obesity. The procedure is often technically straightforward, if somewhat challenging, and the complication rate is usually determined by the degree of obesity and any and coexistence of other underlying risk factors such as smoking, diabetes, pulmonary disease, and cardiovascular disease. The success in reducing obesity is variable, and failure rates are well reported. Both the success and the complication rates are closely related to patient selection. The incidence of nutritionally related complications increases proportionally with the amount of the small bowel that is bypassed. For instance, hepatic dysfunction, renal and biliary calculi, and malnutrition are more common with more extensive small intestinal bypass. Major problems include wound infection of port sites or the implanted reservoir, atelectasis and pneumonia, injury to other abdominal organs, conversion to open operation, anastomotic leakage and intra-abdominal infection, venous thromboembolism, stomal ulceration and bleeding, bolus obstruction or stomal stenosis, pouch or stomal dilatation, dysphagia, and inability to eat and rarely systemic infection, multisystem failure, and death.

Major Complications/Consequences

The major complications occurring after laparoscopic gastric bypass are wound infection of port sites, chest infection, or intra-abdominal infection. These can be serious. Anastomotic leakage is unusual but can be catastrophic if it is considerable and/or undetected. Possible conversion to open operation is important to warn the patient about. Systemic infection and multisystem failure may then ensue and is the major cause of mortality when it occurs. Bleeding is rarely severe and usually controlled at surgery. Failure of stomal function can occur. Occasionally mechanical obstruction needs to be excluded from edema, malpositioning, kinking, improper stapling, or insufficient stoma opening size. Usually, improved stomal function occurs after a period of days but can occasionally take weeks. Anastomotic stenosis can occur (early or late) and dilatation or refashioning may be required. Bolus obstruction is not uncommon, early or later, with or without stomal stenosis, and may require endoscopy or rarely further surgery for removal of the bolus material. Stomal ulceration may occasionally cause very significant bleeding. Stomal dilatation or pouch dilatation can occur and can reduce the effectiveness of the procedure. Depending on the method, erosion any permanent sutures or other foreign material can occur. Splenectomy may be necessary from injury during retraction in somewhere <1 % of cases. Gas embolus and major vascular or bowel injury are additional serious, although very rare, complications of the laparoscopic approach. Venous thromboembolism is a serious and potentially lethal complication, which is more common in obese patients having surgery.

Consent and Risk Reduction

Main Points to Explain

- Infection (including peritonitis)
- Bleeding
- Respiratory infection
- Laparoscopic complications
- Conversion to open surgery
- Anastomotic leakage
- Long-term bypass problems
- Further surgery, laparotomy
- Risks without surgery

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Chapter 6
Small Bowel Surgery

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General Perspective and Overview

The relative risks and complications increase proportionately according to the site of resection and anastomosis within the small bowel and the underlying disease process. This is principally related to the surgical accessibility, ability to reduce tension, blood supply, risk of tissue injury, hematoma formation, and technical ease of achieving anastomosis. Risk of small bowel anastomotic leakage and failure is far less than that experienced with large bowel anastomoses, especially rectal.

Serosal tears may be recognized by the "stripe" sign indicating the exposure of the underlying smooth muscle, which should be repaired transversely with continuous monofilament absorbable suture to reduce risk of full-thickness perforation occurring. Excision of any necrotic or frayed tissue is usually prudent.

The main serious complication is **anastomotic leakage,** which can be minimized by adequate mobilization, reduction of tension, and ensuring satisfactory blood supply to the bowel. Avoidance of twisting or obstruction of bowel, either at the anastomosis or at the ileostomy, is imperative. Anastomotic leakage is associated with infection and may lead to **abscess formation**, **peritonitis,** and **systemic sepsis**. **Multisystem failure** and **death** remain serious potential complications of small bowel surgery and systemic infection. Multiple anastomoses, Crohn's disease,

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established infection, and preexisting malnutrition are associated with increased risk of anastomotic leakage. **Hematoma formation** may arise from mesenteric vessel oozing, and this may predispose to infection.

Risk of inadvertent **small bowel perforation** is higher when division of multiple dense adhesions is performed, and is particularly increased with long, tedious operations where fatigue may occur and in laparoscopic division of adhesions in patients having had a previous laparotomy. If leakage of small bowel content is not noticed at the time of the initial surgery, infection and peritonitis will supervene, requiring early re-laparotomy, associated with increased risk of abscess formation and multisystem organ failure and mortality. In this setting resection of the injured bowel is recommended and stoma formation, either ileostomy or jejunostomy, rather than an anastomosis or suture repair. Established intraperitoneal infection, severe bowel edema from chronic obstruction, and attenuated, ischemic bowel are other examples where anastomosis may be less advisable. Stomas are associated with separate complications also.

Removal of a large length of small bowel may predispose to malabsorption and may be associated with more **frequent bowel actions and reduced control**, all of which may recover partially or completely over the months postoperatively: however, some patients are left with long-standing problems of the short bowel (gut) syndrome.

Positioning on the operating table has been associated with increased risk of **deep venous thrombosis** and **nerve palsies**, especially in prolonged procedures.

Possible reduction in the risk of misunderstandings over complications or consequences from small bowel surgery might be achieved by:

- Good explanation of the risks, aims, benefits, and limitations of the procedure(s)
- Useful planning considering the anatomy, approach, alternatives, and method
- Avoiding likely associated vessels and nerves
- Adequate clinical follow-up

With these factors and facts in mind, the information given in this chapter must be appropriately and discernibly interpreted and used.

Important Note

It should be emphasized that the risks and frequencies that are given here *represent derived figures*. These *figures are best estimates of relative frequencies across most institutions*, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities and different surgeons. In addition, the risks of complications in lower- or higher-risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient and staff or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedures or surgical approaches. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

For risks and complications associated with other procedures, see the relevant chapter.

Open (Feeding) Jejunostomy

Description

General anesthesia is usually used, but in high-risk patients, local anesthesia infiltration may sometimes be used. Jejunostomy is often performed for postoperative feeding as an intraoperative procedure. The aim is to establish a portal to the small bowel from the exterior. The most common procedure today is to make a small upper midline incision and identify a loop of the proximal small bowel that can easily be brought up to meet the anterior abdominal wall. A large-bore (20–24 FrG) Foley balloon catheter is inserted through a separate abdominal wall incision several centimeters lateral to the midline incision. A nonabsorbable purse-string suture is inserted into the anterior wall of the small bowel, and the Foley catheter is inserted into the bowel through a stab wound in the middle of the purse string. The balloon is inflated with about 5–10 ml of saline. The purse string is tightened and tied around the catheter. The small bowel is brought into apposition with the inside of the anterior abdominal wall by gentle traction on the catheter. Sutures are then placed to hold the bowel to the exit point of the catheter on the inside of the abdominal wall, and the Foley catheter is secured into position against the skin. Alternative catheters, with or without a balloon, can be used in different ways, but the principle is essentially the same.

Anatomical Points

The colon, stomach, liver, and omentum may overlie the small bowel and make access difficult. Although these organs are at risk, generally these can be displaced to enable the procedure to be performed. Pectus excavatum or other deformities, including obesity, may also make the procedure more challenging.

Perspective

See Table 6.1. Jejunostomy is used for feeding, drainage, or both. Open jejunostomies are frequently used today for enteral feeding as part of major abdominal surgical procedures, especially upper gastrointestinal or hepatobiliary procedures where oral feeding may be delayed.

Table 6.1 Open (feeding) jejunostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection	
Wound[a]	5–20 %
Subcutaneous cellulitis; abscess[a]	1–5 %
Intraperitoneal	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation	1–5 %
Jejunal leakage	1–5 %
Jejunal fistula (after removal of tube)	1–5 %
Tube dislodgement (internalization or extraction)[a]	1–5 %
Paralytic ileus	1–5 %
Rare significant/serious problems	
Discharging abscess sinus	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Less serious complications	
Gastroesophageal reflux (feed induced)	5–20 %
Hernia formation (incisional)	0.1–1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

Major Complications

Occasionally, the balloon of a Foley catheter may migrate distally and can lead to s**mall bowel obstruction**. Separation of the small bowel from the anterior abdominal wall may result in **intraperitoneal leakage** of intestinal contents and peritonitis, with or without abscess formation or generalized sepsis. **Pressure necrosis** of the bowel against the catheter balloon and free **perforation** are rare. The most frequent complication, however, occurs around the exit of the catheter where **minor infection and excoriation** are very common. Associated **abscess formation** is not uncommon. **Systemic sepsis** is infrequent but may be severe, often related to the underlying condition(s), and can lead to death.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Further surgery

Small Bowel Adhesion Surgery (Without Resection) Division of Small Bowel Band Adhesion(s) (Including Division of Complex Adhesions)

Description

General anesthesia is used. The patient may be positioned supine or in the modified Lloyd-Davies position, with a urinary catheter in the bladder.

The objective of the procedure is to divide the adhesion(s) responsible for the surgical indication, nearly always small bowel obstruction. Adhesions can vary from a *single band*, which is usually divided with either the scalpel, diathermy, or dissecting scissors, to *complex adhesions* encasing and joining the bowel and/or other organs.

Previous surgery, inflammation, abscess, irradiation damage, or the presence of mesh often adds complexity. Irrigation and blunt dissection can significantly aid the development of planes between the small bowel serosa and other tissues.

Irrigation using a drawing-up cannula connected to a standard I/V set or the "irrigating" scalpel aids in dissection by creating a plane of "edema" around the small bowel and washing away any blood or fluid, making the dissection of adhesions easier. Alternatively injection of saline with a hypodermic syringe has similar benefits. Judicious use of the diathermy at a low setting has a similar effect with heat and fumes generated, opening up the plane for dissection

Peritoneal lavage with warm saline is performed to remove debris and contamination. Serosal tears may be recognized by the "stripe" sign indicating the exposure of the underlying smooth muscle bands, which should be repaired transversely with continuous monofilament absorbable suture before full-thickness perforation occurs. Excision any necrotic or frayed tissue is usually prudent.

Anatomical Points

There are few congenital abnormalities that change the anatomy of the small bowel except Merkel's diverticulum, malrotation, and the presence of Ladd's bands in the right upper quadrant. The major variation that is relevant in this operation is the site and extent of the adhesions.

Perspective

See Table 6.2. This operation can be one of the most demanding in general surgery, particularly when dealing with multiple adhesions, especially those associated with

Table 6.2 Small bowel adhesion surgery (without resection) and division of small bowel band adhesion(s) (including division of complex adhesions) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Paralytic ileus[a]	50–80 %
Bowel perforation (sometimes multiple)[a]	1–5 %
Small bowel fistulae[a]	1–5 %
Intolerance of large meals (necessity for small frequent meals)[a]	20–50 %
Rare significant/serious problems	
Possibility of ileostomy/colostomy[a]	0.1–1 %
Recurrent small bowel obstruction (early or late)[a] [ischemic stenosis/ adhesion re-formation]	0.1–1 %
Diarrhea	0.1–1 %
Nutritional deficiency[a] – anemia, B12 malabsorption[a]	0.1–1 %
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Seroma formation	0.1–1 %
Wound dehiscence[a]	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

irradiation, abscesses, or mesh. The ultimate objective is to divide all adhesions without sustaining injury to the small bowel or other organs. Breaches of the serosa are not uncommon, and full thickness (enterotomy) may occur in up to 40 % of cases with dense adhesions. Serosal tears may be repaired with interrupted monofilament absorbable material. Resection of a damaged small bowel segment may be necessary. The operation notes should include a diagram of the sites of enterotomies and resection lengths measured from the duodenal-jejunal (DJ) flexure. The consequences of enterotomy are significant and include wound infection, wound dehiscence, small bowel obstruction, intra-abdominal abscess, intra-abdominal leak, perforation of small bowel content with generalized peritonitis, and enterocutaneous fistula.

Major Complications

The main complications arise from **perforation**, either concealed or revealed, occurring during division of adhesions. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be serious sometimes leading to **multisystem organ failure. Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can recur and may be a repetitive, monotonous problem, requiring much hospitalization and surgery.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of ileostomy
- Risk of organ injury
- Risk of further surgery

Resection of Small Bowel (with Primary Anastomosis)

Description

General anesthesia is used. Patient may be positioned, with a urinary catheter, supine or in the modified Lloyd-Davies position to provide better access for the scrub nurse or for the surgeon in accessing the left upper quadrant of the stomach. If irrigation is being used to aid in the dissection, then a plastic incisive drape combined with adhesive irrigation bags is useful.

If this is "redo" or reentry surgery, access is best achieved by also extending the incision above/below the existing scar into the "virgin" abdominal wall. The old scar should be excised. Entry to the abdominal cavity should be by careful dissection with combination of sharp dissection and irrigation or diathermy.

The objective of the operation is to perform a resection of the small bowel with end-to-end anastomosis. A good arterial blood supply in both bowel ends is essential before attempting an anastomosis. Single- or double-layer continuous techniques using monofilament absorbable suture material are usually used. Stapling techniques have become popular using a combination of the GIA stapler and linear cutter performing a functional end-to-end (or end-side or side-side) anastomosis.

The most common indications are for multiple adhesions and for ischemic segments from band adhesions. The position(s) of small bowel anastomosis from the DJ flexure and/or ileocecal valve should be measured with a sterile ruler and clearly documented in the operation notes with a diagram.

Contraindications to anastomosis such as intra-abdominal sepsis, significant medical comorbidities, or risk factors reducing wound healing make an ileostomy and mucous fistula preferable, often through the same stomal aperture. Serosal tears may be recognized by the "stripe" sign indicating the exposure of the underlying smooth muscle bands, which should be repaired transversely with continuous monofilament absorbable suture before full-thickness perforation occurs. Excision of any necrotic or frayed tissue is usually prudent.

Anatomical Points

There are a few anatomical points that affect the small bowel except for Meckel's diverticulum, malrotation of the cecum, and Ladd's bands. Situs abdominus inversus is very rare.

Perspective

See Table 6.3. The complications of this operation often depend on the initial pathology for which the procedure was performed. The most serious complication being anastomotic leakage, the risk of which is increased by distal obstruction, often caused by distal adhesions, hence the need to dissect all adhesions from the DJ flexure to the ileocecal valve. The consequence of an anastomotic leakage is contamination of the peritoneal cavity, leading to generalized peritonitis or intra-abdominal abscess formation, typically in the paracolic gutters, pelvis, or the subphrenic spaces. Anastomotic leakages are reduced, by ensuring good blood supply to the bowel ends, no tension, and no factors contraindicating an anastomosis. Wound infection, small bowel obstruction, and enterocutaneous fistula are significant but fortunately uncommon complications.

Major Complications

The main complications arise from **perforation**, either concealed or revealed, occurring during division of adhesions/bowel resection. Anastomotic leakage is a serious complication and may lead to generalized or localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be serious sometimes leading to **multisystem organ failure** and is the main cause of

Table 6.3 Resection of small bowel (with primary anastomosis) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Paralytic ileus[a]	50–80 %
Bowel perforation (sometimes multiple)[a]	1–5 %
Intolerance of large meals (necessity for small frequent meals)	20–50 %
Rare significant/serious problems	
Possibility of ileostomy/colostomy (rare)[a]	0.1–1 %
Anastomotic breakdown/leakage	0.1–1 %
Recurrent small bowel obstruction (early or late)[a] [anastomotic stenosis/ischemic stenosis/adhesion re-formation]	0.1–1 %
Diarrhea	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption[a]	0.1–1 %
Short gut syndrome (extensive small bowel resection)[a]	<0.1 %
Pancreatitis/pancreatic injury/pancreatic cyst/leakage/pancreatic fistula	
Unresectability of ischemic/pathological segment	0.1–1 %
Small bowel fistulae[a]	1–5 %
Colonic injury/ischemia/fistula (middle colic arterial injury)[a]	0.1–1 %
Gastric/small bowel ischemia[a] (gastroepiploic, mesenteric arterial injury)	0.1–1 %
Vascular injury	0.1–1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Seroma formation	0.1–1 %
Wound dehiscence	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

death when it occurs. **Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can recur and may be a repetitive, monotonous problem, requiring much hospitalization and surgery.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of ileostomy
- Risk of organ injury
- Risk of further surgery

Resection of Small Bowel (Without Primary Anastomosis) Ileostomy and Mucous Fistula

Description

General anesthesia is used. Preoperative counselling and siting with a stomal therapist is desirable. Positioning may be supine or in the modified Lloyd-Davies position with a urinary catheter to provide better access for the scrub nurse or for the surgeon in accessing the left upper abdominal quadrant.

If irrigation is being used to aid in the dissection, then a plastic incisive drape combined with adhesive irrigation bags is useful.

If this is "redo" or "reentry" surgery, access is best achieved by also extending the incision above/below the existing scar into the "virgin" abdominal wall. The old scar should be excised. Entry to the abdominal cavity should be by careful dissection with combination of sharp dissection and irrigation or diathermy.

This procedure is often performed where it is unsafe to perform a small bowel anastomosis because of the presence of intra-abdominal sepsis, past irradiation, or mesh or in a patient who has medical comorbidities or other risk factors that reduce wound healing capacity, e.g., diabetes, renal failure, or malnutrition.

The aim therefore is to create a stoma using the proximal end of the small bowel that has been resected and create a mucous fistula of the distal end. This procedure is often performed in the emergency setting. Ideally the stoma should be properly sited preoperatively. In the emergency setting, this is in the horizontal plane 3–4 cm to the right of the umbilicus. The aperture in the skin and the abdominal wall should be adequate so that the proximal small bowel and the distal small bowel can easily be passed through the aperture with their associated mesentery (2–3 finger widths). An end ileostomy with a "spout" of at least 2 cm fashioned using a Brooke technique aids skin protection and bag entry. The distal bowel mucous fistula can be brought out adjacent to the end ileostomy through the same aperture. Stapling the distal end after confirming that it is distal using a linear stapler and suturing the end of the staple line with a monofilament nonabsorbable suture material to the rectus

sheath removes the mucous fistula and allows the whole aperture for the end ileostomy. The site of the stoma and distal bowel length should be measured by sterile ruler and clearly documented using a diagram in the operation notes. The abdominal wall and skin should be closed before fashioning/maturing the stoma to reduce contamination.

Anatomical Points

There are a few anatomical points that affect the small bowel except for Meckel's diverticulum, malrotation of the cecum, and Ladd's bands. A shortened mesentery or severe obesity may make obtaining sufficient SB length difficult for stoma formation. Situs abdominus inversus is very rare.

Perspective

See Table 6.4. Major complications of this operation often relate to complications of the ileostomy. Most serious in the initial postoperative period is ischemia of the stoma, avoided by ensuring good blood supply to the bowel ends, no tension, an adequate aperture, and no factors contraindicating ileostomy. Ischemia and retraction may lead to intraperitoneal leakage and generalized or localized peritonitis and sepsis. The initial pathology for which the procedure was performed and comorbidities often determine complications experienced. Fistula formation occurring in the small bowel proximal to the stoma may create a peristomal abscess, and leakage of small bowel contents into the subcutaneous tissue can be severely problematic.

Longer-term stoma complications include retraction, prolapse, peristomal hernia, and stenosis. Almost all stomas formed eventually develop some form of complication. Persistent proximal or even distal obstruction can be problematic in ensuring stomal function and distal SB drainage, respectively. Stomal skin problems and bag adherence are common issues that are troublesome.

Wound infection, small bowel obstruction, and enterocutaneous fistula are significant but fortunately uncommon complications. Later reversal of the ileostomy may be considered and is usually straightforward, but can be challenging in some situations.

Major Complications

The main complications arise from **perforation**, either concealed or revealed, occurring during division of adhesions/bowel resection. **Stomal ischemia, retraction, and leakage** are serious complications and may lead to generalized or

Table 6.4 Resection of small bowel (without primary anastomosis), ileostomy, and mucous fistula estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	5–20 %
Subcutaneous	5–20 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Paralytic ileus[a]	50–80 %
Bowel perforation (sometimes multiple)[a]	1–5 %
Stomal ulceration	1–5 %
Para-stomal hernia formation	1–5 %
Small bowel fistulae[a]	1–5 %
Intolerance of large meals (necessity for small frequent meals)	20–50 %
Rare significant/serious problems	
Stomal retraction	0.1–1 %
Stomal prolapse	0.1–1 %
Para-stomal fistula formation	0.1–1 %
Stomal stenosis	0.1–1 %
Recurrent small bowel obstruction (early or late)[a] [ischemic stenosis/adhesion formation]	0.1–1 %
Diarrhea	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption[a]	0.1–1 %
Short gut syndrome (extensive small bowel resection)[a]	<0.1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula	<0.1 %
Seroma formation	0.1–1 %
Colonic injury/ischemia/fistula (middle colic arterial injury)[a]	0.1–1 %
Gastric/small bowel ischemia[a] (gastroepiploic, mesenteric arterial injury)	0.1–1 %
Vascular injury	0.1–1 %
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound dehiscence	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining for 6–8 weeks)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be serious sometimes leading to **multisystem organ failure** and is the main cause of **death** when it occurs. **Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can recur and may be a repetitive, monotonous problem, requiring much hospitalization and surgery. Later ileostomy reversal is associated with risk of obstruction, leakage, and sepsis.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Stomal complications
- Risk of organ injury
- Risk of further surgery

Open Enteroenterostomy (Including Small Bowel Open Palliative Bypass)

Description

General anesthesia is used. Positioning is in the supine or in the modified Lloyd-Davies position with a urinary catheter to provide better access for the scrub nurse or for the surgeon in accessing the left upper abdominal quadrant. If irrigation is being used to aid in the dissection, then a plastic incisive drape combined with adhesive irrigation bags is useful. Often this is "redo" surgery and access is best achieved by also extending the incision above/below the existing scar into the "virgin" abdominal wall. The old scar should be excised. Entry to the abdominal cavity should be by careful dissection with combination of sharp dissection and irrigation or diathermy. The objective of this operation is to perform a bypass usually for a malignant or inflammatory obstruction that is not resectable. For this reason, the proximal bowel is typically dilated and the distal small bowel collapsed. The anastomosis is almost always side to side using longitudinal enterotomies in the proximal and distal bowel, using a single-layer continuous monofilament absorbable suture material alone or with a GIA stapler. It is usual to perform some form of

decompression of the proximal bowel to relieve pressure and allow better approximation – the authors favor either an intercostal thoracic catheter attached to suction with a side hole cut in the catheter to allow decompression with lower pressure suction or a large-bore (16G) needle attached to a 5 ml syringe with plunger removed to take the end of the suction tubing. The tube/needle is moved around to extract gas and fluid and the insertion hole(s) closed with 3/0 monofilament absorbable sutures. Serosal tears may be recognized by the "stripe" sign indicating the exposure of the underlying smooth muscle bands, which should be repaired transversely with continuous monofilament absorbable suture before full-thickness perforation occurs. Excision any necrotic or frayed tissue is usually prudent.

Anatomical Points

There are a few anatomical points that affect the small bowel except for Meckel's diverticulum, malrotation of the cecum, and Ladd's bands. Situs abdominus inversus is very rare. Previous surgery and the underlying pathology, causing acquired anatomical distortion or modification, largely determine the technical difficulties encountered.

Perspective

See Table 6.5. The aim of this operation is often palliative to relieve small bowel obstruction in a patient who has disseminated intra-abdominal malignancy and a poor prognosis, usually with an expected median survival of some 3–9 months. The patients are often malnourished or have other medical comorbidities that mitigate against good wound healing. Consequently wound infection, wound dehiscence, small bowel obstruction, anastomotic leakage, and enterocutaneous fistula are more common than in healthier patients. Sometimes the procedure does not alleviate the obstructive problem. Occasionally, the palliation is remarkably good with return of good levels of functioning and improved quality of life. Sometimes the procedure is therapeutic, especially in the high-anesthetic-risk patient with benign very dense adhesions or indeterminate mass, where an expedient operation may assist. Repeat surgery is sometimes indicated in some settings.

Major Complications

The main complications arise from **perforation**, either concealed or revealed, occurring during division of adhesions/bowel resection or from the anastomosis. **Anastomotic leakage** is a serious complication and may lead to generalized or

Table 6.5 Open enteroenterostomy (including small bowel open palliative bypass) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Paralytic ileus[a]	50–80 %
Bowel perforation (sometimes multiple)[a]	1–5 %
Small bowel fistulae[a]	1–5 %
Intolerance of large meals (necessity for small frequent meals)	20–50 %
Rare significant/serious problems	
Small bowel obstruction (early or late)[a] [anastomotic stenosis/ischemic stenosis/adhesion formation]	0.1–1 %
Anastomotic breakdown/leakage	0.1–1 %
Possibility of colostomy/ileostomy (rare)[a]	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/leakage/pancreatic fistula	
Diarrhea	0.1–1 %
Seroma formation	0.1–1 %
Colonic injury/ischemia/fistula (middle colic arterial injury)[a]	0.1–1 %
Gastric/small bowel ischemia[a] (gastroepiploic, mesenteric arterial injury)	0.1–1 %
Vascular injury	0.1–1 %
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound dehiscence	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be serious sometimes leading to **multisystem organ failure** and is the main cause of **death** when it occurs. **Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can recur and may be a repetitive, monotonous problem, requiring much hospitalization and even further surgery.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of ileostomy
- Risk of organ injury
- Risk of further surgery

Laparoscopic Enteroenterostomy

Description

General anesthesia is used. Laparoscopic procedures have assumed an important place in intestinal bypass and are being developed continually. Positioning is in the supine or in the modified Lloyd-Davies position with a urinary catheter to provide better access for the scrub nurse or for the surgeon in accessing the left upper abdominal quadrant. Entry to the abdominal cavity should be by careful open cutdown to avoid vascular or bowel injury. The objective of this operation is to perform a bypass for either malignant or inflammatory obstruction that is not resectable. For this reason, the proximal bowel is typically dilated and the distal small bowel collapsed. The anastomosis is almost always side to side using longitudinal enterotomies in the proximal and distal bowel, using a single-layer continuous monofilament absorbable suture material alone or with a stapler. It is usual to perform some form of decompression of the proximal bowel to relieve pressure and allow better approximation which can be by preoperative suction and/or intraoperative needle puncture. Serosal tears may be recognized by the "stripe" sign indicating the exposure of the underlying smooth muscle bands, which should be repaired transversely with continuous monofilament absorbable suture before full-thickness perforation occurs. Excision any necrotic or frayed tissue is usually prudent.

Anatomical Points

There are a few anatomical points that affect the small bowel except for Meckel's diverticulum, malrotation of the cecum, and Ladd's bands. Situs abdominus inversus is very rare. Previous surgery and the underlying pathology, causing acquired anatomical distortion or modification, largely determine the technical difficulties encountered.

Perspective

See Table 6.6. The aim of this operation is often palliative to relieve small bowel obstruction in a patient who has disseminated intra-abdominal malignancy and a poor prognosis, usually with an expected median survival of some 3–9 months.

Table 6.6 Laparoscopic enteroenterostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Port site	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Conversion to open operation	1–5 %
Paralytic ileus[a]	50–80 %
Small bowel fistulae[a]	1–5 %
Intolerance of large meals (necessity for small frequent meals)	20–50 %
Rare significant/serious problems	
Injury to the bowel or blood vessels (trochar or diathermy)	0.1–1 %
Gas embolus	0.1–1 %
Port site hernia formation	0.1–1 %
Small bowel obstruction (early or late)[a] [anastomotic stenosis/ ischemic stenosis/adhesion formation]	0.1–1 %
Possibility of colostomy/ileostomy (rare)[a]	0.1–1 %
Anastomotic breakdown/leakage	0.1–1 %
Diarrhea	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/leakage/pancreatic fistula	
Seroma formation	0.1–1 %
Colonic injury/ischemia/fistula (middle colic arterial injury)[a]	0.1–1 %
Gastric/small bowel ischemia[a]	0.1–1 %
(Gastroepiploic, mesenteric arterial injury)	
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound dehiscence	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

The patients are often malnourished or have other medical comorbidities that mitigate against good wound healing. Consequently wound infection, wound dehiscence, small bowel obstruction, anastomotic leakage, and enterocutaneous fistula are more common than in healthier patients. Sometimes the procedure does not alleviate the obstructive problem. Occasionally, the palliation is remarkably good with return of good levels of functioning and improved quality of life. Sometimes the procedure is therapeutic, especially in the high-anesthetic-risk patient with benign very dense adhesions or indeterminate mass, where an expedient operation may assist. Repeat surgery is sometimes indicated in some settings. Laparoscopic methods carry a range of specific attendant advantages and risks over open techniques.

Major Complications

The main complications arise from **perforation**, either concealed or revealed, occurring during division of adhesions/bowel resection or from the anastomosis. **Anastomotic leakage** is a serious complication and may lead to generalized or localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be serious sometimes leading to **multisystem organ failure** and is the main cause of **death** when it occurs. **Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can recur and may be a repetitive, monotonous problem, requiring much hospitalization and even further surgery. **Gas embolus** and **major vascular or bowel injury** are additional serious, although very rare, complications of the laparoscopic approach.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of ileostomy
- Risk of organ injury
- Gas embolism
- Risk of open operation
- Risk of further surgery

Small Bowel Tumor Resection Surgery

Description

General anesthesia is used. Positioning in the supine or modified Lloyd-Davies position with a urinary catheter may provide better access for the scrub nurse or for the surgeon in accessing the left upper abdominal quadrant. If irrigation is being used to aid in the dissection, then a plastic incisive drape combined with adhesive irrigation bags is useful. If this is "redo" surgery, access is best achieved by also extending the incision above/below the existing scar into the "virgin" abdominal wall. The old scar should be excised. Entry to the abdominal cavity should be by careful dissection with combination of sharp dissection and irrigation or diathermy. The objective of this operation is to perform a resection of the small bowel tumor (usually malignant), the mesentery, and lymph glands and perform an end-to-end anastomosis. Because small bowel tumors often present late with bowel obstruction, there are often many lymph glands involved in the mesentery and the resection often therefore is palliative. In some circumstances a palliative enteroenterostomy may be more appropriate. The length of SB resection depends on mesenteric lymph gland involvement and local invasion. Wedge resection of the tumor and mesentery is sometimes achievable. A good arterial blood supply in both bowel ends is essential before attempting an anastomosis. Single- or double-layer continuous techniques using monofilament absorbable suture material are usually used. Absence of tumor at the margins is imperative. Stapling techniques have become popular using a combination of the GIA stapler and linear cutter performing a functional end-to-end (or end-side or side-side) anastomosis. Good hemostasis, especially of the mesenteric and omental vessels, is essential.

Anatomical Points

There are a few anatomical points that affect the small bowel except for Meckel's diverticulum, malrotation of the cecum, and Ladd's bands. Situs abdominus inversus is very rare. Previous surgery and the underlying pathology, causing acquired anatomical distortion or modification, largely determine the technical difficulties encountered.

Perspective

See Table 6.7. The most serious complication is anastomotic leakage, and this will occur in two situations: the first is where there has been a technical problem, either inadequate blood supply or poor technical anastomotic technique; and the second

Table 6.7 Small bowel tumor resection surgery estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Unresectability of malignancy/involved resection margins[a]	Individual
Tumor recurrence[a]	Individual
Paralytic ileus[a]	50–80 %
Bowel perforation (sometimes multiple)[a]	1–5 %
Small bowel fistulae[a]	1–5 %
Intolerance of large meals (necessity for small frequent meals)	20–50 %
Deep venous thrombosis	1–5 %
Rare significant/serious problems	
Anastomotic breakdown/leakage	0.1–1 %
Possibility of colostomy/ileostomy (rare)[a]	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption[a]	0.1–1 %
Short gut syndrome (extensive small bowel resection)[a]	<0.1
Liver/biliary/bowel/renal/adrenal/diaphragmatic injury[a]	0.1–1 %
Thoracic duct injury (chylous leak, fistula)[a]	<0.1
Diarrhea	0.1–1 %
Splenic injury[a]	0.1–1 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Pancreatitis/pancreatic injury/pancreatic cyst/leakage/pancreatic fistula	
Seroma formation	0.1–1 %
Colonic injury/ischemia/fistula (middle colic arterial injury)[a]	0.1–1 %
Gastric/small bowel ischemia[a] (gastroepiploic, mesenteric arterial injury)	0.1–1 %
Vascular injury	0.1–1 %
Small bowel obstruction (early or late)[a] [anastomotic stenosis/ischemic stenosis/adhesion formation]	0.1–1 %
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80
Chronic (>12 weeks)	1–5 %
Wound dehiscence	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

situation is where the patient has an increased risk of poor wound healing because of either coexisting medical morbidities, e.g., diabetes and/or malnutrition and the patient's other treatment(s), or underlying disease process causing immunosuppression and/or poor wound healing. Wound infection is the most common complication, followed by wound dehiscence or long-term incisional hernia formation. Breakdown of the anastomosis may lead to generalized peritonitis or localized intra-abdominal abscess in either the pericolic gutter, pelvis, or subphrenic space. Severe sepsis may result. Enterocutaneous fistula may also occur.

Major Complications

The main complications arise from **perforation**, either concealed or revealed, occurring during division of adhesions/bowel resection. **Stomal ischemia, retraction, and leakage** are serious complications and may lead to generalized or localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be serious sometimes leading to **multisystem organ failure** and is the main cause of **death** when it occurs. **Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can recur and may be a repetitive, monotonous problem, requiring much hospitalization and surgery. Later ileostomy reversal is associated with risk of obstruction, leakage, and sepsis.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of ileostomy
- Risk of organ injury
- Risk of unresectability
- Risk of tumor recurrence
- Risk of further surgery

Open Ileostomy (End/Loop Ileostomy, Without Resection)

Description

General anesthesia is used. Preoperative counselling and siting with a stomal therapist is desirable. Positioning may be supine or in the modified Lloyd-Davies position with a urinary catheter to provide better access for the scrub nurse or for the surgeon

in accessing the left upper abdominal quadrant. If this is "redo" surgery, access is best achieved by also extending the incision above/below the existing scar into the "virgin" abdominal wall. The old scar should be excised. Entry to the abdominal cavity should be by careful dissection with combination of sharp dissection and irrigation or diathermy. This procedure is relatively rarely performed alone where the small bowel needs to be defunctioned to rest the distal SB or colon or for perianal trauma/sepsis. End ileostomy is more usually performed during colonic/rectal anastomosis for diversion of the fecal stream to reduce stress on the anastomosis. The aim therefore is to create a stoma using a loop of SB or an end ileostomy (+/− a mucous fistula). This procedure may be performed in the emergency setting for local external anal/rectal trauma. Ideally the stoma should be properly sited preoperatively. In the emergency setting this is in the horizontal plane 3–4 cm to the right of the umbilicus. The aperture in the skin and the abdominal wall should be adequate so that the proximal small bowel and the distal small bowel can easily be passed through the aperture with their associated mesentery (2–3 finger widths). An end ileostomy with a "spout" of least 2 cm fashioned using a "Brooke" technique aids skin protection and bag entry. The distal bowel mucous fistula can be brought out adjacent to the end ileostomy through the same aperture. Stapling the distal end after confirming that it is distal using a linear stapler and suturing the end of the staple line with a monofilament nonabsorbable suture material to the rectus sheath removes the mucous fistula and allows the whole aperture for the end ileostomy. The site of the stoma and distal bowel length should be measured by sterile ruler and clearly documented using a diagram in the operation notes. The abdominal wall and skin should be closed before fashioning/maturing the stoma, to reduce contamination. The presence of intra-abdominal sepsis, past irradiation, mesh or in a patient who has medical comorbidities or other risk factors that reduce wound healing capacity, e.g., diabetes, renal failure, or malnutrition is associated with higher risk of complications with the stoma.

Anatomical Points

There are a few anatomical points that affect the small bowel except for Meckel's diverticulum, malrotation of the cecum, and Ladd's bands. A shortened mesentery or severe obesity may make obtaining sufficient SB length difficult for stoma formation. Situs abdominus inversus is very rare.

Perspective

See Table 6.8. Major complications of this operation often relate to complications of the ileostomy. The most serious in the initial postoperative period is ischemia of the stoma, avoided by ensuring good blood supply to the bowel ends, no tension, an adequate aperture, and no factors contraindicating ileostomy. Ischemia and

Table 6.8 Open ileostomy (end/loop ileostomy, without resection) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Stomal ulceration	1–5 %
Para-stomal hernia formation	1–5 %
Electrolyte/fluid disturbance	5–20 %
Diarrhea (longer term)	1–5 %
Nutritional deficiency – anemia, B12 malabsorption[a]	1–5 %
Paralytic ileus[a]	50–80 %
Bowel perforation (sometimes multiple)[a]	1–5 %
Small bowel fistulae[a]	1–5 %
Intolerance of large meals (necessity for small frequent meals) (gastroepiploic, mesenteric arterial injury)	20–50 %
Vascular injury	0.1–1 %
Rare significant/serious problems	
Stomal stenosis/obstruction	0.1–1 %
Stomal retraction	0.1–1 %
Stomal prolapse	0.1–1 %
Para-stomal fistula formation	0.1–1 %
Malpositioning of ileostomy	0.1–1 %
Selection of incorrect limb of loop as distal end[b]	<0.1 %
Pancreatitis/pancreatic injury/pancreatic cyst/leakage/fistula	0.1–1 %
Seroma formation	0.1–1 %
Colonic injury/ischemia/fistula (middle colic arterial injury)[a]	0.1–1 %
Gastric/small bowel ischemia[a]	0.1–1 %
Small bowel obstruction (early or late)[a] [anastomotic stenosis/ischemic stenosis/adhesion formation]	0.1–1 %
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Wound dehiscence	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences
[b]Failure to ensure correct orientation of bowel; surgeon error

retraction may lead to intraperitoneal leakage and generalized or localized peritonitis and sepsis. Tension can be a serious problem in patients with a shorter mesentery or abdominal obesity where obtaining sufficient tension-free length may be difficult. The initial pathology for which the procedure was performed and comorbidities often determine complications experienced.

Fistula formation occurring in the small bowel proximal to the stoma may create a peristomal abscess, and leakage of small bowel contents into the subcutaneous tissue can be severely problematic. Longer-term stoma complications include retraction, prolapse, peristomal hernia, and stenosis. Almost all stomas formed eventually develop some form of complication. Persistent proximal or even distal obstruction can be problematic in ensuring stomal function and distal SB drainage, respectively. Stomal skin problems and bag adherence are common issues that are troublesome. Wound infection, small bowel obstruction, and enterocutaneous fistula are significant but fortunately uncommon complications. Later reversal of the ileostomy may be considered and is usually straightforward, but can be challenging in some situations.

Major Complications

The main complications arise from **perforation**, either concealed or revealed, occurring during division of adhesions/bowel resection/bowel mobilization. **Stomal ischemia, retraction, and leakage** are serious complications and may lead to generalized or localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be serious sometimes leading to **multisystem organ failure. Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can occur and may be a repetitive, monotonous problem, requiring much hospitalization and surgery. Later ileostomy reversal is associated with risk of obstruction, leakage, and sepsis.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Stomal complications
- Risk of organ injury
- Risk of further surgery

Laparoscopic Ileostomy (Loop or End Ileostomy)

Description

General anesthesia is used. Preoperative counselling and siting with a stomal therapist is desirable. Laparoscopic procedures have assumed an important place in intestinal surgery and are being developed continually. Positioning is in the supine or in the modified Lloyd-Davies position with a urinary catheter to provide better access for the scrub nurse or for the surgeon in accessing the left upper abdominal quadrant. Entry to the abdominal cavity should be by careful open cutdown to avoid vascular or bowel injury. This procedure is relatively rarely performed alone, usually for benign diseases, where the small bowel needs to be defunctioned to rest the distal SB or colon or for perianal trauma/sepsis. End ileostomy is more usually performed during laparoscopic colonic/rectal anastomosis for diversion of the fecal stream to reduce stress on the anastomosis. The aim therefore is to create a stoma using a loop of SB or an end ileostomy (+/– a mucous fistula). This procedure may be performed in the emergency setting for local external anal/rectal trauma. Ideally the stoma should be properly sited preoperatively. In the emergency setting this is in the horizontal plane 3–4 cm to the right of the umbilicus. The aperture in the skin and the abdominal wall should be adequate so that the proximal small bowel and the distal small bowel can easily be passed through the aperture with their associated mesentery (2–3 finger widths). An end ileostomy with a "spout" of least 2 cm fashioned using a Brooke technique aids skin protection and bag entry. The distal bowel mucous fistula can be brought out adjacent to the end ileostomy through the same aperture. Stapling the distal end after confirming that it is distal using a linear stapler and suturing the end of the staple line with a monofilament nonabsorbable suture material to the rectus sheath removes the mucous fistula and allows the whole aperture for the end ileostomy. The site of the stoma and distal bowel length should be measured by sterile ruler and clearly documented using a diagram in the operation notes. The abdominal wall and skin should be closed before fashioning/maturing the stoma, to reduce contamination. The presence of intra-abdominal sepsis, past irradiation, mesh or in a patient who has medical comorbidities or other risk factors that reduce wound healing capacity, e.g., diabetes, renal failure, or malnutrition is associated with higher risk of complications with the stoma.

Anatomical Points

There are a few anatomical points that affect the small bowel except for Meckel's diverticulum, malrotation of the cecum, and Ladd's bands. A shortened mesentery or severe obesity may make obtaining sufficient SB length difficult for stoma formation. Adhesions can dictate the ability to perform or difficulty of the laparoscopic approach. Situs abdominus inversus is very rare.

Perspective

See Table 6.9. The procedure is usually easily performed with few complications of note. Major complications of this operation relate primarily to complications of the ileostomy. The most serious in the initial postoperative period is ischemia of the stoma, avoided by ensuring good blood supply to the bowel ends, no tension, an adequate aperture, and no factors contraindicating ileostomy. Ischemia and retraction may lead to intraperitoneal leakage and generalized or localized peritonitis and sepsis. Tension can be a serious problem in patients with a shorter mesentery or abdominal obesity where obtaining sufficient tension-free length may be difficult. The initial pathology for which the procedure was performed and comorbidities often determine complications experienced. Fistula formation occurring in the small bowel proximal to the stoma may create a peristomal abscess and leakage of small bowel contents into the subcutaneous tissue can be severely problematic. Longer-term stoma complications include retraction, prolapse, peristomal hernia, and stenosis. Almost all stomas formed eventually develop some form of complication. Persistent proximal or even distal obstruction can be problematic in ensuring stomal function and distal SB drainage, respectively. Stomal skin problems and bag adherence are common issues that are troublesome. Wound infection, small bowel obstruction, and enterocutaneous fistula are significant but fortunately uncommon complications. Later reversal of the ileostomy may be considered and is usually straightforward, but can be challenging in some situations. Laparoscopic methods carry a range of specific attendant advantages and risks over open techniques.

Major Complications

The main complications arise from **perforation**, either concealed or revealed, occurring during division of adhesions/bowel resection/bowel mobilization. **Stomal ischemia, retraction, and leakage** are serious complications and may lead to generalized or localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be serious sometimes leading to **multisystem organ failure** and is the main cause of **death** when it occurs. **Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can occur and may be a repetitive, monotonous problem, requiring much hospitalization and even further surgery. Later ileostomy reversal is associated with risk of obstruction, leakage, and sepsis. **Gas embolus** and **major vascular or bowel injury** are additional serious, although very rare, complications of the laparoscopic approach.

Table 6.9 Laparoscopic ileostomy (loop or end ileostomy) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Port site	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Conversion to open operation	1–5 %
Stomal ulceration	1–5 %
Para-stomal hernia formation	1–5 %
Electrolyte/fluid disturbance	5–20 %
Paralytic ileus[a]	50–80 %
Small bowel fistulae[a]	1–5 %
Rare significant/serious problems	
Stomal retraction	0.1–1 %
Stomal prolapse	0.1–1 %
Para-stomal fistula formation	0.1–1 %
Injury to the bowel or blood vessels (trochar or diathermy)	0.1–1 %
Gas embolus	0.1–1 %
Stomal stenosis/obstruction	0.1–1 %
Malpositioning of ileostomy	0.1–1 %
Selection of incorrect limb of loop as distal end[b]	<0.1 %
Small bowel obstruction (early or late)[a] [anastomotic stenosis/ischemic stenosis/adhesion formation]	0.1–1 %
Diarrhea	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/fistula	0.1–1 %
Seroma formation	0.1–1 %
Colonic injury/ischemia/fistula (middle colic arterial injury)[a]	0.1–1 %
Gastric/small bowel ischemia[a] (gastroepiploic, mesenteric arterial injury)	0.1–1 %
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Intolerance of large meals (necessity for small frequent meals)	20–50 %
Wound dehiscence	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Port site hernia formation	0.1–1 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences
[b]Failure to ensure correct orientation of bowel, surgeon error

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Stomal complications
- Risk of organ injury
- Risk of open surgery
- Risk of further surgery

Open Reversal of Previous Loop or End Ileostomy

Description

General anesthesia is used. Positioning is in the supine or in the modified Lloyd-Davies position with a urinary catheter to provide better access for the scrub nurse or for the surgeon in accessing the left upper abdominal quadrant. Entry to the abdominal cavity should be by careful open cutdown around the stoma (+/− mucous fistula) site to reduce risk of vascular or bowel injury. This procedure is usually relatively straightforward and performed alone where the small bowel continuity can be restored safely. The aim therefore is to join the stomal and mucous fistula limbs by end-to-end anastomosis using a sutured or stapled technique. The stomal end is usually excised. The laparotomy used is generally small and localized to the stomal region; however, a separate midline approach is sometimes required. The aperture in the abdominal wall is usually closed directly with several heavy monofilament sutures. Delayed primary skin closure may be used to reduce infection as contamination is common. The procedure may be more difficult if the distal end has been returned to the abdomen in the initial end-ileostomy procedure. Infection risk is increased for the patient with past irradiation or mesh or when medical comorbidities or other risk factors that reduce wound healing capacity (e.g., diabetes, renal failure, or malnutrition) are present.

Anatomical Points

The main anatomical points that affect this procedure are acquired through previous surgery and/or complications such as abscess or fistula/sinus formation. A shortened mesentery or severe obesity increases difficulty and risk of complications. Excessive scarring may make definition of anatomical planes challenging.

Perspective

See Table 6.10. Major complications of this operation often relate to complications of the anastomosis. The most serious in the initial postoperative period are ischemia and leakage. Intraperitoneal leakage and generalized or localized peritonitis and sepsis may lead to systemic sepsis and multiorgan failure. Local infection, cellulitis, and abscess formation are not uncommon. The underlying pathology for which the procedure was performed and comorbidities often determine complications experienced. Fistula or sinus formation can also occur but is rare. Hernia formation is

Table 6.10 Open reversal of previous loop or end ileostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	0.1–1 %
Paralytic ileus[a]	50–80 %
Bowel perforation (sometimes multiple)[a]	1–5 %
Small bowel fistulae[a]	1–5 %
Rare significant/serious problems	
Anastomotic breakdown/leakage	0.1–1 %
Small bowel obstruction (early or late)[a] [anastomotic stenosis/ischemic stenosis/adhesion formation]	0.1–1 %
Diarrhea	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption[a]	0.1–1 %
Colonic injury/ischemia/fistula[a]	0.1–1 %
Vascular injury	0.1–1 %
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Intolerance of large meals (necessity for small frequent meals)	20–50 %
Wound dehiscence	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

more common after infection, and small bowel obstruction at the anastomosis or from adhesions is also possible.

Major Complications

The main complications arise from **anastomotic leakage** and **perforation**, either concealed or revealed. Leakage is a serious complication and may lead to generalized or localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis,** may occur and be sometimes serious leading to **multisystem organ failure** and is the main cause of **death** when it occurs. **Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula** formation are serious but less common problems. **Small bowel obstruction** can occur and may be a repetitive, monotonous problem, requiring much hospitalization and even further surgery.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of repeat ileostomy
- Risk of organ injury
- Risk of further surgery

Crohn's Stricturoplasty (Open)

Description

General anesthesia is used. Positioning is in the supine or in the modified Lloyd-Davies position with a urinary catheter to provide better access for the scrub nurse or for the surgeon in accessing the left upper abdominal quadrant. If this is "redo" surgery, access is best achieved by also extending the incision above/below the existing scar into the "virgin" abdominal wall. The old scar should be excised. Entry to the abdominal cavity should be by careful dissection with combination of sharp dissection and irrigation or diathermy. The objective of this operation is to relieve SB obstruction due to the wall thickening from Crohn's ileitis. The usual method relies on longitudinal enterotomies through the thickened zones with transverse closure (so called Crohn's stricturoplasty), using interrupted monofilament

sutures. This procedure is often relatively straightforward, and multiple areas can be treated in this way, with or without SB resection and direct end-to-end anastomosis in some cases. Infection risk is increased for the patient with past irradiation, on immunosuppressive therapy, or with mesh or when medical comorbidities or other risk factors that may reduce wound healing capacity, e.g., diabetes, renal failure, active inflammation, or malnutrition, are present. Good hemostasis, especially of the mesenteric and omental vessels, is essential to avoid bleeding or hematoma formation.

Anatomical Points

The main anatomical points that affect this procedure are acquired through previous surgery and/or complications such as abscess or fistula/sinus formation and excessive SB thickening. Crohn's disease typically has areas on normal appearing bowel between the affected segments. The extent of the affected bowel modifies the surgical anatomy. The existence of fistulae, sinuses, and adhesions to other structures usually increases the risks of surgical complications. A shortened mesentery or severe obesity increases the difficulty and complication risk. Excessive scarring may make definition of anatomical planes challenging.

Perspective

See Table 6.11. Major complications of this operation often relate to complications of the anastomosis. The most serious in the initial postoperative period are ischemia and leakage. Intraperitoneal leakage and generalized or localized peritonitis and sepsis may lead to systemic sepsis and multiorgan failure. Local infection, cellulitis, and abscess formation are not uncommon. The Heineke-Mikulicz-type stricturoplasty is the most common (81 %), followed by the Finney type (10 %). The underlying Crohn's pathology for which the procedure was performed and comorbidities often determine complications experienced. Fistula or sinus formation can also occur but is rare, either pre- or postoperatively. If present preoperatively, the risk is increased postoperatively. Hernia formation is more common after infection, and small bowel obstruction at the anastomosis or from adhesions is also possible. Recurrence of Crohn's strictures is common; although not an operative complication per se, these usually occur at sites other than at the stricturoplasty site(s).

Major Complications

The main complications arise from **anastomotic leakage** and **perforation**, either concealed or revealed. Leakage is a serious complication and may lead to

Table 6.11 Crohn's stricturoplasty (open) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Intra-abdominal	1–5 %
Recurrence of stricture(s) (all sites, previous and new)	20–50 %
Paralytic ileus[a]	50–80 %
Anastomotic breakdown/leakage	1–5 %
Rare significant/serious problems	
Small bowel obstruction (early or late)[a] [anastomotic stenosis/ischemic stenosis/adhesion formation]	0.1–1 %
Bowel perforation (sometimes multiple)[a]	0.1–1 %
Small bowel fistulae[a]	0.1–1 %
Vascular injury	0.1–1 %
Carcinoma at stricturoplasty	<0.1 %
Multisystem organ failure[a] (renal, pulmonary, cardiac failure)	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness [wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Intolerance of large meals (necessity for small frequent meals)	1–5 %
Wound dehiscence	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

generalized or localized sepsis. **Infection**, including **abscess** formation, **wound infection**, and **peritonitis**, may occur and be sometimes serious leading to **multi-system organ failure** and is the main cause of **death** when it rarely occurs. **Local infection** is relatively common and sometimes a chronic problem**. Bleeding** is rarely serious, but oozing can be problematic and may cause mesenteric hematoma(s) that can become infected. **Wound dehiscence** and **enterocutaneous fistula/sinus** formation are serious but less common problems. **Small bowel obstruction** can occur and may be a repetitive, monotonous problem, requiring much hospitalization and even further surgery. The creation of a **stoma** (ileostomy and/or colostomy) may be required in specific circumstances.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of stoma
- Risk of organ injury
- Recurrent strictures
- Risk of further surgery

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Chapter 7
Biliary and Duodenal Surgery

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General Perspective and Overview

The relative risks and complications increase proportionately according to the type of procedure performed and the nature of the pathology or underlying disease process. When complex biliary resection and anastomosis is required, the risks are usually increased. This is principally related to the surgical difficulty, ability to expose the region, blood supply, risk of tissue injury, hematoma formation, and technical ease of achieving the resection and/or anastomosis. Risk of anastomotic leakage and failure usually carries significant risks of infection with associated risks of morbidity and even mortality.

Resections for malignancy often carry higher risks associated with problems with early diagnosis, incomplete resection, and immunosuppression.

The main serious complication is **anastomotic leakage,** which can be minimized by the adequate mobilization, reduction of tension, and ensuring satisfactory blood supply to and inclusion of the mucosal edges in an anastomosis. Avoidance of tension at the anastomosis is imperative. Anastomotic leakage is associated with infection and may lead to **abscess formation**, **peritonitis,** and **systemic sepsis**. **Multisystem failure** and **death** remain serious potential complications of small bowel surgery and systemic infection. Multiple anastomoses, established infection, and preexisting malnutrition are associated with increased risk of anastomotic leakage. **Hematoma formation** may arise from oozing and this may predispose to

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infection. **Biliary leakage** is another problem either from an anastomosis or from small biliary ducts that are inadvertently outside of an anastomosis. Despite recent advances in laparoscopic surgery, there is often little variation on the indications for initial cholangiography during cholecystectomy by either the open and laparoscopic approaches or subsequent exploration (by ERCP, laparoscopically, or open). All of these can lead to **bile duct injury and chronic biliary stricture** that can require both the transient or permanent biliary cannulation for adequate biliary drainage.

Positioning on the operating table has been associated with increased risk of **deep venous thrombosis** and **nerve palsies**, especially in prolonged procedures.

Possible reduction in the risk of misunderstandings over complications or consequences from biliary surgery might be achieved by:

- Good explanation of the risks, aims, benefits, and limitations of the procedure(s)
- Useful planning considering the anatomy, approach, alternatives, and method
- Avoiding likely associated vessels and nerves
- Adequate clinical follow-up

With these factors and facts in mind, the information given in this chapter must be appropriately and discernibly interpreted and used.

Important Note
It should be emphasized that the risks and frequencies that are given here *represent derived figures*. These *figures are best estimates of relative frequencies across most institutions*, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities and different surgeons. In addition, the risks of complications in lower- or higher-risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient, staff, or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedures or surgical approaches. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

For risks and complications associated with other procedures, see the relevant chapter.

Endoscopic Retrograde Cholangiopancreatography (ERCP)

Description

Intravenous (IV) sedation or general anesthesia is used. The aim of the procedure is to perform endoscopy, pancreatography, and cholangiography, often with same-day

discharge. A side-viewing duodenoscope is used to adequately visualize/locate the ampulla of Vater. Pharyngeal topical anesthesia with IV narcotics and sedation are used according to the surgeon's preference. An initial endoscopic evaluation of the stomach and duodenum is performed. In almost all patients, the biliary duct is selectively cannulated and identified by the injection of dilute radiographic dye during continuous fluoroscopic evaluation, also with still x-ray images of ductal anatomy. Routine cannulation and injection of the pancreatic duct may not be performed, but is indicated in some patients. There is a greater incidence of pancreatitis associated with pancreatic duct cannulation and radiographic contrast injection. After adequate radiologic delineation, other procedures (stone extraction, biliary and pancreatic duct stenting, forceps biopsy, brush cytology, and/or therapeutic sphincterotomy) may be performed. A skilled endoscopist is usually able to cannulate the common bile duct as well as the pancreatic duct (when needed) in well over 90 % of patients. Certain patient factors, such as a duodenal diverticulum, ulceration, previous surgery, stenosis of the second portion of the duodenum from previous injury, or invasion by a pancreatic mass, may make the identification of the ampulla difficult. Attempts to locate the ampulla through a Billroth-II gastrojejunostomy can also be difficult.

Anatomical Points

Knowledge of common variations in biliary ductal anatomy is essential for the accurate interpretation of cholangiograms. The prevalence of these forms of anatomic points is demonstrated in Fig. 7.1, with a majority having the standard bifurcation of the common hepatic duct. A trifurcation of the common hepatic duct is the second most common. In almost all cases, the posterior biliary segments lie more laterally than the anterior segments, such that when cholangiograms are evaluated, segments 6 and 7 ducts are seen inferio-laterally and superio-laterally, respectively. Other commonly seen radiographic presentations are the posterior sectoral ducts arching close to the confluence of the common hepatic duct. In addition to these variances, a right sectoral duct can cross to the left and join the left hepatic duct in 28 % of patients; in 22 %, this is the posterior sectoral duct and in 6 % the anterior sectoral duct.

Perspective

See Table 7.1. Post-ERCP pancreatitis remains the major source of morbidity. The severity of this pancreatitis can be significant, requiring surgical debridement and drainage. The three most common risk factors for post-ERCP pancreatitis remain sphincter of Oddi dysfunction, difficult cannulation, and previous sphincterotomy. In most patients, post-ERCP pancreatitis is actually transient hyperamylasemia and is self-limited, requiring only IV medications and supportive care while patients are in the hospital. This complication can be devastating in the patient with a surgically resectable pancreatic cancer that can be made unresectable following ERCP, with

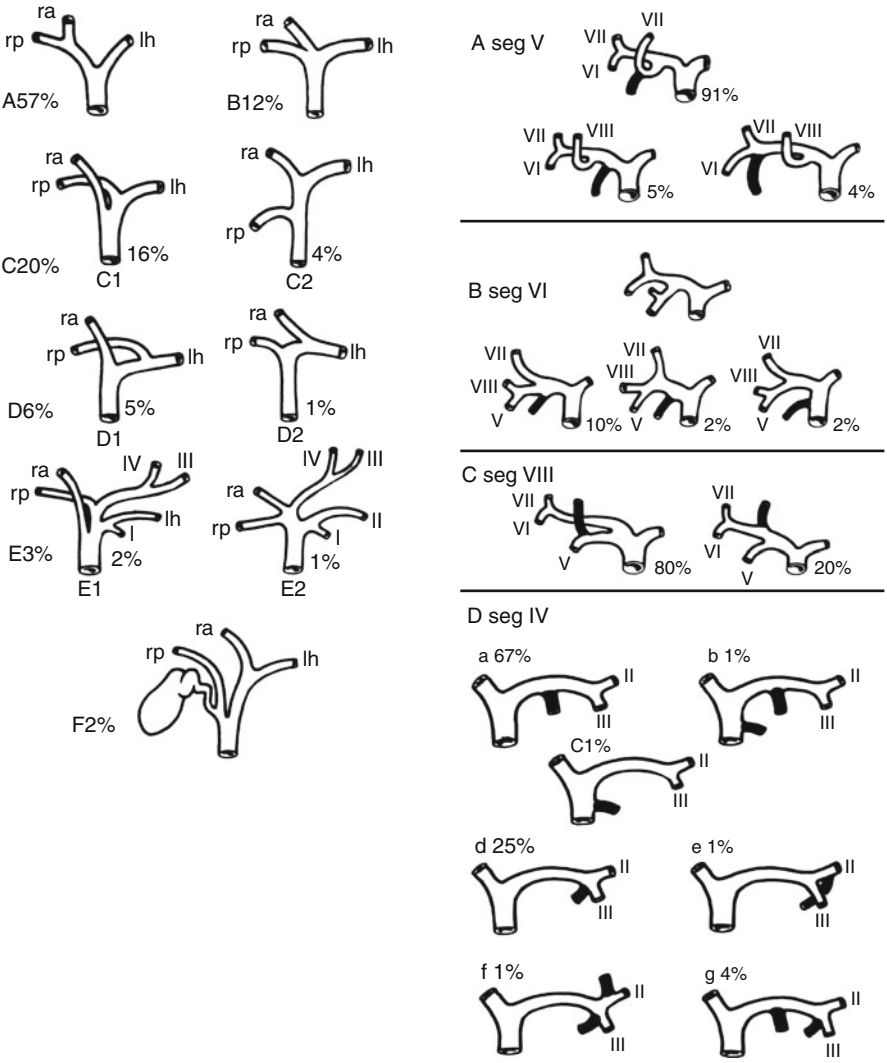

Fig. 7.1 Multiple variations of common hepatic bile duct anatomy. (**a**) Normal anatomy of the hepatic bile duct confluence. (**b**) Trifurcation type anatomy of the left hepatic with the anterior and posterior sectoral ducts. (**c**) Right anterior duct (c1) and posterior duct (c2) with common hepatic bile duct drainage. (**d**) Aberrant drainage of right sectoral ducts into left hepatic duct. (**e**) Absence of normal hepatic confluence. (**f**) Absence of right hepatic duct, with right posterior draining into cystic duct

pancreatic duct cannulation and contrast injection. Thus, the decision for pancreatic duct cannulation and contrast injection should be made judiciously. The fundamental philosophy of ERCP is that it is most dangerous for patients who need it least. MRI imaging of the cholangiopancreatic system (MRCP) offers an alternative in some cases. Bleeding is rarely severe, but this is a small but important risk of ERCP. Failure to cannulate the CBD or pancreatic duct or failure to obtain a satisfactory representative biopsy can depend on the pathology, but may significantly influence diagnosis and decision-making.

Table 7.1 Endoscopic retrograde cholangiopancreatography (ERCP) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	
Cholangitis[a]	1–5 %
Intra-abdominal (abscess or free perforation)	0.1–1 %
Systemic[a]	0.1–1 %
Bleeding[a]	
Sphincterotomy site	1–5 %
Bile duct	0.1–1 %
Perforation[a]	
Esophagus	<0.1 %
Stomach	<0.1 %
Duodenum	0.1–1 %
Bile duct	<0.1 %
Failure rate of ERCP (not technically possible to complete ERCP)[a]	1–5 %
Failure to visualize the ampulla[a]	1–5 %
Failure to adequately biopsy lesion(s)[a]	1–5 %
Failure to stent[a]	1–5 %
Failure to image the duct[a]	1–5 %
Failure to adequately drain the bile duct[a]	1–5 %
Pancreatitis[a]	1–5 %
Rare significant/serious problems	
Bile leak	0.1–1 %
Fistula	0.1–1 %
Injury to mouth, teeth, pharynx, or larynx	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Biliary obstruction[a]	0.1–1 %
Ampullary stenosis[a]	0.1–1 %
Stent migration[a]	0.1–1 %
Multisystem organ failure[a]	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Paralytic ileus	0.1–1 %
Blood transfusion	<0.1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences. The presence of preexisting pancreatitis, infection, or other pathology may influence the relative risk of specific complications

Major Complications

The most common complication remains **pancreatitis**, with an overall incidence (depending on the patient indication/selection) of about 6.7 %. This complication can occur after any form of ERCP, but it most commonly follows pancreatic duct cannulation and radiographic dye injection. Other causes of post-ERCP pancreatitis include distal bile duct balloon dilatation, which leads to swelling of the sphincter and transient occlusion of the distal pancreatic duct. Various methods have been utilized to prevent this complication, with the most common being the use of a transient pancreatic duct

stent. This prevents distal pancreatic duct obstruction and reduces the incidence of post-ERCP pancreatitis following this form of distal bile duct dilatation. More common is transient hyperamylasemia, which occurs in 40–75 % of patients, but is self-limiting and usually asymptomatic. **Duodenal perforation** is another serious complication related to difficulty in passing the side-viewing endoscope through the pylorus and past the duodenal bulb into the second portion of the duodenum. This complication can lead to **sepsis** from intraperitoneal or retroperitoneal spillage. Treatment is defined by the extent of leakage and the patient's clinical presentation. In a small subset of patients, a retroperitoneal duodenal perforation can be managed nonoperatively with IV antibiotics and supportive care. Otherwise, **open surgical intervention** to repair the duodenum with possible duodenal exclusion may be indicated. Wound drainage is usually required. **Bleeding** from the sphincterotomy site is another form of serious complication. This most commonly occurs when the incision is used to make a sphincterotomy at the 1–2 o'clock position of the sphincter, instead of the 11 o'clock position. This failure to properly place the incision can lead to **significant hemorrhage** from the gastroduodenal artery. In anticoagulated patients, risk is considerable and reversal may avoid bleeding. **Cholangitis** can occur with instrumentation of the bile duct; however, it is usually adequately treated with IV antibiotics provided there is adequate biliary drainage. **Infection** is usually secondary to one of the complications above, but may be severe and is a major cause for **morbidity**, **multisystem organ failure,** and even **mortality**.

Consent and Risk Reduction

Main Points to Explain

- Risk of perforation/leakage/fistula
- Infection
- Bleeding
- Risk of failed diagnosis
- Risk of injury to mouth/teeth
- Risk of open operation
- Risk of further surgery

Open Choledochostomy and Choledochoscopy (Rigid or Flexible)

Description

General anesthesia is used. Choledochoscopy is usually performed with removal of the gallbladder. Open choledochoscopy is nowadays very rarely performed alone as a separate procedure after cholecystectomy for later diagnosis of common bile duct stones. Alternative, closed methods (usually ERCP) or minimally invasive common bile duct (CBD) exploration are usually preferable options. The aim is similar to choledocoscopy when performed with cholecystectomy, that is, to inspect the distal

common bile duct (CBD), the proximal hepatic duct, and sectoral ducts. *Cholangiography* may be used first to fill the CBD with radiopaque contrast material to show the ductal anatomy (showing constrictions, branching, and duct size), any filling defects (usually calculi), and to indicate the drainage pattern of the duct. CBD scope use was initially defined by Bakes in 1923. Rigid choledochoscopes with varying degrees of angulation allowed visualization with limited optics and accessibility. Flexible choledocoscopy, in 1976, permitted better and easier vision. Choledochostomy is a fundamental maneuver in biliary surgery, primarily in the management of common bile duct stones and bile duct obstruction. The technique of choledochostomy usually follows an open cholecystectomy and open choledochotomy. It is preferable that the larger 5 mm flexible choledochoscope is attached to a monitor, with a 2 mm working instrument channel. The scope is connected to a pressure irrigation system for adequate visualization. The scope is introduced through an 8–10 mm longitudinal choledochotomy in the common bile duct. Slow circumferential inspection of the distal common bile duct then proceeds down to and through the sphincter into the second portion of the duodenum. The instrument is reversed and the common hepatic duct, the left hepatic duct, and the right anterior and posterior sectoral ducts should be inspected. Gallstones are usually visualized easily. Most are "free floating" in the common bile duct because of the constant irrigation. Some will easily pass into the duodenum because of the pressure of the irrigation system. Others may be found in the ampulla, embedded in the duodenal wall, or in a diverticulum of the distal duct. For the free-floating stone that does not pass into duodenum, either a basket or the balloon can be utilized for extraction of the stones through the choledochotomy. Some choledochoscopy instrument sets also include forceps that can be helpful in the removal of an impacted stone. Other techniques that can be used are the administration of IV glucagon, as well as a gentle dilatation of the ampulla with the choledochoscope. In the presence of multiple small calculi, either in the distal common bile duct or, more commonly, within the hepatic ductal system, biliary-enteric bypass should be considered.

Anatomical Points

The anatomical pattern is partly dependent on the natural anatomy and also on any previous surgery. The variations in natural anatomy are described below for other procedures. Previous cholecystectomy may lead to distortion of the duct due principally to scarring and adhesions. Primary dissection to identify the anterior surface of the common bile duct can be difficult in a small subset of patients who have variant biliary anatomy in the form of an early right posterior sectoral duct takeoff, a long tortuous cystic duct, or an early bifurcation of the common bile duct. This variance in biliary anatomy can lead to significant biliary damage due to inadvertent ligation or improper identification, which can lead to a choledochotomy, performed in a variant bile duct that is too small for cannulation. Surrounding organs (e.g., colon, small bowel, liver, duodenum, and stomach) may be adherent to the hilar structures including the CBD, increasing risk of injury. An enlarged liver or narrow costal angle may impede access.

Perspective

See Table 7.2. The importance of endoscopic intraluminal inspection of the extrahepatic biliary system cannot be overemphasized. Choledochoscopy remains the most accurate method to detect and remove bile duct stones. Various debates in regard to the percentage of remaining stones following either open cholecystectomy or laparoscopic cholecystectomy further emphasize the need for choledochoscopy. All agree that choledochoscopy can result in the recovery of additional stones in upwards of 10–15 % of patients following standard attempts of stone extraction. Because of the significant rise in the incidence of laparoscopic cholecystectomy, the

Table 7.2 Open choledochostomy and choledochoscopy (rigid or flexible) estimated frequency of complications, risks, and consequences

Complications, risks and consequences	Estimated frequency
Most significant/serious complications	
Infection[a]	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Cholangitis[a]	1–5 %
Abscess[a]	0.1–1 %
Systemic[a]	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Failure rate (not technically possible to complete choledochoscopy)[a]	1–5 %
Failure to reach the ampulla[a]	1–5 %
Failure to visualize duct/remove calculi from the duct[a]	1–5 %
Rare significant/serious problems	
Perforation or injury (laceration/dissection)[a]	
Bile duct, ampulla, duodenum, small bowel, colon	0.1–1 %
Small bowel obstruction (early or late)[a] [Adhesion formation]	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Biliary/pancreatic leak[a]	0.1–1 %
Pancreatitis[a]	0.1–1 %
Biliary obstruction[a]	0.1–1 %
Late bile duct/ampullary stenosis[a]	0.1–1 %
Fistula (duodenal/biliary/pancreatic)[a]	<0.1 %
Multisystem organ failure[a]	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	5–20 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
T-tube biliary drainage[a]	>80 %
Wound scarring (poor cosmesis)	1–5 %
Wound drain tube(s)[a]	1–5 %
Blood transfusion	<0.1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

performance of open cholecystectomy, with open choledochostomy and operative removal of common bile ducts, has decreased significantly in the last 5–10 years. This has placed greater emphasis on surgical programs creating structured training courses on animal models so that the technique of open cholecystectomy, open choledochotomy, and choledochoscopy can be performed safely and proficiently. The ability to perform these procedures at the initial operation can prevent significant postoperative morbidity and chronic biliary instrumentation in these patients. The major chronic disability that can occur after a common bile duct exploration is damage and stricture to the extrahepatic biliary system. This primarily occurs with inadequate exposure of the common bile duct, incomplete identification of the common bile duct, or failure to recognize a small diameter common bile duct. Further surgery for drainage may be required. Persistent bile leakage, bile peritonitis, and/or fistula formation are rare, but potentially serious complications that may require further surgery. Inadvertent T-tube dislodgement or removal may delay recovery. Arterial injury and bleeding is also another significant risk factor related to anatomical point, primarily in jaundiced patients who undergo this procedure. Careful dissection, as well as visualization of either an accessory or replaced right hepatic artery, cannot be overemphasized. Bile leak is very common in the immediate postoperative period from closure of a choledochotomy or from the raw liver. This type of bile leak is often inconsequential and almost always resolves via the drain tube or spontaneously and seldom requires reoperation. The need for radiological cannulation of a bile collection is rare. Infection is usually transient and limited or treated with antibiotics. Severe systemic sepsis is life threatening, but rare, and usually associated with established preoperative sepsis. Failure to visualize the bile duct adequately occurs infrequently, but may dictate an alternative approach.

Major Complications

Bile duct injury is a major complication related to a CBD exploration. Primary dissection to identify the anterior surface of the CBD can be difficult in a small subset of patients who have variant biliary anatomy in the form of an early right posterior sectoral duct takeoff, a long tortuous cystic duct, or an early bifurcation of the CBD. These variations in biliary anatomy can lead to significant biliary damage because of inadvertent ligation or transection or choledochotomy performed in portion of the bile duct too small for primary closure or even exploration. **Bile duct perforation** or mucosal tears may result from placement of the choledochoscope into a bile duct that is too small or into a variant biliary duct. If perforation is appreciated at the time of choledochotomy, primary repair may not provide a long-term effective solution and hepaticojejunostomy should be considered. The incidence of **biliary stricture** after undergoing a biliary exploration is usually small, but when this complication develops it is significant, often requiring further surgery, sometimes including biliary bypass procedures. Stricture results from bile duct trauma, either from chronic choledocholithiasis or iatrogenic from choledochotomy, choledochoscopy, instrumentation or inadvertent laceration, or ligation. As described above this can occur at

any level in the biliary tree and may only become evident years after biliary surgery. **Damage of the ampulla** can result from chronically impacted CBD stones at the ampulla, causing edema and mucosal irritation. After the removal of an impacted CBD stone, further instrumentation of the ampulla with the choledochoscope can lead to mucosal tears, which can lead to long-term stricture formation and require further biliary instrumentation for drainage. **Bleeding** during dissection of the CBD can occur. A right hepatic artery can transverse anterior to the bile duct, which can be injured or ligated during this dissection. The portal vein should also be properly identified on the medial-posterior surface of the CBD to ensure that only anterior dissection of the common bile duct is performed prior to choledochotomy. **Missing a retained stone** due to patient anatomy, inflammation, or ductal diverticula can occur causing poor visualization of the distal CBD, CHD, and sectoral hepatic ducts. Improper use of the choledochoscope or inadequate flow of irrigation is possible technical contributors to this. This can lead to the retention of CBD stones, which can lead to later **cholangitis**. Further biliary instrumentation by ERCP, percutaneous transhepatic cholangiography, or repeat surgical exploration may be required. Cholangitis prior to or at surgery or postoperatively can result in severe **sepsis** and **multisystem organ failure** and is the major cause of **mortality** when it occurs.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Pancreatitis
- Infection
- Bleeding
- Risk of organ injury
- Risk of further surgery

Open Cholecystectomy (Without Common Bile Duct Exploration)

Description

General anesthesia is used. The aim of the procedure is to remove the gallbladder (GB) and its contents. The ***"retrograde"*** technique is defined by the initial dissection of the hilar structures of the GB within Calot's triangle, then dissecting toward the fundus. The ***"anterograde or antegrade"*** (fundus down) technique is defined by removal of the GB from the liver bed first, before transection of the cystic duct and artery. The operation is usually performed through either a right subcostal, right upper transverse, or an upper midline incision. After adequate exposure is obtained, the use

of the retrograde or anterograde technique depends on surgeon preference, as well as the degree of inflammation present. If significant GB inflammation is present, the anterograde technique can avoid inadvertent biliary or arterial injury and is also usually easier, along an "inflammatory plane" around the GB. The three integral steps in performing an open cholecystectomy are (1) identification/ligation/division of the cystic duct near the GB infundibulum, (2) identification/ligation/division of the cystic artery distal to the right hepatic artery, and (3) removal of the GB from the liver bed with meticulous hemostasis. An inflamed GB can often be "pinched" from the liver bed. A drain can be left in patients in whom significant inflammation/ooze is encountered.

Anatomical Points

Variations in *biliary ductal anatomy* are numerous (Fig. 7.1), and a surgeon should be aware of these to prevent biliary injury and subsequent stricture during an open cholecystectomy. A majority have the standard bifurcation of the common hepatic duct, with a trifurcation of the common hepatic duct being the second most common. In almost all cases, the posterior biliary segments lie more laterally than the anterior segments, such that in the evaluation of cholangiograms, the segment 6 and 7 ducts are seen inferio-laterally and superio-laterally, respectively. Other common radiographic presentations show the posterior sectoral ducts arching close to the confluence of the common hepatic duct. In addition, a right sectoral duct can cross to the left and join the left hepatic duct in 28 % of patients; in 22 %, this is the posterior sectoral duct, and in 6 %, it is the anterior sectoral duct. *Hepatic arterial* anatomic point should also be considered when performing any type of biliary surgical exploration and/or instrumentation (Fig. 7.2). In 25 % of patients, the right hepatic artery will either be completely replaced or have a large accessory branch from the superior mesenteric artery. In addition, the left hepatic artery can be completely replaced or have a large accessory branch from the left gastric artery through the lesser omentum. In other less common variances, the left and right can originate from the celiac trunk or branch from a very short common hepatic artery. The least common variance is origination of the gastroduodenal artery from the right hepatic artery. *Hepatic portal* anatomic point should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.3). Knowledge and proper identification of the coronary vein cannot be overemphasized since this can lead to substantial blood loss while attempting to gain exposure of the medial aspect of the common bile duct. The course of the portal vein (PV) is behind the common bile duct and the common hepatic duct as it approaches the liver. It then bifurcates into right PV and smaller left PV. The LPV will remain extrahepatic for a longer length behind the left hepatic artery until it enters the umbilical fissure. The RPV is a very short structure that will branch quickly into the right anterior and right posterior sectoral branches. Another main variant is division of the portal vein more proximally with the right anterior and the right posterior branching independently (Fig. 7.3).

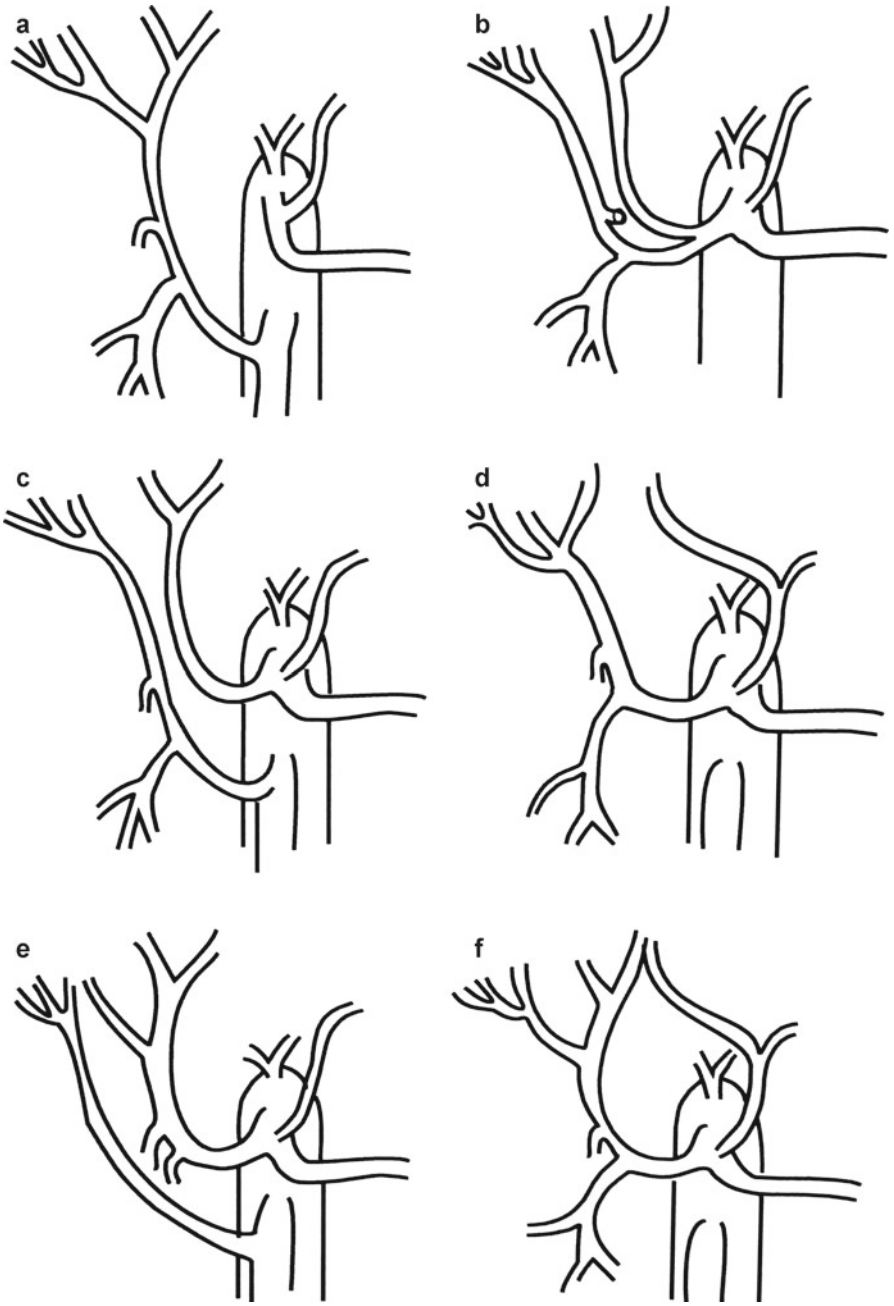

Fig. 7.2 Hepatic arterial anatomic point is common, with over 25 % of patients having either a partial or complete replacement of the right hepatic artery from the superior mesenteric artery **(a**, **c**, **e)**. In addition, the left hepatic artery may either be partially or completely replaced from the left gastric artery **(d**, **f)**. In a small subset of patients, the left or right hepatic artery may arise from the celiac axis **(b**, **c)**. Lastly, the gastroduodenal artery may arise from the right hepatic artery **(b**, **c)**

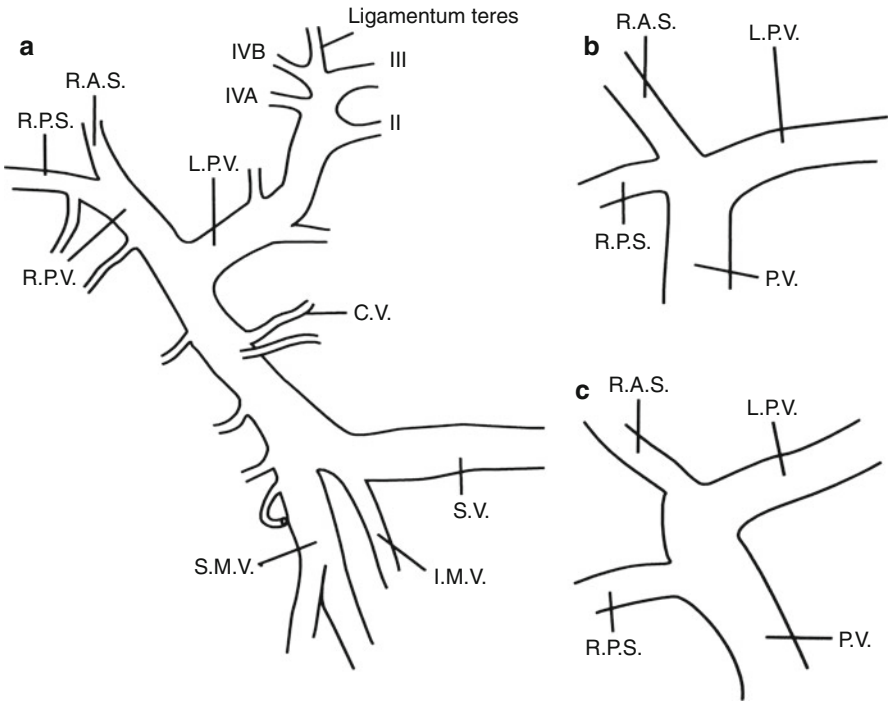

Fig. 7.3 Portal venous anatomic point is less common, with the most common venous anatomy having (**a**) the portal vein (*PV*) arise from the confluence of the superior mesenteric vein (*SMV*) and the splenic vein (*SV*), with the inferior mesenteric vein (*IMV*) draining into the SV. (**b**) Another anatomic point may arise from the lack of a true right portal vein with the right posterior sectoral (RPS) and the right anterior sectoral (*RAS*) arising from a common trunk with the left portal vein (*LPV*). (**c**) Lastly, the division of the right portal vein may occur more proximally with the RPS arising independently from the portal venous trunk

Perspective

See Table 7.3. Laparoscopic cholecystectomy has made open cholecystectomy rare. Surgeons nowadays often receive little exposure to open cholecystectomy. Knowledge and the technical expertise in performing the occasional open cholecystectomy cannot be overemphasized. However, there is often little variation on the indications for initial cholangiography during cholecystectomy by either the open and laparoscopic approaches. When poor access or GB inflammation may not allow laparoscopic exposure, open cholecystectomy should be regarded as a safe alternative, not a failed laparoscopic cholecystectomy. Open cholecystectomy still remains an important, essential technique for patients in whom a laparoscopic cholecystectomy cannot be safely performed. Whether complications of open cholecystectomy are higher through relative surgeon, inexperience is controversial. The main risks are bile duct injury, including transection, and ligation and bleeding from the liver or hepatic vascular system or from other organs, omentum, or abdominal wall. Retained calculi are another complication.

Table 7.3 Open cholecystectomy (*without* common bile duct exploration) estimated frequency of complications, risks, and consequences

Complications, risks and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Wound/intra-abdominal	
Rare significant/serious problems	
Failure to detect/remove calculi[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Seroma formation	0.1–1 %
Injury to the bowel or blood vessels[a]	0.1–1 %
Duodenal/gastric/small bowel/colonic	
Vascular injury[a]	0.1–1 %
Liver injury	0.1–1 %
Bile duct injury/bile leak/collection/fistula[a]	0.1–1 %
Jaundice (dislodgement of gallstones into common bile duct)[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Operative cholangiogram complications[a]	
Dye reaction/cholangitis/pancreatitis/radiation exposure	<0.1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus[a]	50–80 %
Wound dehiscence	0.1–1 %
Muscle weakness (atrophy due to denervation esp. Kocher' incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

Note: include risks and complications of bile duct exploration when performed in unison with open cholecystectomy (see later)

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

Major Complications

A rare, but serious complication that can occur during an open cholecystectomy is **common bile duct ligation/injury**. If a common bile duct injury is identified intra-operatively, primary repair is almost always associated with chronic **biliary stricture** and inadequate biliary drainage. The universally accepted technique for managing common bile duct injury is either a choledochoduodenostomy (for distal common bile duct injury) or a hepaticojejunostomy (for common hepatic duct

injury). Injury of a small diameter (less than 5 mm) low posterior sectoral bile duct takeoff (anatomic point) can be managed with proximal ligation alone, but if the duct diameter is larger, then biliary reconstruction with either the duodenum or with a Roux-en-Y of jejunum is indicated. Recent reports have demonstrated that immediate intraoperative reconstruction for major bile duct injury will lead to an equivalent quality of life when compared to patients who underwent an uncomplicated cholecystectomy. **Arterial injury** inadvertently of the right hepatic artery or the right posterior sectoral artery can occur causing **hemorrhage,** and ligation of the hepatic artery reduces local hepatic blood flow. These complications may be avoided by careful dissection close to the infundibulum of the GB. In a normal patient without hyperbilirubinemia, attempts at reconstruction should not be made and the surgeon should ensure that there is adequate ligation. If, however, this complication occurs in a patient with underlying liver failure, or hyperbilirubinemia, then there should be precise evaluation to determine whether arterial reconstitution can be achieved to avoid postoperative liver ischemia. This complication can be devastating to these types of patients because of their inability to tolerate an additional insult of arterial ischemia in the face of hyperbilirubinemia. **Postoperative bleeding** can result from a posterior cystic artery or bleeding from the liver bed. Precise dissection during removal of the GB and identification and ligation of a possible posterior cystic artery should always be performed during open cholecystectomy. Hemostasis of the liver bed is best achieved using initial pressure on a dry pack, but also by either staying in the subserosal plane during removal of the GB or with the use of diathermy or argon beam coagulation after removal. Injury to the portal vein, vena cava, or liver parenchyma is very uncommon, but is a serious complication when it occurs. **Injury to the colon, antrum of the stomach, small bowel, or more commonly the second portion of the duodenum** can occur especially with dissection of dense adhesions from GB wall inflammation. Immediate primary repair, depending on the size and extent of injury, is indicated if this occurs. A **biliary leak** (BL)**/ collection** and/or **biliary fistula** can occur because of either dislodgement of the ligature on the cystic duct, failure to identify an accessory cystic duct at operation, or superficial liver injury causing peripheral bile duct leakage. The management of these types of injuries is primarily dictated by symptoms and/or the volume of BL via an intraoperative drain or on CT/US imaging postoperatively. Asymptomatic BL < 200 ml/day needs observation alone, since most of these resolve. When BL > 200 ml/day and persistent, US-guided percutaneous drainage, percutaneous transhepatic cholangiography, or ERCP, and drainage are often required.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of leakage/fistula
- Pancreatitis
- Risk of further surgery

Laparoscopic Cholecystectomy (Without Common Bile Duct Exploration)

Description

General anesthesia is used for this procedure with the aim of removing the gallbladder (GB) with a minimally invasive technique. The variations in this technique primarily relate to the number and size of abdominal ports used and patient positioning. Typically four ports are placed: an umbilical 10 or 12 mm port for the camera; a 10 mm epigastric port 4 cm below the xiphoid process, entering to the right side of the falciform ligament; and two 5 mm trocars placed at the midclavicular line just above the umbilicus and the anterior axillary line 4–5 cm below the costal margin, respectively. These enable manipulation of the GB. In this way, the fundus (tip) of the gallbladder can be retracted up and over the liver and the infundibulum can be extracted at a 90° angle to the common bile duct. A CO_2 gas pneumoperitoneum is maintained at approximately 12–15 mmHg intra-abdominal pressure, and dissection of Calot's triangle close to the GB is commenced. Both the cystic artery and the cystic duct are identified close to the GB and then ligated using clips. The common bile duct and the common hepatic duct may be identified (not always feasible) prior to ligation and transection of the cystic duct. The gallbladder is dissected, usually retrogradely, in a subserosal plane using diathermy cautery. Image intensification, and intraoperative cholangiography via the cystic duct or GB, may be useful to define both anatomy and detect calculi, prior to division of the cystic duct. In the presence of inflammation or oozing, a temporary drain may be used via one of the 5 mm trocar port sites.

Anatomical Points

Variations in *biliary ductal system* are numerous (Fig. 7.1) and require explanation to reduce biliary injury and subsequent stricture during an open cholecystectomy. The majority of anatomic points have a standard bifurcation of the common hepatic duct, with a trifurcation of the common hepatic duct being the second most common. In almost all cases, the posterior biliary segments lie more laterally than the anterior segments, such that in the evaluation of cholangiograms the segment 6 and 7 ducts are seen inferio-laterally and superio-laterally, respectively. Other common radiographic presentations are for the posterior sectoral ducts to be seen arching close to the confluence of the common hepatic duct. In addition, a right sectoral duct can cross to the left and join the left hepatic duct in 28 % of patients; in 22 %, this is the posterior sectoral duct, and in 6 % the anterior sectoral duct. *Hepatic arterial* anatomic point should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.2). In 25 % of patients the right hepatic artery will either be completely replaced or have a large accessory branch from the

superior mesenteric artery. In addition the left hepatic artery can be completely replaced or have a large accessory branch from the left gastric artery through the lesser omentum. In other less common variants, the left and right can originate from the celiac trunk or branch from a very short common hepatic artery. The least common variant is origination of the gastroduodenal artery from the right hepatic artery. *Hepatic portal* anatomic point should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.3). Knowledge and proper identification of the coronary vein (CV) cannot be overemphasized, since this can lead to substantial blood loss while attempting to gain exposure of the medial aspect of the common bile duct. The course of the portal vein is behind the common bile duct and the common hepatic duct as it approaches the liver. There it usually bifurcates into a larger right (RPV) and smaller left portal vein (LPV). The LPV remains extrahepatic for a longer period behind the left hepatic artery, until it enters the umbilical fissure. The RPV is very short and branches quickly into the right anterior and right posterior sectoral branches. The one main variance is division of the portal vein more proximally with the right anterior and the right posterior branching independently (Fig. 7.3). Occasionally, hepatic vessels may lie in the gallbladder bed, where they are in danger during dissection of the GB from the liver.

Perspective

See Table 7.4. The rapid acceptance of laparoscopic cholecystectomy has placed it among the most common procedures performed by the general surgeon in most medical centers. Laparoscopic cholecystectomy indications are the same as for open cholecystectomy including symptomatic cholelithiasis, acute cholecystitis, chronic cholecystitis, acalculous cholecystitis, and asymptomatic cholelithiasis in patients with sickle cell disease, chronic immunosuppression, or renal transplant and occasionally prophylactically in people travelling to isolated areas (e.g., Antarctic missions or space). Contraindications to laparoscopic cholecystectomy include inability to tolerate general anesthesia or pneumoperitoneum, refractory coagulopathy, and advanced gallbladder (GB) carcinoma. Relative contraindications have continued to change, depending upon the surgeon's preference, but include previous upper abdominal surgery, cholangitis, early GB carcinoma, pregnancy, diffuse peritonitis, cirrhosis, portal hypertension, and severe chronic obstructive pulmonary disease (COPD). These indications, as well as contraindications, should always be considered carefully so that an adequate complication risk-versus-benefit discussion can take place with the patient. Most procedures are not associated with complications. However, the complications that can occur during a laparoscopic cholecystectomy can be severe and chronically debilitating. Complications related to trocar injury of bowel or major blood vessels (aorta, inferior vena cava, iliac vessels) or gas embolism should always be considered. Bile duct injury related to inadvertent common bile duct laceration or ligation remains a low, but severe, risk in all patients undergoing this procedure. Most injuries related

Table 7.4 Laparoscopic cholecystectomy (*without* common bile duct exploration) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Systemic	0.1–1 %
Port site	0.1–1 %
Bleeding/hematoma formation	1–5 %
Wound/intra-abdominal	
Conversion to open operation	1–5 %
Rare significant/serious problems	
Failure to detect/remove calculi[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Seroma formation	0.1–1 %
Injury to the bowel or blood vessels (trocar or diathermy)[a]	0.1–1 %
Duodenal/gastric/small bowel/colonic	
Vascular injury	0.1–1 %
Liver injury	0.1–1 %
Bile duct injury/bile leak/collection/fistula	0.1–1 %
Necessity for open biliary drainage procedure(s) after duct injury[a]	0.1–1 %
Jaundice (dislodgement of gallstones into common bile duct)[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Pneumothorax	0.1–1 %
Deep venous thrombosis	0.1–1 %
Gas embolus[a]	0.1–1 %
Operative cholangiogram complications	
Dye reaction/cholangitis/pancreatitis/radiation exposure	< 0.1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus[a]	50–80 %
Wound dehiscence	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	0.1–1 %
Port-site hernia formation[a]	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)	1–5 %

Note: include risks and complications of bile duct exploration when performed in unison with open cholecystectomy (see later)

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

to laparoscopic cholecystectomy should be repaired through open exploratory operation(s). This allows full inspection of the abdomen, especially at the trocar insertion sites, and adequate access to evaluate and deal with the problem.

Major Complications

Bile duct injuries (BDI), usually to the common bile duct, are among the most serious complications during laparoscopic cholecystectomy. The incidence of BDI (0.2–0.6 %) has been reported to be three times higher than for open cholecystectomy (0.1–0.25 %). Recent data from centers with expertise in laparoscopic cholecystectomy show low rates of BDI similar to open cholecystectomy. More importantly, the number of cases of common bile duct injury in which there is a delay in diagnosis is also increasing, which has an adverse outcome for patients (Schol et al. 1995). It is paramount to avoid bile duct injuries by risk reduction at the initial operation. Many reports have demonstrated the important techniques in prevention of this injury including dissection close to the infundibulum, extraction of the infundibulum to create a right angle to the common bile duct, and, most importantly and ideally, identification of the common bile duct prior to transection of the cystic duct. Working close to the GB, defining the GB edge, and clip ligating only definite cystic arterial and duct structures close to the GB are useful methods. Another technique, which has recently gained acceptance, is performing the procedure in a "dome-down technique" (similar to open cholecystectomy) so that proper identification of the common bile duct can be achieved once the entire GB has been removed from the liver bed. In the case of a bile duct injury, attempted primary repair of the duct is almost universally associated with chronic biliary stricture and inadequate biliary drainage. The universally accepted technique in managing an inadvertent common bile duct ligation is a choledochoduodenostomy if the injury is within the distal common bile duct, a choledochojejunostomy if the injury is higher on the common bile duct, or a hepaticojejunostomy if the injury is within the common hepatic duct. If the bile duct injury occurs because of the anatomic point of a low posterior sectoral bile duct takeoff, it can be managed by one of two techniques. If this low takeoff is small in diameter (less than 5 mm), then adequate proximal ligation should be performed and no further reconstruction is indicated. However, if the diameter of this duct is larger (>1 cm), then some form of biliary reconstruction, with either the duodenum or a Roux-en-Y of jejunum, is indicated. Immediate intraoperative repair of any major bile duct injury is usually indicated and should not normally be left to a second operation. Currently, an immediate open repair of bile duct injuries is often far easier than failed attempts at laparoscopic repairs and subsequent reoperation, but this is dictated by surgeon preference. **Trocar injury** is another serious complication that usually occurs primarily through the use of a Verres needle (with the closed puncture technique) or a trocar introduced without direct intra-abdominal vision. Injury to the bowel or vascular injury may result. Risk may be reduced almost completely using the "open cutdown technique" for entry into the peritoneal cavity under direct vision (Hassan technique), placement of the camera via this port, and then laparoscopic vision of puncture of the abdominal wall for the other trocars. Retractable trocars, introducing rods and sharp stylettes, can also reduce risks.

Bowel injury to the colon or small bowel may occur, especially if adhesions from previous surgery are present. Patients with any degree of GB inflammation

can develop a dense inflammation of either the colon, stomach antrum, or more commonly the second portion of the duodenum to the GB wall. Immediate primary repair is usually indicated. **Arterial injury** and **hemorrhage** can result inadvertently to the right hepatic artery or the right posterior sectoral artery. Ligation can reduce local hepatic blood flow. These complications may be avoided by dissection against the infundibulum of the GB. In a normal patient without hyperbilirubinemia, attempts at reconstruction should not be made and the surgeon should ensure that there is adequate ligation. However, in a patient with underlying liver failure, or hyperbilirubinemia, there should be precise evaluation to determine whether arterial reconstitution can be achieved to avoid postoperative liver ischemia. This complication can be devastating to these types of patients because of their inability to tolerate an additional insult of arterial ischemia in the face of hyperbilirubinemia (Yoshidome et al. 2000). Other major trocar-induced vascular injuries include the inferior vena cava or the aorta, associated with rapid catastrophic bleeding and recorded deaths. **Postoperative bleeding** is another complication that occurs either because of the inability to identify a posterior cystic artery or because of inadequate hemostasis at the liver bed. Precise dissection during removal of the GB and identification and ligation of a possible posterior cystic artery should always be performed during laparoscopic cholecystectomy. Hemostasis of the liver bed is best achieved either by staying in the subserosal plane during removal of the GB or with the use of diathermy or an argon beam coagulator after removal. Inflammation often increases bleeding risk. Injury to the portal vein, vena cava, or liver parenchyma is very uncommon, but is a serious complication when it occurs. **Injury to the colon, antrum of the stomach, small bowel, or more commonly the second portion of the duodenum** can occur especially with dissection of dense adhesions from GB wall inflammation. Immediate primary repair, depending on the size and extent of injury, is indicated if this occurs. **Gas embolus** from entry of gas into the vascular system is rare and usually due to direct puncture and insufflation of CO_2 with the Verres needle approach when establishing the pneumoperitoneum. It is usually catastrophic when large amounts of gas enter the heart and pulmonary circulation (reducing pumping and oxygenation). Risk is virtually abolished when open peritoneal access approaches are used and gas is insufflated via a large port. A **biliary leak** (BL)**/collection** and/or **biliary fistula** can occur because of either dislodgement of the ligature on the cystic duct, failure to identify an accessory cystic duct at operation, or superficial liver injury causing peripheral bile duct leakage. The management of these types of injuries is primarily dictated by symptoms and/or the volume of BL via an intraoperative drain or on CT/US imaging postoperatively. Asymptomatic BL < 200 ml/day needs observation alone, since most of these resolve. When BL > 200 ml/day and persistent, US-guided percutaneous drainage, percutaneous transhepatic cholangiography, or ERCP, and drainage are often required.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of leakage/fistula
- Bile duct injury
- Pancreatitis
- Risk of open operation
- Risk of further surgery

Open Cholecystectomy with Common Bile Duct Exploration

Description

General anesthesia is used. The aims are to remove the gallbladder (GB) and to intraluminally inspect the common bile duct (CBD), as well as to remove any obstructing lesions, most commonly stones. Surgical exploration of the CBD usually occurs with open cholecystectomy for symptomatic cholelithiasis or cholecystitis. An upper midline incision or a right subcostal incision is used for adequate exposure. Cholecystectomy is then performed, and an *intraoperative cholangiogram* may be performed via the cannulated cystic duct or by direct puncture of the CBD or GB (usually at the site chosen for choledochotomy or through the GB fundus, respectively). Mobilization of the hepatic flexure of colon and/or the duodenal "C" may be necessary to expose and mobilize the lower CBD and ampulla. Following this, dissection of the anterior and lateral portions of the portal pedicle will aid in identifying the common bile duct. If this is done in conjunction with an open cholecystectomy, the cystic duct can be traced to the common bile duct origin. Once the CBD is located, the lower third is dissected. Stay sutures are then usually inserted on either side for counter traction and an anterior longitudinal choledochotomy is performed. The choledochotomy is preferably made in the larger CBD, rather than the smaller diameter common hepatic duct. Once the choledochotomy has been performed, inspection of the common bile duct is then begun, usually with palpation, then vigorous irrigation distally and proximally to remove retained stones, followed by inspection with a flexible choledochoscope. Depending on the extent of stone disease within the common bile duct, the duct is either closed primarily or in conjunction with the use of a

choledochoduodenostomy (Blumgart and Fong 2000). A biliary T-tube may be placed through the choledochotomy and the CBD is closed around this, especially if distal inflammation or residual obstruction is present. A variety of tubes can be used, and some surgeons choose not to use a biliary drainage tube. An intra-abdominal drain is placed to collect any bile that may leak transiently from the choledochotomy site.

Anatomical Points

Knowledge of both the common and uncommon biliary anatomical points is required. Intraoperative cholangiography is useful in defining the individual biliary anatomy. ***Variations in biliary ductal anatomy*** are numerous (Fig. 7.1) and are essential for the accurate interpretation of cholangiograms. Identification of the common bile duct [avoiding the common hepatic duct (CHD)] should always be confirmed to ensure that a choledochotomy is not performed in a bile duct that is too small. Standard bifurcation of the CHD is most common. Trifurcation of the CHD is the second most common configuration. In almost all cases, the posterior biliary segments lie more laterally than the anterior segments, such that in the evaluation of cholangiograms, the segment 6 and 7 ducts are seen inferio-laterally and superio-laterally, respectively. Other common radiographic presentations are for the posterior sectoral ducts to be seen arching close to the confluence of the common hepatic duct. In addition, a right sectoral duct can cross to the left and join the left hepatic duct in 28 % of patients; in 22 %, this is the posterior sectoral duct, and in 6 % the anterior sectoral duct. ***Hepatic arterial anatomic points*** should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.2). The presence of either an accessory or replaced right hepatic artery that will traverse the posterolateral aspect of the common bile duct should always be remembered so that inadvertent arterial damage is not caused during dissection. In 25 % of patients the right hepatic artery will be either completely replaced or have a large accessory branch from the superior mesenteric artery. In addition, the left hepatic artery can be completely replaced or have a large accessory branch from the left gastric artery through the lesser omentum. In other less common variants, the left and right hepatic arteries can originate from the celiac trunk or branch from a very short common hepatic artery. Another less common variant is the origin of the gastroduodenal artery from the right hepatic artery. ***Hepatic portal anatomic points*** are important when performing any type of biliary exploration and/or instrumentation (Fig. 7.3). Knowledge and proper identification of the coronary vein (CV), between portal vein and stomach, cannot be overemphasized since this can lead to substantial blood loss while attempting to gain exposure of the medial aspect of the CBD. The course of the portal vein is posterior to the CBD and CHD as it approaches the liver, to bifurcate into the larger right (RPV) and smaller left portal veins (LPV). The LPV remains extrahepatic for a longer length behind the left hepatic artery until it enters the umbilical fissure. The RPV is a very short structure that will branch quickly into

the right anterior and right posterior sectoral branches (Fig. 7.3). On occasions the portal vein may divide more proximally with the right anterior and the right posterior branching independently (Fig. 7.3) and more closely embracing the CBD.

Perspective

See Table 7.5. The major chronic disability that can occur after a common bile duct exploration is damage and stricture to the extrahepatic biliary system. This primarily occurs with inadequate exposure of the common bile duct, incomplete identification of the common bile duct, or failure to recognize a small diameter common bile duct. All of these can lead to bile duct injury and chronic biliary stricture that can require both the transient or permanent biliary cannulation for adequate biliary drainage. Further surgery for drainage may be required. Persistent bile leakage, bile peritonitis, and/or fistula formation are rare, but potentially serious complications that may require further surgery. Inadvertent T-tube dislodgement or removal (if used) may delay recovery. Arterial injury and bleeding is also another significant risk factor related to anatomical point, primarily in jaundiced patients who undergo this procedure. Careful dissection, as well as visualization of either an accessory or replaced right hepatic artery, cannot be overemphasized. Bile leak is very common in the immediate postoperative period from closure of a choledochotomy or from the gallbladder bed. This type of bile leak is often inconsequential and almost always resolves via the drain tube or spontaneously and seldom requires reoperation. The need for radiological cannulation of a bile collection is rare. Infection is usually transient and limited or treated with antibiotics. Severe systemic sepsis is life threatening, but rare, and usually associated with established preoperative sepsis. Failure to visualize the bile duct adequately occurs infrequently, but may dictate an alternative approach.

Major Complications

Bile duct injury is a major complication related to a CBD exploration. Primary dissection to identify the anterior surface of the CBD can be difficult in a small subset of patients who have variant biliary anatomy in the form of an early right posterior sectoral duct takeoff, a long tortuous cystic duct, or an early bifurcation of the CBD. These variations in biliary anatomy can lead to significant biliary damage because of inadvertent ligation or transection or choledochotomy performed in portion of the bile duct too small for primary closure or even exploration. The universally accepted techniques for managing serious common bile duct injury are either a choledochoduodenostomy (for distal common bile duct injury) or a hepaticojejunostomy (for common hepatic duct injury). Injury of a small diameter (less than 5 mm) low posterior sectoral bile duct takeoff (anatomic point) can be managed with proximal

Table 7.5 Open cholecystectomy *with* common bile duct exploration estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Cholangitis	1–5 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	5–20 %
Wound/intra-abdominal	
Insertion of T-tube[a]	>80 %
Rare significant/serious problems	
Failure to detect/remove calculi[a]	0.1–1 %
Jaundice (dislodgement of gallstones into common bile duct)[a]	0.1–1 %
Aspiration pneumonitis[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Seroma formation	0.1–1 %
Injury to the bowel or blood vessels[a]	0.1–1 %
Duodenal/gastric/small bowel/colonic	
Vascular injury[a]	0.1–1 %
Liver injury	0.1–1 %
Bile/hepatic duct injury/bile leak/collection/fistula[a]	0.1–1 %
Biliary obstruction[a]	0.1–1 %
Ampullary stenosis[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Operative cholangiogram complications[a]	
Dye reaction/cholangitis/pancreatitis/radiation exposure	<0.1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus[a]	50–80 %
Wound dehiscence[a]	0.1–1 %
Blood transfusion[a]	<0.1 %
Muscle weakness (atrophy due to denervation esp. Kocher' incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %
T-tube-related complications (if used)	
Dislodgement of T-tube[a]	1–5 %
Blockage of T-tube[a]	0.1–1 %
Persistent biliary fistula (after removal; cholangio-cutaneous)[a]	0.1–1 %
T-tube cholangiogram[a]	
Dye reaction/cholangitis/pancreatitis/radiation exposure	<0.1 %

Note: include risks and complications of bile duct exploration when performed in unison with open cholecystectomy (see later)

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

ligation alone, but if the duct diameter is larger, then biliary reconstruction with either the duodenum or a Roux-en-Y of jejunum is indicated. Recent reports have demonstrated that immediate intraoperative reconstruction for major bile duct injury will lead to an equivalent quality of life when compared to patients who underwent an uncomplicated cholecystectomy (Blumgart and Fong 2000). **Bile duct perforation** or mucosal tears may result from attempted placement of the choledochoscope into a bile duct that is too small or into a variant biliary duct. If perforation is appreciated at the time of choledochotomy, primary repair may not provide a long-term effective solution and hepaticojejunostomy should be considered. The incidence of **biliary stricture** after undergoing a biliary exploration is usually small, but when this complication develops it is significant, often requiring further surgery, sometimes including biliary bypass procedures. Stricture results from bile duct trauma, either from chronic choledocholithiasis or iatrogenic from choledochotomy, choledochoscopy, instrumentation or inadvertent laceration, or ligation. As described above this can occur at any level in the biliary tree and may only become evident years after biliary surgery. **Damage of the ampulla** from chronically impacted CBD stones at the ampulla, edema, mucosal irritation, and scarring can occur. After the removal of an impacted CBD stone, further instrumentation of the ampulla with the choledochoscope can lead to mucosal tears, which can lead to long-term stricture formation and require further biliary instrumentation for drainage. **Bleeding** may arise from hepatic artery variant anatomy during dissection of the CBD. In a small subset of patients, a right hepatic artery can transverse anterior to the bile duct, which can be injured or ligated during this dissection. The portal vein should also be properly identified on the medial-posterior surface of the CBD to ensure that only anterior dissection of the common bile duct is performed prior to choledochotomy. **Postoperative bleeding** can result from a posterior cystic artery or bleeding from the liver bed. Precise dissection during removal of the GB and identification and ligation of a possible posterior cystic artery should always be performed during open cholecystectomy. Hemostasis of the liver bed is best achieved using initial pressure on a dry pack, but also by either staying in the subserosal plane during removal of the GB, or with the use of diathermy or argon beam coagulation after removal. Injury to the portal vein, vena cava, or liver parenchyma is very uncommon, but is a serious complication when it occurs. **Injury to the colon, antrum of the stomach, small bowel, or more commonly, the second portion of the duodenum** can occur especially with dissection of dense adhesions from GB wall inflammation. Immediate primary repair, depending on the size and extent of injury, is indicated if this occurs. **Missing a retained stone** due to patient anatomy, inflammation, or ductal diverticula causing poor visualization of the distal CBD, CHD, and sectoral hepatic ducts can occur. Improper use of the choledochoscope or inadequate flow of the pressure irrigation is possible technical contributors to this. This can lead to the retention of CBD stones, which can lead to later **cholangitis**. A **biliary leak** (BL)**/collection** and/or **biliary fistula** can occur because of either dislodgement of the ligature on the cystic duct, failure to identify an accessory cystic duct at operation, or superficial liver injury causing peripheral bile duct leakage. Further biliary instrumentation in the form of US-guided percutaneous drainage, ERCP, percutaneous transhepatic cholangiography, or repeat surgical exploration may be required. Cholangitis prior to or at surgery or postoperatively can result in severe **sepsis** and **multisystem organ failure** and is a major cause of **mortality** when it occurs.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Bile duct injury
- Risk of leakage/fistula
- Pancreatitis
- Risk of further surgery

Laparoscopic Cholecystectomy with Exploration of the Common Bile Duct

Description

General anesthesia is used for all laparoscopic approaches to remove the gallbladder (GB) and explore the common bile duct (CBD) and for choledochotomy. The aims of this procedure are to remove the GB with open intraluminal CBD exploration, as well as removal of any obstructing lesions, most commonly gallstones. Laparoscopic CBD exploration is usually performed after the completion of a laparoscopic cholecystectomy, and either *intraoperative cholangiogram or CBD ultrasound* is employed for identifying CBD abnormalities, principally calculi. There are three main minimally invasive techniques in the removal of CBD stones: (1) transcystic duct exploration using either a grasper or basket in order to remove the retained stone through the cystic duct, (2) pushing the stone through the sphincter of Oddi into the second portion of the duodenum, or (3) laparoscopic CBD exploration by choledochotomy, which is fully described here. If the CBD diameter is greater than 1 cm, an anterior choledochotomy is performed through a longitudinal incision of the CBD superior to the duodenum. A 2 mm choledochoscope is passed through one of the 5 mm ports to inspect the common hepatic duct, the right and left hepatic bile ducts, and the CBD. Residual stones are removed or flushed from the CBD, either via the choledochotomy or pushed into the duodenum. Closure of the CBD can be performed in three different types of established techniques (Wu and Soper 2002). The first is primary closure, associated with a demonstrated greater incidence of stenosis of variable clinical significance. The second technique is closure over a T-tube with subsequent removal some weeks later. Although shown to be effective, with reduced CBD stenosis, it requires more operative time. The third (less common) technique is closure of the CBD over an antegrade stent via the choledochotomy, recently shown be effective without significant stenosis or prolonging operative time. Ultimately, the surgeon's preference, clinical situation,

and the CBD diameter will be defined by the type of closure used. Occasionally, conversion to open operation is required for hemorrhage or for safety due to poor access or visibility.

Anatomical Points

Knowledge of the common and uncommon biliary and vascular anatomical points is essential for reducing mishap during biliary surgery. An accessory or replaced right hepatic artery traversing the posterior, lateral aspect of the CBD may be present and may result in inadvertent arterial damage. Correct identification of the common bile duct, rather than the common hepatic duct, should be confirmed to ensure that a choledochotomy is not performed in a bile duct that is too small. The variations in *biliary ductal anatomy* are numerous (Fig. 7.1) and are essential for the accurate interpretation of cholangiograms. The prevalence of these forms of anatomic points are demonstrated in Fig. 7.1, with a majority having the standard bifurcation of the common hepatic duct with a trifurcation of the common hepatic duct being the second most common. In almost all cases, the posterior biliary segments lie more laterally than the anterior segments, such that in the evaluation of cholangiograms the segment 6 and 7 ducts are seen inferio-laterally and superiolaterally, respectively. Other common radiographic presentations are for the posterior sectoral ducts to be seen arching close to the confluence of the common hepatic duct. In addition, a right sectoral duct can cross to the left and join the left hepatic duct in 28 % of patients; in 22 %, this is the posterior sectoral duct, and in 6 % it is the anterior sectoral duct. *Hepatic arterial* anatomic point should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.2). In 25 % of patients the right hepatic artery will either be completely replaced or have a large accessory branch from the superior mesenteric artery. In addition the left hepatic artery can be completely replaced or have a large accessory branch from the left gastric artery through the lesser omentum. In other less common variances, the left and right can originate from the celiac trunk or branch from a very short common hepatic artery. A less common variant is origination of the gastroduodenal artery from the right hepatic artery. *Hepatic portal* anatomic point should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.3). Knowledge and proper identification of the coronary vein (CV), between portal vein and stomach, cannot be overemphasized since this can lead to substantial blood loss while attempting to gain exposure of the medial aspect of the common bile duct. The course of the portal vein is behind the CBD and the common hepatic duct as it approaches the liver, to bifurcate into the larger right (RPV) and smaller left portal veins (LPV). The LPV remains extrahepatic for a longer period behind the left hepatic artery until it enters the umbilical fissure. The RPV is very short and branches quickly into the right anterior and right posterior sectoral branches. On occasions the portal vein may divide more proximally with the right anterior and the right posterior branching independently (Fig. 7.3) and more closely embracing the CBD.

Perspective

See Table 7.6. Management of cholelithiasis and choledocholithiasis in most hospitals requires the collaboration of two specialized teams. The gastroenterologists/surgical endoscopists and the laparoscopic surgical teams often deal with a single illness. In the majority of hospitals, this usually requires two separate procedures, with the potential of increasing overall morbidity and cost. The method of common bile duct surgical exploration by choledochotomy requires surgical expertise, but can provide a simple one-stage procedure. It is not always available in all surgical centers. The surgical complications that can occur during a laparoscopic common

Table 7.6 Laparoscopic cholecystectomy *with* exploration of the common bile duct

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	5–20 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Cholangitis[a]	1–5 %
Systemic	1–5 %
Port site	0.1–1 %
Bleeding/hematoma formation	1–5 %
Wound/intra-abdominal	
Conversion to open operation	1–5 %
Insertion of T-tube[a]	50–80 %
Rare significant/serious problems	
Failure to detect/remove calculi[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Seroma formation	0.1–1 %
Injury to the bowel or blood vessels (trocar or diathermy)[a]	0.1–1 %
Duodenal/gastric/small bowel/colonic	
Vascular injury	0.1–1 %
Liver injury	0.1–1 %
Bile duct injury/bile leak/collection/fistula	0.1–1 %
Necessity for open biliary drainage procedure(s) after duct injury[a]	0.1–1 %
Biliary stricture[a]	<0.1 %
Jaundice (dislodgement of gallstones into common bile duct)[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Pneumothorax	0.1–1 %
Chest/lung infections[a]	1–5 %
Deep venous thrombosis	0.1–1 %
Gas embolus[a]	0.1–1 %
Operative cholangiogram complications	
Dye reaction/cholangitis/pancreatitis/radiation exposure	<0.1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	<0.1 %

Table 7.6 (continued)

Complications, risks, and consequences	Estimated frequency
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus[a]	50–80 %
Wound dehiscence	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	0.1–1 %
Port-site hernia formation[a]	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %
T-tube-related complications (if used)	
Dislodgement of T-tube[a]	1–5 %
Blockage of T-tube[a]	0.1–1 %
Persistent biliary fistula (after removal; cholangio-cutaneous)[a]	0.1–1 %
T-tube cholangiogram[a]	
Dye reaction/cholangitis/pancreatitis/radiation exposure	<0.1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences. Infection may predate surgery and be exacerbated by duct/GB manipulation

bile duct exploration, by choledochotomy, remain similar to any other form of laparoscopic biliary surgery. Primary complications often relate to Anatomical Points in the bile duct, arterial, or portal venous anatomy. This failure to identify anatomy or other technical difficulties can be more safely dealt with by conversion to an open CBD exploration procedure or postoperative ERCP, if indicated. Conversion to an open technique occurs in approximately 4 % of patients, often due to bleeding, variant anatomy, and poor visualization of the anatomical structures. Conversion to an open technique for safety should not be labeled a laparoscopic technique failure. Open common bile duct exploration remains the standard of surgical care in patients with choledocholithiasis in many centers. Minor bleeding is common, as is transient infection and fever with biliary manipulation especially when preexisting infection is present. Bile leakage is common and usually minor, often being asymptomatic. Elderly patients are more subject to complications, in general. Major complications are not usual.

Major Complications

Bile duct injury with concomitant **biliary stricture** remains the most serious major complication following laparoscopic common bile duct exploration by choledochotomy. Choledochotomy in a CBD that is too small in diameter (less than 1 cm) is a cause of stenosis that can be avoided by intraoperative identification and decision to not perform the procedure. Other than this, the incidence of biliary stricture following

a laparoscopic bile duct exploration is primarily related to the type of closure that is utilized. For severe CBD stricture, injury, or division, **open surgical exploration and repair** with a choledochoduodenostomy or Roux-en-Y hepaticojejunostomy may be required, involving one or two further operations. **Conversion to open operation** for safety reasons, if injury, poor visibility or bleeding should occur, or failure to progress, and is a small but significant risk to mention to the patient. **Biliary leakage** may occur from bile leaks around the choledochotomy or dislodgement of a T-tube (in < 1 % of patients). Most are small bile leaks, but some will require radiologically or surgically placed drains or ERCP-guided stent placement depending on the amount of biliary drainage and symptoms. If identified at operation a drain may be placed then. **Bleeding:** During dissection of the common bile duct, hepatic artery variant anatomy should also be identified. In a small subset of patients, a right hepatic artery can transverse anterior to the bile duct and is in danger of injury or ligation during dissection. Before choledochotomy, it should be verified that the portal vein (PV) lies on the medial-posterior aspect of the common bile duct to avoid catastrophic injury of an aberrant PV during the (anterior) dissection of the common bile duct. Rarely, substantial bleeding may arise from the portal vein, IVC, or liver. **Gas embolism and vascular/bowel injury** are rare but devastating complications that may be reduced by open cutdown entry techniques. **Hyperamylasemia and pancreatitis** can occur postoperatively in approximately 20 % and 1 % of patients, respectively, are usually mild, and can be managed nonsurgically in a majority of cases. Severe pancreatitis is relatively rare.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of leakage/fistula
- Bile duct injury
- Pancreatitis
- Risk of open operation
- Risk of further surgery

Biliary Bypass Drainage Procedures

Description

General anesthesia is used. The aim is to bypass bile around an obstruction in the biliary system. Types of bypass include loop choledochojejunostomy, loop hepaticojejunostomy, Roux-en-Y choledochojejunostomy, Roux-en-Y hepaticojejunostomy,

choledochoduodenostomy, and variations on these. The indications for a biliary bypass are commonly for obstructive jaundice due to either a benign or malignant stricture of the hepatic duct, common bile duct or duodenum. Palliative biliary bypass for advanced malignancy is probably the commonest indication overall. Multiple variations of hepaticojejunostomy exist because of Anatomical Points, site of obstructing lesion, or difficulty in obtaining exposure to the liver hilum because of adhesions or tumor involvement. Adequate biliary drainage is essential for patients who are faced with biliary obstruction from either a benign or malignant lesion. There are three critically important principles in performing a biliary-enteric anastomosis: first, identification of a healthy bile duct proximal to the site of obstruction; second, preparation of a segment of gastrointestinal tract, most commonly a Roux-en-Y loop of jejunum for anastomosis; and third, direct mucosa-to-mucosa anastomosis between a healthy bile duct and a segment of gastrointestinal tract (Blumgart and Fong 2000). The site of obstruction, as well as the ability to obtain a healthy segment of bile duct determines which of the four primary types of biliary bypass should be used. They are cholecystojejunostomy, choledochojejunostomy, hepaticojejunostomy, and segmental (segment 3 or 5) biliary bypass. Surgeon preference will dictate the need for a trans-anastomotic stenting of the bile duct to the jejunum. A midline laparotomy or inverted "V" incision is frequently used.

Anatomical Points

The variations in the biliary ductal anatomy have been previously described (Fig. 7.1). The junction between the cystic duct and the main extrahepatic biliary system can be very high, almost within the hilus of the liver, or very low at the superior aspect of the pancreas. The low junction between the cystic and the common hepatic duct is important when a cholecystojejunostomy is being considered as a biliary bypass for pancreatic or distal bile duct malignancy. The main right hepatic duct may be absent, with the anterior and posterior sectoral ducts of the right lobe joining the left hepatic duct separately to form the common hepatic duct. A majority of the ductal anomalies occur in conjunction with the right and the cystic ducts. Consistent anatomy usually occurs with the left hepatic duct and its branches. The can be important when, rarely, the hilus cannot be approached because of dense adhesions or tumors and a segment III or V biliary bypass is required (Jarnagin et al. 1998). In 25 % of patients the right hepatic artery will be either completely replaced or have a large accessory branch from the superior mesenteric artery. In addition the left hepatic artery can be completely replaced or have a large accessory branch from the left gastric artery through the lesser omentum (Fig. 7.2). In other less common variances the left and right can originate from the celiac trunk or branch from a very short common hepatic artery. The last less common variance can be the origination of the gastroduodenal artery from the right hepatic artery. Hepatic portal anatomic point should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.3). Identification of the coronary vein (CV) cannot be

overemphasized since to avert substantial blood loss while attempting to gain exposure of the medial aspect of the common bile duct. The course of the portal vein is behind the common bile duct and the common hepatic duct as it approaches the liver. There it will usually bifurcate the larger right (RPV) and smaller left portal veins (LPV). The LPV will remain extrahepatic for a longer period behind the left hepatic artery until it enters the umbilical fissure. The RPV is a very short structure that will branch quickly into the right anterior and right posterior sectoral branches. One main variance remains: the division of the portal vein more proximally with the right anterior and the right posterior branches occurring independently (Fig. 7.3).

Perspective

See Table 7.7. Biliary leakage is a major complication from anastomotic failure or direct leakage from any cut liver surface. Continued drainage, collection, or infection may ensue. Failure to relieve the obstruction or re-obstruction can occur with advancing malignancy. Bleeding at the time or after of surgery can occur and is rarely major. Infection is often preexisting and may be episodic in the form of ascending cholangitis or peritonitis, systemic sepsis, and occasionally leading to multisystem organ failure and death. Death from progressive malignancy is a more common sequela if this is the primary reason for surgery. Later complications for longer survivors include reflux cholangitis and biliary stenosis.

Major Complications

The major complication in performing a biliary bypass drainage is related to postoperative **biliary leak**, caused by inability to adequately anastomose healthy bile duct mucosa to the jejunum, or from leakage of small biliary radicals. These can predominately be managed with the use of a drain placed intraoperatively and removed when drainage abates. **Biliary Stricture** after palliative biliary bypass drainage for malignant disease is uncommon, because life expectancy is often limited. However, for benign disease the incidence of biliary stricture in patients who undergo biliary bypass can occur, relating to the small diameter of the duct anastomosed or due to scarring at the anastomosis. The management of these types of strictures primarily depends on the location of the anastomosis. **Surgical exploration and revision** of the anastomosis may be required. Those that are technically impossible to revise can be managed with percutaneous drainage, dilation, and possible permanent wall stent placement, depending on the ductal anatomy. **Reflux cholangitis** is a delayed complication after biliary bypass occurs, primarily because of two reasons: (1) reflux of gastrointestinal contents into the biliary system, occurring more often when duodenum is utilized for biliary bypass compared with jejunum (Tocchi et al. 2001), but also when a Roux limb of jejunum is too short (less than 70 cm), and (2) when

Table 7.7 Biliary bypass drainage procedures estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Cholangitis	1–5 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Wound/intra-abdominal	
Injury/perforation/damage (duodenum, ampulla, bile duct/pancreatic duct, small bowel, colon)[a]	1–5 %
Failure to adequately drain duct/gallbladder[a]	1–5 %
T-tube biliary drainage[a]	1–5 %
Rare significant/serious problems	
Failure of suture/staple line (anastomotic breakdown)[a]	0.1–1 %
Aspiration pneumonitis[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Duodenal/enteric stenosis/obstruction[a]	0.1–1 %
Seroma formation	0.1–1 %
Vascular injury[a]	0.1–1 %
Liver injury	0.1–1 %
Bile/hepatic duct injury/bile leak/collection/fistula[a]	0.1–1 %
Late bile duct/enteric stenosis[a]	0.1–1 %
Biliary obstruction[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Wound dehiscence[a]	0.1–1 %
Blood transfusion[a]	<0.1 %
Muscle weakness (atrophy due to denervation esp. Kocher' incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %
T-tube-related complications (if used)	
Dislodgement of T-tube[a]	1–5 %
Blockage of T-tube[a]	0.1–1 %
Persistent biliary fistula (after removal; cholangio-cutaneous)[a]	0.1–1 %
T-tube cholangiogram[a]	
Dye reaction/cholangitis/pancreatitis/radiation exposure	<0.1 %

[a]Dependent on underlying pathology, anatomy, surgical tecnique, and preferences

excessive jejunum is distal to the anastomosis creating a "sump" for chronically infected bile and small bowel contents that can reflux intermittently into the biliary system. Isolated reflux cholangitis events can be managed with IV antibiotics; however, repeated reflux cholangitis should be managed surgically with a revision of the anastomosis, if feasible. **Bleeding** is rarely a serious problem, as is the need for **blood transfusion**. **Infection** may be a serious problem leading to **abscess formation** or **systemic sepsis** and uncommonly **multisystem organ failure** and **death**.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of leakage/fistula
- Bile duct injury/stenosis
- Pancreatitis
- Risk of further surgery

Resection of the Upper Bile Duct: Roux-en-Y Hepaticojejunostomy

Description

General anesthesia is used. The surgical evaluation and resection of the upper bile duct is primarily indicated for proximal cholangiocarcinomas. The resection of the isolated upper bile duct is not a common procedure, primarily because cholangiocarcinoma universally extends into the second order intrahepatic bile ducts. Thus, some form of hepatic resection is almost universally required to obtain a R0 resection. However, in a few cases, local resection of small tumors not extending into the second order intrahepatic bile ducts, and not involving the major vessels, may be possible. In this situation resection includes removal of the extrahepatic bile duct with the gall bladder and cystic duct. The resection of the upper bile duct can be technically difficult without adequate exposure and length at the hilus during exploration. An adequate surgical incision, as well as incising of the hilar plate, is integral to the success and safety of performing a resection of the upper bile duct. Once this is obtained, the surgical anastomosis between a Roux loop of jejunum is also of importance. The three primary factors involved in the success of any anastomosis should always be utilized: (1) the identification of a healthy bile duct, (2) the preparation of a segment of gastrointestinal tract that is not under undue tension, and (3) a direct mucosa-to-mucosa anastomosis between this healthy duct and the segment

of gastrointestinal tract. Again, surgeon preference will primarily dictate the need for a trans-anastomotic stenting between the bile duct and the anastomosed jejunum. Either a midline or a subcostal incision is utilized to gain exposure to the extrahepatic bile duct.

Anatomical Points

The variations in the biliary ductal anatomy have been previously described (Fig. 7.1). The most important ductal anomalies related to biliary bypass are the type of confluence that exists between the right and left ducts in relation to the cystic duct. The most common variation occurs from the abnormal junction between the cystic duct and the main extrahepatic biliary system. The cystic duct can join the common hepatic duct very high, almost within the hilus of the liver, or very low at the superior aspect of the pancreas. This very low junction between the cystic and the common hepatic duct is important when a cholecystojejunostomy is being considered for biliary bypass for a pancreatic or distal bile duct malignancy. The main right hepatic duct may be absent with the anterior and posterior sectoral ducts of the right lobe joining the left hepatic duct separately to form the common hepatic duct. A majority of the ductal anomalies all occur in conjunction with the right and cystic ducts. There is a consistent anatomy related to the left hepatic duct and its branches. The reason this concept is important relates to the rare occasion when the hilus cannot be approached because of dense adhesions or tumors, and the need for a segment III biliary bypass is required (Jarnagin et al. 1998). Hepatic arterial anatomic point should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.2). In 25 % of patients the right hepatic artery will either be completely replaced or have a large accessory branch from the superior mesenteric artery. In addition the left hepatic artery can be completely replaced or have a large accessory branch from the left gastric artery through the lesser omentum. In other less common variances, the left and right can originate from the celiac trunk or branch from a very short common hepatic artery. The last less common variance can be the origination of the gastroduodenal artery from the right hepatic artery. Hepatic portal anatomic point should also be considered when performing any type of biliary exploration and/or instrumentation (Fig. 7.3). Identification of the coronary vein (CV) cannot be overemphasized since this can lead to substantial blood loss while attempting to gain exposure of the medial aspect of the common bile duct. The course of the portal vein is behind the common bile duct and the common hepatic duct as it approaches the liver. There it will usually bifurcate into the larger right portal veins (RPV) and smaller left portal veins (LPV). The LPV will remain extrahepatic for a longer period behind the left hepatic artery until it enters the umbilical fissure. The RPV is a very short structure that will branch quickly into the right anterior and right posterior sectoral branches. The one main variance remains that of the division of the portal vein more proximally with the right anterior and the right posterior branching independently (Fig. 7.3).

Perspective

See Table 7.8. Biliary leakage is a major complication from anastomotic failure or direct leakage from any cut liver surface. Continued drainage or infection may ensue. Bleeding at the time of or after surgery can occur and is rarely major. Infection may be episodic in the form of ascending cholangitis, or peritonitis, systemic sepsis, and occasionally leading to multisystem organ failure and death. Death from progressive malignancy is a more common sequela, if this is the primary reason for surgery. Later complications for longer survivors include reflux cholangitis and biliary stenosis.

Table 7.8 Resection of the upper bile duct: Roux-en-Y hepaticojejunostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	0.1–1 %
Cholangitis	1–5 %
Liver (hepatitis; abscess)[a]	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Wound/GI/raw liver surface/intra-abdominal	
Failure to adequately drain duct/gallbladder[a]	1–5 %
T-tube biliary drainage[a]	1–5 %
Bile leak/collection[a]	20–50 %
Rare significant/serious problems	
Failure of suture/staple line (anastomotic breakdown)[a]	0.1–1 %
Aspiration pneumonitis[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Injury to the bowel or blood vessels (duodenum, ampulla, bile duct/pancreatic duct, small bowel, colon, vena cava, portal vessels)[a]	0.1–1 %
Seroma formation	0.1–1 %
Liver injury	0.1–1 %
Bile/hepatic duct injury/fistula[a]	0.1–1 %
Biliary ascites[a]	<0.1 %
Late bile duct/enteric stenosis[a]	0.1–1 %
Biliary obstruction[a]	0.1–1 %
Small bowel ischemia/fistula[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	<0.1 %

Table 7.8 (continued)

Complications, risks, and consequences	Estimated frequency
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	50–80 %
Wound dehiscence[a]	0.1–1 %
Blood transfusion[a]	<0.1 %
Muscle weakness (atrophy due to denervation esp. Kocher' incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

Major Complications

The major complication in performing biliary bypass drainage is related to postoperative **biliary leak**, caused by inadequate identification of healthy bile duct mucosa, an inadequate anastomosis to the jejunum, or leakage from small biliary radicals. These can predominately be managed with the use of a drain placed intraoperatively and removed when drainage abates. **Biliary stricture** after palliative biliary bypass drainage for malignant disease is uncommon because life expectancy is limited. However, for benign disease the incidence of biliary stricture in patients who undergo biliary bypass can occur, relating to the diameter of the duct anastomosed or due to a small subclinical leak that leads to scarring of the anastomosis. The management of these types of strictures primarily depends on the location of the anastomosis. Surgical exploration and revision of the anastomosis may be required. Those that are technically impossible to revise can be managed with percutaneous drainage, dilation, and possible permanent wall stent placement, depending on the ductal anatomy. **Reflux cholangitis** is a delayed complication after biliary bypass occurs, primarily because of two reasons: (i) reflux of gastrointestinal contents into the biliary system, occurring more often when duodenum is utilized for biliary bypass compared with jejunum (Tocchi et al. 2001), but also when a Roux limb of jejunum is too short (less than 70 cm), and (ii) when excessive jejunum is distal to the anastomosis creating a "sump" for chronically infected bile and small bowel contents that can reflux intermittently into the biliary system. Isolated reflux cholangitis events can be managed with IV antibiotics; however, repeated reflux cholangitis should be managed surgically with a revision of the anastomosis. **Recurrent or persistent jaundice** can also occur, which may require either reoperation and/or external drainage. **Bleeding** is rarely a serious problem, as is the need for **blood transfusion**. **Infection** may be a serious problem leading to **abscess formation** or **systemic sepsis** and uncommonly **multisystem organ failure** and **death**.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of leakage/fistula
- Bile duct injury/stenosis
- Pancreatitis
- Risk of open operation
- Risk of further surgery

Mobilization of Duodenum (Kocher's Procedure)

Description

General anesthesia is used. The aim is to mobilize the second and third parts of the duodenum to allow it to be brought anteriorly and to the left side. The main indications for this are (i) for inspection of the duodenum for possible perforation from either trauma or peptic ulceration and (ii) for improving the access during choledochoscopy or ampullary/duodenal/pancreatic head surgery. Duodenal mobilization is seldom performed alone. The peritoneal covering over the retroperitoneally placed 2nd and 3rd parts of the duodenum is divided laterally to expose the posterior aspect of the duodenum, and the duodenum is usually able to be pushed medially and anteriorly using blunt dissection by finger or swab stick. The distal bile duct and entry into the duodenum can typically be exposed using this approach. Care is taken to avoid injury to the right renal vessels, vena cava, mesocolon, or bile duct. A midline laparotomy is usually used, but other concurrent surgeries may dictate an alternative approach.

Anatomical Points

The variations in the biliary ductal anatomy have been previously described (Fig. 7.1). The junction between the cystic duct and the main extrahepatic biliary system can be very high, almost within the hilus of the liver, or very low at the superior aspect of the pancreas. The low junction between the cystic and the common hepatic duct is important to define when a duodenal mobilization is performed. The remaining anatomy is usually consistent, except when renal anomalies (e.g., horseshoe kidney), scarring, and inflammation occur, or tumor distorts the anatomy, or very rarely when situs inversus is present.

Table 7.9 Mobilization of duodenum (Kocher's procedure) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Bleeding/hematoma formation[a]	1–5 %
Wound/intra-abdominal	
Rare significant/serious problems	
Infection[a] overall	0.1–1 %
Subcutaneous	0.1–1 %
Intra-abdominal/pelvic	0.1–1 %
Cholangitis[a]	0.1–1 %
Systemic	0.1–1 %
Injury/perforation/damage (duodenum, ampulla, bile duct/pancreatic duct, small bowel, colon/liver)[a]	0.1–1 %
Failure to adequately mobilize the duodenum[a]	0.1–1 %
Failure of suture/staple line (anastomotic breakdown)[a]	0.1–1 %
Aspiration pneumonitis[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Vascular injury[a]	0.1–1 %
Late bile duct/enteric stenosis[a]	0.1–1 %
Biliary obstruction[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	<0.1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Wound dehiscence[a]	0.1–1 %
Blood transfusion[a]	<0.1 %
Muscle weakness (atrophy due to denervation esp. Kocher' incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences. Risks may be modified by pathology and concurrent surgical procedures

Perspective

See Table 7.9. Complications from duodenal mobilization are uncommon, but this depends on the indication(s) for the surgery. Biliary leakage is a major complication from inadvertent perforation or from anastomotic failure if duodenotomy is performed. Continued drainage, collection, or infection may ensue. Bleeding at the time of or after surgery can occur and is rarely major. Infection may be preexisting

and may be episodic in the form of ascending cholangitis, or peritonitis, systemic sepsis, and occasionally leading to multisystem organ failure and death. Death from progressive malignancy is a more common sequela if this is the finding at surgery. Later complications for longer survivors include reflux cholangitis and biliary stenosis, if bile duct injury occurs.

Major Complications

Complications are uncommon following simple duodenal mobilization. The major complication is postoperative **biliary leakage**, caused by inadvertent perforation or from anastomotic failure if duodenotomy is performed. **Biliary stricture** may occur if the bile duct is injured. **Pancreatitis** can occur from pancreatic mobilization or injury. **Bleeding** is rarely a serious problem, as is the need for **blood transfusion**. **Infection** may be a serious problem leading to **abscess formation** or **systemic sepsis** and uncommonly **multisystem organ failure** and **death**.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of duodenal injury/leakage/fistula
- Bile duct injury
- Pancreatitis
- Risk of further surgery

Open Ampulla of Vater Exploration

Description

General anesthesia is used. The aim is to mobilize the duodenum and perform an anterior longitudinal duodenotomy to locate the papilla of Vater for surgical exploration. The indication was often an impacted gallstone at the ampulla or papilla or more rarely to determine the nature of a ductal/duodenal lesion at this site. This procedure is less often performed in the modern era of endoscopic surgery (including ERCP). The duodenum is mobilized. The peritoneal covering over the

retroperitoneally placed 2nd and 3rd parts of the duodenum is divided laterally to expose the posterior aspect of the duodenum, and the duodenum is usually able to be pushed medially and anteriorly using blunt dissection by finger or swab stick. The distal bile duct and entry into the duodenum can typically be exposed using this approach. A duodenotomy is then performed to expose the intraluminal common bile duct (CBD) opening. The ampulla can be cannulated, explored with, or without incision into the duct. Care is taken to avoid perforation through the duodenal wall or injury to the right renal vessels, vena cava, mesocolon, or bile duct. A midline laparotomy is usually used, but other concurrent surgeries may dictate an alternative approach. A protective naso-duodenal tube may be placed across the anastomosis intraluminally to decompress the duodenum, attempting to reduce duodenal anastomotic leakage. An external drain is often placed to detect early and manage any collection or anastomotic leakage, forming a controlled fistula, if it eventuates.

Anatomical Points

The variations in the biliary ductal anatomy have been previously described (Fig. 7.1). The junction between the cystic duct and the main extrahepatic biliary system can be very high, almost within the hilus of the liver, or very low at the superior aspect of the pancreas. The low junction between the cystic and the common hepatic duct is important to define when a duodenal mobilization is performed. The remaining anatomy is usually consistent, except when renal anomalies (e.g., horseshoe kidney), scarring, inflammation occur, or tumor distorts the anatomy, or very rarely when situs inversus is present. The CBD papilla can be either separate or coincident with the pancreatic duct opening.

Perspective

See Table 7.10. Complications from duodenal mobilization, duodenotomy, and papilla of Vater surgery depend on the indication(s) for the surgery. Duodenal and biliary leakages are major complications from anastomotic failure and inadvertent biliary injury, respectively. Continued drainage, collection, or infection may ensue. Fistula formation may be problematic when it occurs, as it is often high output and chronic. Bleeding at the time of or after surgery can occur and is rarely major. Infection may be preexisting and may be episodic in the form of ascending cholangitis, or peritonitis, systemic sepsis, and occasionally leading to multisystem organ failure and death. Later complications for longer survivors include duodenal stenosis or biliary stenosis, if bile duct injury occurs.

Table 7.10 Open ampulla of Vater exploration estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	1–5 %
Cholangitis[a]	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Wound/intra-abdominal	
Fistula (duodenal/biliary/pancreatic)[a]	1–5 %
Delayed gastric emptying[a]	1–5 %
T-tube biliary drainage[a]	20–50 %
Rare significant/serious problems	
Injury/perforation/damage (duodenum/ampulla, bile duct/pancreatic duct, small bowel, colon, liver)[a]	0.1–1 %
Failure to adequately mobilize the duodenum[a]	0.1–1 %
Failure to correct the problem[a]	0.1–1 %
Failure of suture/staple line (anastomotic breakdown)[a]	0.1–1 %
Duodenal fistula[a]	0.1–1 %
Aspiration pneumonitis[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Vascular injury[a]	0.1–1 %
Late bile duct/papilla (re-)stenosis[a]	0.1–1 %
Duodenal stenosis/obstruction[a]	0.1–1 %
Biliary obstruction[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Wound dehiscence[a]	0.1–1 %
Blood transfusion[a]	<0.1 %
Muscle weakness (atrophy due to denervation esp. Kocher' incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	20–50 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences. Risks may be modified by pathology and concurrent surgical procedures

Major Complications

Complications are not insignificant following duodenotomy and papilla of Vater surgery. The major complication is postoperative **duodenal leakage**, caused by anastomotic failure. **Biliary stricture** may occur if the bile duct is injured. **Pancreatitis** can occur from pancreatic mobilization or injury. Formation of a collection and high-output drainage through the wound drain can lead to chronic fistula formation, associated with prolonged hospitalization. **Bleeding** is rarely a serious problem, as is the need for **blood transfusion**. **Infection** may be a serious problem leading to **abscess formation** or **systemic sepsis**, and uncommonly **multisystem organ failure** and **death**.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of duodenal leakage/fistula
- Bile duct injury/stenosis
- Pancreatitis
- Risk of further surgery

Duodenal Stricture Resection

Description

General anesthesia is used. The aim is to mobilize and resect the region of a duodenal stricture, typically arising from scarring associated with chronic duodenal ulceration in the second and third parts of the duodenum, and to reanastomose the ends. This procedure is rarely performed in the modern era of proton-pump acid inhibitors and more effective ulcer treatments. The duodenum is mobilized. The peritoneal covering over the retroperitoneally placed 2nd and 3rd parts of the duodenum is divided laterally to expose the posterior aspect of the duodenum, and the duodenum is usually able to be pushed medially and anteriorly using blunt dissection by finger or swab stick. The distal bile duct and entry into the duodenum can typically be exposed using this approach. Care is taken to avoid injury to the right renal vessels, vena cava, mesocolon, or bile duct. A midline laparotomy is usually used, but

other concurrent surgeries may dictate an alternative approach. A protective nasoduodenal tube may be placed across the anastomosis intraluminally to decompress the duodenum, attempting to reduce duodenal anastomotic leakage. An external drain is often placed to detect early and manage any collection or anastomotic leakage, forming a controlled fistula, if it eventuates.

Anatomical Points

The variations in the biliary ductal anatomy have been previously described (Fig. 7.1). The junction between the cystic duct and the main extrahepatic biliary system can be very high, almost within the hilus of the liver, or very low at the superior aspect of the pancreas. The low junction between the cystic and the common hepatic duct is important to define when a duodenal mobilization is performed. The remaining anatomy is usually consistent, except when renal anomalies (e.g., horseshoe kidney), scarring, and inflammation occur, or tumor distorts the anatomy, or very rarely when situs inversus is present.

Perspective

See Table 7.11. Complications from duodenal mobilization and resection depend on the indication(s) for the surgery. Duodenal and biliary leakages are major complications from anastomotic failure and inadvertent biliary injury, respectively. Continued drainage, collection or infection may ensue. Bleeding at the time of or after surgery can occur and is rarely major. Infection may be preexisting and may be episodic in the form of ascending cholangitis, or peritonitis, systemic sepsis and occasionally leading to multisystem organ failure and death. Later complications for longer survivors include duodenal restenosis or biliary stenosis, if bile duct injury occurs.

Major Complications

Complications are not insignificant following duodenal mobilization, resection, and reanastomosis. The major complication is postoperative **duodenal leakage**, caused by anastomotic failure. **Biliary stricture** may occur if the bile duct is injured. **Pancreatitis** can occur from pancreatic mobilization or injury. Formation of a collection and high-output drainage through the wound drain can lead to chronic fistula formation, associated with prolonged hospitalization. **Bleeding** is rarely a serious

Table 7.11 Duodenal stricture resection estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	1–5 %
Subcutaneous	1–5 %
Intra-abdominal/pelvic	1–5 %
Cholangitis[a]	0.1–1 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Wound/intra-abdominal	
Rare significant/serious problems	
Injury/perforation/damage (ampulla, bile duct/pancreatic duct, small bowel, colon, liver)[a]	0.1–1 %
Failure to adequately mobilize the duodenum[a]	0.1–1 %
Failure to fully resect stricture[a]	0.1–1 %
Failure of suture/staple line (anastomotic breakdown)[a]	0.1–1 %
Duodenal fistula[a]	0.1–1 %
Aspiration pneumonitis[a]	0.1–1 %
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	0.1–1 %
Vascular injury[a]	0.1–1 %
Late bile duct/duodenal (re-)stenosis[a]	0.1–1 %
Biliary obstruction[a]	0.1–1 %
Small bowel obstruction (early or late)[a]	0.1–1 %
Possibility of colostomy/ileostomy (very rare)[a]	< 0.1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Death[a]	0.1–1 %
Less serious complications	
Pain/tenderness	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	1–5 %
Paralytic ileus	20–50 %
Wound dehiscence[a]	0.1–1 %
Blood transfusion[a]	<0.1 %
Muscle weakness (atrophy due to denervation esp. Kocher' incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Wound drain tube(s)[a]	1–5 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences. Risks may be modified by pathology and concurrent surgical procedures

problem, as is the need for **blood transfusion**. **Infection** may be a serious problem leading to **abscess formation** or **systemic sepsis** and uncommonly **multisystem organ failure** and **death**.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of duodenal injury/leakage/fistula
- Bile duct injury
- Pancreatitis
- Risk of further surgery

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Chapter 8
Liver Resection Surgery

Robert C.G. Martin, Kelly M. McMasters, Guy Maddern, Jonathan Koea, and Brendon J. Coventry

General Perspective and Overview

Liver resection surgery has gradually evolved from an exceedingly complex, high risk, novel set of procedures associated with a relatively high complication rate and significant blood loss to surgery that is more routine (although still highly specialized), now typically associated with reduced risk and minimal blood loss (Fan et al. 1999) (Fig. 8.1). The use of **high-quality preoperative imaging with three-dimensional reconstructions** prior to any form of hepatectomy has enhanced selection, operative planning, and risk reduction significantly. This reduction in perioperative risk is the result of a number of factors. *Patient selection* has been optimized in terms of cardiopulmonary fitness, detecting the presence of underlying liver disease such as cirrhosis or steatosis, and utilization of *preoperative portal vein embolization* in cases where extended resections are employed. An improved understanding of intrahepatic anatomy and routine use of *intraoperative ultrasound* has enhanced the surgeon's ability to perform precise resections, limiting blood loss and preserving parenchyma. *Intraoperative care* has also been improved with the introduction of low central venous pressure anesthesia to reduce intraoperative blood

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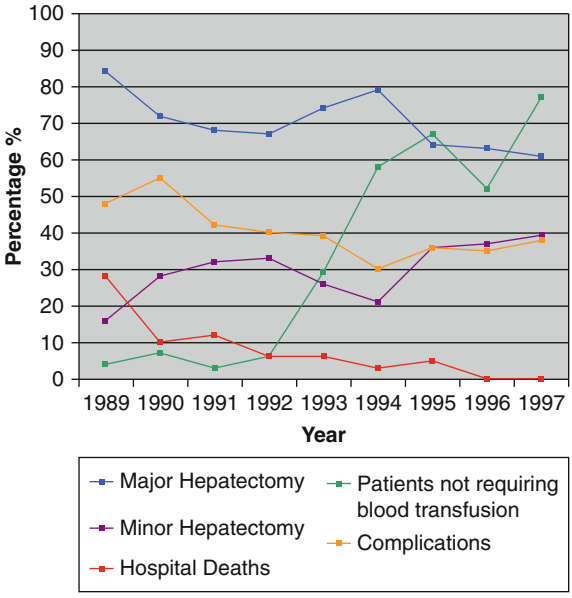

Fig. 8.1 Trends in hepatic resection over a 10-year period showing increased utilization of segmental resections over major hepatectomy, reduced use of perioperative blood transfusion, and decreased morbidity and mortality (From Fan et al. 1999 with permission)

loss and judicious use of coagulation factors, while postoperative physiological support and intensive care has become widely available.

Despite these points, there is a significant risk of complications associated with liver resection surgery. Often this is related to the underlying pathology and indications for which the surgery is being performed.

Intraoperative bleeding is the major complication associated with hepatic lobectomy, hemihepatectomy, partial hepatectomy, or extended hepatectomy, especially from injury to large portal inflow structures, the inferior vena cava, or the hepatic venous outflow structures. **Adequate exposure and knowledge of the possible anatomical points** is necessary to reduce risk of mishap. Excessive oozing from multiple small veins is especially important to control. **Air embolus** is another rare but severe life-threatening complication. **Postoperative hepatic failure** continues to remain a severe and lethal complication following any form of major hepatectomy. **Postoperative bile leak, biloma, bile collection, bile ascites, and biliary fistula** remain relatively common complications following major hepatic resection. **Tumor recurrence** following resection of malignancy is a significant problem and is integrally related to the pathology and width of resection margin of normal liver around the lesions(s). **Coagulopathy** and **infection** are other potentially serious complications and may lead to **multisystem organ failure** and **death**.

With these factors and facts in mind, the information given in these chapters must be appropriately and discernibly interpreted and used.

The **use of specialized units with standardized preoperative assessment, multidisciplinary input, adequate surgical volume, and high-quality postoperative care** is essential to the success of liver resectional surgery overall and can significantly reduce risk of complications or aid early detection, prompt intervention, and cost.

Important Note
It should be emphasized that the risks and frequencies that are given here represent derived figures. These figures are best estimates of relative frequencies across most institutions, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities and different surgeons. In addition, the risks of complications in lower or higher risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient, staff, or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedures or surgical approaches. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

Limited Liver Resection (Segmentectomy, Sectorectomy, and Sector Resection)

Description

General anesthesia is utilized for segmental liver resection. The aim of performing a segmental or sectorial resection is to remove a solitary benign or malignant liver lesion, although several lesions may be amenable to segmental resection or to treat segmental biliary strictures, trauma, or abscess. The goal is to achieve negative margins around tumor(s), as well as excising any liver parenchyma devascularized from occlusion of segmental portal inflow. Segmental resections can be combined with a contralateral major hepatectomy for complete resection of bilateral disease. Segmental resection is also used in patients with underlying liver dysfunction (e.g., cirrhosis, steatosis, or fibrosis) at risk of liver failure who would not tolerate a major liver resection. Segmental or sectorial resection is commonly utilized in patients with solitary hepatocellular carcinoma or in patients with a single metastasis (e.g., colorectal carcinoma, melanoma).

Anatomical Points

The anatomical points in the performance of segmentectomy or sectorectomy is primarily dictated by the possible variant inflow that can occur with the right lobe of the liver. The right hepatic inflow that supplies segments 5, 6, 7, and 8 arises from the junction of the right and left portal vein. In a majority of cases, there is

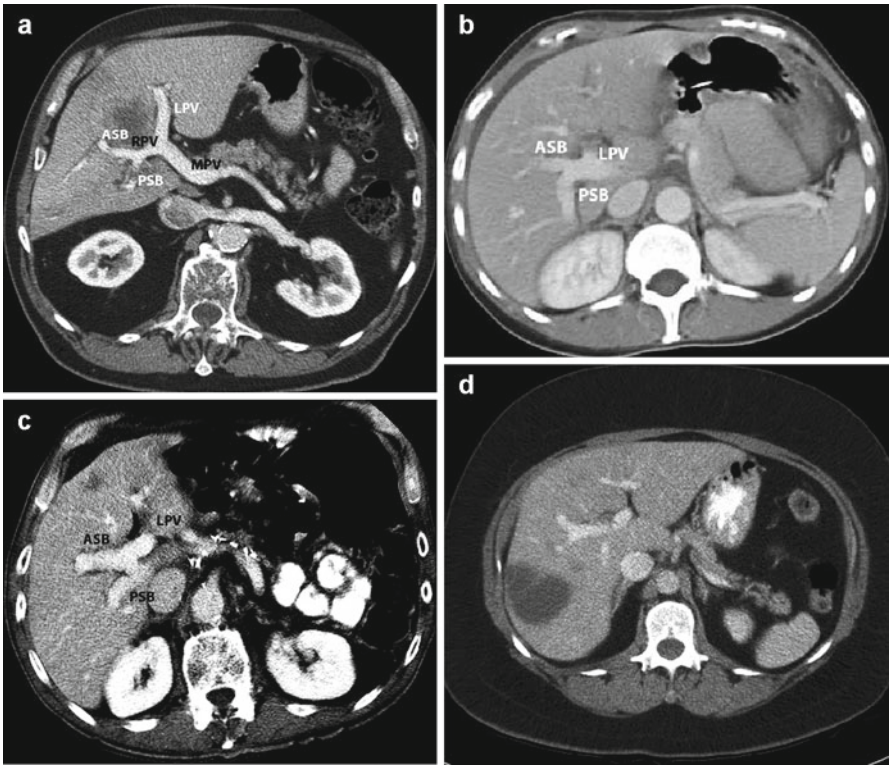

Fig. 8.2 (**a**) CT scan showing normal portal venous anatomy with the left portal vein (*LPV*) and right portal vein (*RPV*) arising from the main portal vein (*MPV*). The RPV divides into an anterior sectorial branch (*ASB*) supplying segments 5 and 8 and posterior sectorial branch (*PSB*) supplying segments 6 and 7. (**b**) CT scan showing trifurcation of the main portal vein into LPV, ASB, and PSB. (**c**) CT scan showing early takeoff of the PSB from the MPV with subsequent division of the remaining branch into LPV and ASB. (**d**) CT scan showing segment-6 (*SEG 6*) branch arising from the ASB while the segment-7 (*SEG 7*) portal branch arises from the MPV

a common right portal vein that branches into the right anterior sectorial and right posterior sectorial branches (Fig. 8.2a). However, the main right portal vein leading to the right anterior and right posterior sectorial branches may be absent, instead originating at the same junction as the left portal vein (Fig. 8.2b). Another main portal anatomical points can occur with the early takeoff of the right posterior sectorial vein, with the bifurcation then occurring at the left portal vein and the right anterior sectorial vein (Fig. 8.2c). Inflow within the right hepatic lobe can also vary with segment-6 inflow branches originating from the anterior sectorial branches and creating an isolated segment-7 branch (Fig. 8.2d). This anatomical point is important to ensure that only a single segment of inflow is occluded instead of the entire right lobe or the anterior or posterior segment, respectively.

Perspective

See Table 8.1. Potential major complications of hepatic resection are bleeding and biliary leakage. Bleeding during segmentectomy and sectorectomy will occur primarily from the outflow hepatic veins. These are thin walled veins that tear easily and can develop lateral tears, which can extend up to the main venous branches or to the inferior vena cava underneath intact hepatic parenchyma. Thus, any form of segmentectomy or sectorial resection must identify all of the major hepatic venous outflow structures to ensure adequate hemostasis and to minimize blood loss. Biliary leakage is primarily a problem in patients who are undergoing some form of bile duct resection and requiring biliary reconstruction (Tanaka et al. 2002). Biliary leakage is less common when performing a segmentectomy or sectorectomy and primarily will occur because of the inadvertent transection of a (small) bile duct without adequate closure. The performance of a segmentectomy should not be automatically assumed to be a lesser operative procedure compared to hepatic lobectomy or some form of extended hepatic lobectomy, since the anatomical relationships may be more complex to appreciate and the resections can be technically more demanding than lobectomies. Recent evaluations have shown that intraoperative blood loss is significantly greater when a nonanatomical resection is performed, compared to an anatomical hepatic segmentectomy or lobectomy, principally because of difficulty with small venous outflow control during resection. Nonanatomical resection is also associated with a higher margin positivity rate (DeMatteo et al. 2000). All segmental resections are not of similar difficulty. A segment-3 resection is technically more straightforward compared to a segment-8 resection. The accessibility of the inflow and outflow structures, the presence of variant anatomy, the depth and quality of the liver parenchyma, and the patient body habitus can make various types of segmental resections more difficult in certain patients.

Major Complications

Bleeding is the most serious complication accompanying hepatic segmentectomy. Generally venous outflow is not anatomically controlled prior to parenchymal division in contrast to major hepatic resections. Consequently any injury to venous structures is accompanied by significant blood loss. In addition, if the central venous pressure (CVP) is low, the risks of air embolus are increased (Melendez et al. 1998). Hepatic venous outflow hemorrhage from inadvertent transection of the hepatic veins primarily occurs because of the inability to identify anatomical points intraoperatively. **Intraoperative air embolus** can be a severe and life-threatening complication due to inadvertent laceration of the hepatic veins during hepatic parenchymal transection, with aspiration of air into the vena cava. The acute management of a patient who has sustained an air embolus is immediate steep

Table 8.1 Limited liver resection (segmentectomy, sectorectomy, and sector resection) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection	
Wound	5–20 %
Intra-abdominal (including liver/liver bed/subphrenic abscess)	5–20 %
Intrathoracic (pneumonia, pleural)	5–20 %
Mediastinitis (if vena cava isolation is used)	0.1–1 %
Systemic	1–5 %
Bleeding overall	5–20 %
Arterial, venous (caval, renal, portal, hepatic, or lobar vessels)	1–5 %
Raw liver surface	5–20 %
Extrahepatic	1–5 %
Hematoma formation (including subcapsular hepatic)	1–5 %
Biliary obstruction	0.1–1 %
Bile leak	1–5 %
Biliary collection	1–5 %
Bile duct stenosis	0.1–1 %
Biliary ascites	0.1–1 %
Biliary fistula	0.1–1 %
Hyperbilirubinemia	50–80 %
Jaundice	1–5 %
Common/extrahepatic/intrahepatic bile duct injury	1–5 %
Unresectability of malignancy or tumor/involved resection margins[a]	Individual
Recurrence of malignancy[a]	Individual
Serous ascitic collection	5–20 %
Liver injury (to remaining liver)	1–5 %
Pancreatitis/pancreatic injury/cyst/fistula	1–5 %
Bowel injury (stomach, duodenum, small bowel, colon)	1–5 %
Thrombosis	
Arterial	1–5 %
Venous	1–5 %
Surgical emphysema[a] (major)	1–5 %
Pneumothorax	50–80 %
Cardiac arrhythmias (major)	1–5 %
Myocardial injury/cardiac failure/myocardial infarction (hypotension)	1–5 %
Small bowel obstruction (early or late)[a] [Ischemic stenosis/adhesion formation]	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Coagulopathy	1–5 %
Disseminated intravascular coagulopathy	
[a]Consumption transfusion (large bleed)	
Gastrointestinal erosion, ulceration, perforation, hemorrhage	1–5 %
Multisystem failure (renal, pulmonary, cardiac failure)	1–5 %
Death[a]	1–5 %

Table 8.1 (continued)

Complications, risks, and consequences	Estimated frequency
Rare significant/serious problems	
Budd-Chiari (acute)	0.1–1 %
Liver failure (ischemia, toxicity, acute hepatic necrosis) early or late	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Portal venous thrombosis[a]	0.1–1 %
Deep venous thrombosis	0.1–1 %
Air embolus (major)	0.1–1 %
Renal/adrenal injury renal vein	0.1–1 %
Diaphragmatic hernia/injury/paresis	0.1–1 %
Pericardial effusion	<0.1 %
Thoracic duct injury (chylous leak, fistula)[a]	<0.1 %
Splenic injury	0.1–1 %
Conservation (consequent limitation to activity; late rupture)	
Splenectomy	
Hepatic rupture[a]	0.1–1 %
Hepatitis (drug, CMV, recurrent)[a]	0.1–1 %
Renal failure (hepatorenal syndrome)[a]	0.1–1 %
Hyperglycemia	0.1–1 %
Hypoglycemia	0.1–1 %
Wound dehiscence	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)[a]	5–20 %
Paralytic ileus	20–50 %
Muscle weakness (abdominal atrophy due to denervation esp. subcostal incision)	1–5 %
Nutritional deficiency – anemia, B12 malabsorption[a]	5–20 %
Wound scarring (poor cosmesis/wound deformity)	5–20 %
Incisional hernia formation (delayed heavy lifting)	1–5 %
Nasogastric tube[a]	1–5 %
Blood transfusion[a]	5–20 %
Wound drain tube(s)[a]	50–80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

Trendelenburg (head-down) position, with occlusion of the parenchymal transection site with a wet laparotomy gauze pack and aggressive support measures by the anesthetist. This complication can be effectively prevented by ensuring identification and proper ligation of all hepatic venous branches prior to transection. **Postoperative bile leakage** after a segmentectomy or sectorectomy can also lead to significant morbidity, depending on the extent of injury. In general bile leaks following hepatectomy result from leakage from one or more small bile ducts from the liver edge. However, occasionally injury to a main duct can occur. The presence of

bile leaks should be specifically assessed following parenchymal division by holding a wet swab against the parenchymal edge to detect bile staining. Alternatively an intraoperative cholangiogram can be performed to define contrast leakage although a randomized trial showed that this maneuver did not improve rates of postoperative biloma (Ijichi et al. 2000). Similarly, a recent prospective randomized controlled trial has shown that intraoperative drains placed in patients undergoing hepatic resections do not lead to decreased perioperative morbidity or lessen the need for subsequent postoperative drainage (Fong et al. 1996) of hematoma or bile. Thus, meticulous intraoperative hemostasis, as well as identification and ligation of all bile ducts during hepatic transection, cannot be overemphasized. Omentoplasty has been utilized to prevent bile leakage after resection; however in a recent prospective randomized controlled trial, this technique was not found to significantly reduce bile leakage (Paquet et al. 2000). Further review of this report also showed that omentoplasty did not adversely affect the patient either; thus, the utilization should be surgeon-determined. Bile leaks must be suspected in patients with a persistently raised bilirubin postoperatively and should be investigated with CT or ultrasound scans. Most patients who sustain a postoperative bile leak either resolve spontaneously or can be managed with a percutaneous drainage and bedside supportive care. Occasionally, endoscopic retrograde cholangiopancreatography (ERCP) and temporary transampullary stent placement may be required to reduce intra-biliary pressure and encourage healing. **Tumor recurrence** following resection of malignancy is a significant problem and is integrally related to the pathology and width of resection margin of normal liver around the lesions(s). Historically, a macroscopic margin of 1 cm of uninvolved parenchyma around tumors was required for the margin to be considered negative. However there is increasing evidence that a microscopically negative margin, even if this constitutes only several millimeters, is sufficient to cure many patients (Are et al. 2007). Development of further tumor metastases after metastasectomy arising from previously subclinical micrometastases is another limitation to successful surgical treatment. Although these are not strictly complications per se, they are contingent on effective preoperative evaluation and surgical technique. **Coagulopathy** and **liver failure** are rare complications of segmental resections but can occur in patients with significant preoperative hepatic dysfunction. **Infection** of postoperative **collections or bilomas** may also occur. Both liver failure and **sepsis** are potentially serious complications and may lead to **multisystem organ failure** and **death**.

Consent and Risk Reduction

Main Points to Explain

- Bleeding
- Infection
- Problems with GA

- Biliary problems (including biloma, biliary fistula, and bile duct stricture)
- Tumor recurrence*
- Death
- Further surgery; laparotomy

*Depending on underlying pathology

Extensive Liver Resection (Lobectomy, Hemihepatectomy, Partial Hepatectomy, and Trisegmentectomy)

Description

General anesthesia is used for liver resection procedures. The aim of this procedure is to remove a major part of the liver to completely resect benign or malignant liver lesions. The anatomy of the liver blood supply and the location and nature of the pathology can be greatly assisted by high-quality preoperative imaging and sometimes endoscopic retrograde cholangiopancreatography (ERCP). Metastatic or primary hepatic malignancies require adequate negative margins for effective treatment, often necessitating lobectomy, bilateral partial hepatectomy, or extended hepatectomy. Many types of incisions are used for hepatic resection, including an extended midline incision (xiphoid to pubis), a chevron inverted "V" incision often with a midline extension to the xiphoid, an extended subcostal incision with midline extension (hockey stick), and a rarely necessary thoracoabdominal incision. A right subcostal incision with an upper midline extension is sufficient for most cases, and this can be extended to a bilateral subcostal incision quite easily when extra exposure is necessary. Use of an operative table-mounted retractor of one type or another is essential for subcostal retraction and adequate exposure. Adequate mobilization of the liver is a key factor in successful liver resection. For major hepatectomy, mobilization of the liver with division of the diaphragmatic attachments (falciform, right and left coronary ligaments) and exposure of the inferior vena cava and hepatic veins is required. The liver should be completely mobilized from the vena cava by division of short hepatic veins and caudate branches. After adequate mobilization has been achieved, the extent of hepatectomy can then be assessed by bimanual palpation in conjunction with intraoperative ultrasound.

Anatomical Points

The anatomical planes integral to performing a hepatectomy should be known, together with anatomical points. From the anterior aspect, the falciform ligament divides the anatomical liver with the insertion of the ligamentum teres into the left

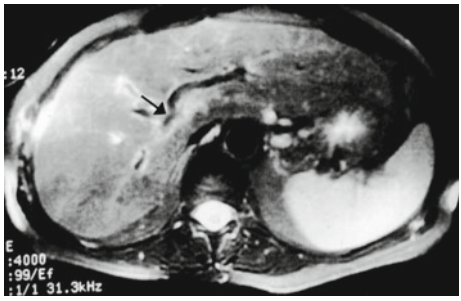

Fig. 8.3 Magnetic resonance scan showing the left portal vein arising in an intrahepatic location from the right anterior sectorial vein (*arrow*)

lateral segments and the right lobe of the liver with segments 4A and 4B. The two underlying intrahepatic planes, the main fissure (or Cantlie's line or the principal plane) and the left sectorial plane, represent the landmarks for common anatomical hepatic resections. The hepatic artery, portal vein, and bile duct are divided into a right and left trunk at the hilum of the liver. This division forms the two functional hemilivers, which meet at the main fissure and define the plane for either a right or left hemihepatectomy. The right portal pedicle will either enter the liver or divide prior to entering the liver, into a posterior and anterior sectorial branch, which supply segments 6 and 7 and 5 and 8, respectively. After this branching, approximately 1–2 cm distal, they branch into the cranial and caudal branches, which define all four segments in the right lobe of the liver. The left portal structures remain extrahepatic before entering the umbilical fissure, after the main branch to the caudate lobe. Once the portal structure enters the umbilical fissure and runs to the insertion of the ligamentum teres, it delivers a posterior branch to segment 2 and then delivers branches to segments 3 and 4. A single left portal vein arching to the left to supply the left lobe but arising from the right portal vein has also been described and should be looked for on preoperative imaging and prior to right portal vein division (Fig. 8.3). In the vast majority of patients, this anatomical division is consistent. In a small number of patients, subtle variations can occur primarily related to the bile duct drainage. The right hepatic bile duct or the right anterior sectorial duct can drain into the left hepatic duct before becoming the common hepatic duct. The hepatic venous drainage of the liver is into three major hepatic veins that run along the intersectorial (right and middle) and intersegmental (left) planes. The only other important anatomical inconsistency for surgeons to be aware of is the small umbilical vein, which runs beneath the falciform between the middle and left hepatic veins. In 70 % of cases, it is single and runs into the terminal portion of the left hepatic vein. This vein provides drainage of at least parts of segment 4B and should be recognized during parenchymal transection in order to avoid inadvertent laceration. After identification of these four major draining veins, the variation in the extent of outflow drainage is minimal. The primary concern prior to any form of hepatectomy should be the identification of at least all three major hepatic veins and the identification of any anomalous venous drainage.

Perspective

See Table 8.2. The importance of adequate high-quality preoperative imaging prior to any form of hepatectomy cannot be overemphasized. A high-quality three-phase (non-contrast, arterial and portal venous phases) spiral CT scan of the abdomen can

Table 8.2 Extensive liver resection (hepatic lobectomy, hemihepatectomy, and extended hepatectomy) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection	
Wound	5–20 %
Intra-abdominal (including liver/liver bed/subphrenic abscess)	5–20 %
Intrathoracic (pneumonia, pleural)	5–20 %
Mediastinitis (if vena cava isolation is used)	0.1–1 %
Systemic	1–5 %
Bleeding (overall)	5–20 %
Arterial, venous (caval, renal, portal, hepatic, or lobar vessels)	1–5 %
Raw liver surface	5–20 %
Extrahepatic	1–5 %
Hematoma formation (including subcapsular hepatic)	1–5 %
Serous ascitic collection	5–20 %
Biliary obstruction	1–5 %
Bile leak	1–5 %
Biliary collection	5–20 %
Bile duct ischemia	1–5 %
Bile duct stenosis	1–5 %
Biliary ascites	1–5 %
Biliary fistula	1–5 %
Hyperbilirubinemia	50–80 %
Jaundice	1–5 %
Common/extrahepatic/intrahepatic bile duct injury	1–5 %
Unresectability of malignancy or tumor/involved resection margins[a]	Individual
Recurrence of malignancy[a]	Individual
Pancreatitis/pancreatic injury/cyst/fistula	1–5 %
Bowel injury (stomach, duodenum, small bowel, colon)	1–5 %
Thrombosis	
Arterial	1–5 %
Venous	1–5 %
Liver failure (ischemia, toxicity, acute hepatic necrosis) early or late	1–5 %
Liver injury (to remaining liver)	1–5 %
Deep venous thrombosis	1–5 %
Surgical emphysema[a] (major)	1–5 %
Cardiac arrhythmias (major)	5–20 %
Pneumothorax	1–5 %

(continued)

Table 8.2 (continued)

Complications, risks, and consequences	Estimated frequency
Myocardial injury/cardiac failure/myocardial infarction (hypotension)	1–5 %
Small bowel obstruction (early or late)[a] [Ischemic stenosis/adhesion formation]	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Gastrointestinal erosion, ulceration, perforation, hemorrhage	1–5 %
Coagulopathy	1–5 %
Disseminated intravascular coagulopathy	
[a]Consumption transfusion (large bleed)	
Multisystem failure (renal, pulmonary, cardiac failure)[a]	5–20 %
Death[a]	1–5 %
Rare significant/serious problems	
Budd-Chiari (acute)	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Portal venous thrombosis[a]	0.1–1 %
Air embolus (major)	0.1–1 %
Pericardial effusion	0.1–1 %
Renal/adrenal injury renal vein	0.1–1 %
Diaphragmatic hernia/injury/paresis	0.1–1 %
Thoracic duct injury (chylous leak, fistula)[a]	0.1–1 %
Splenic injury	0.1–1 %
Conservation (consequent limitation to activity, late rupture)	
Splenectomy	
Hepatic rupture[a]	0.1–1 %
Hepatitis (drug, CMV, recurrent)[a]	0.1–1 %
Renal failure (hepatorenal syndrome)[a]	0.1–1 %
Hyperglycemia	0.1–1 %
Hypoglycemia	0.1–1 %
Less serious complications	
Paralytic ileus	50–80 %
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)[a]	5–20 %
Wound dehiscence	0.1–1 %
Muscle weakness (abdominal atrophy due to denervation esp. subcostal incision)	1–5 %
Nutritional deficiency – anemia, B12 malabsorption[a]	5–20 %
Wound scarring (poor cosmesis/wound deformity)	5–20 %
Incisional hernia formation (delayed heavy lifting)	1–5 %
Nasogastric tube[a]	1–5 %
Blood transfusion[a]	5–20 %
Wound drain tube(s)[a]	50–80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

usually identify all inflow structures and outflow structures to define resectability of hepatic tumors. Failure to preserve adequate blood supply, biliary drainage, and venous drainage can cause significant morbidity and perhaps mortality after major hepatectomy. Abdominal ultrasound can add information for evaluation of inflow or outflow patency; celiac and superior mesenteric artery arteriography or CT angiography can define the hepatic arterial anatomy; and MRI can be more sensitive than CT for detection of some vascular tumors.

Major Complications

Intraoperative bleeding is the major complication in performing a lobectomy, hemihepatectomy, partial hepatectomy, or extended hepatectomy. Inadequate mobilization of the liver or inadvertent injury of either the large portal inflow structures or the inferior vena cava and the hepatic venous outflow structures can be catastrophic. Adequate exposure and knowledge of the possible anatomical points is necessary to reduce risk of mishap. Secure ligation to reduce the risk of **postoperative bleeding** with whatever form of suture or stapler the surgeon prefers cannot be overemphasized. The need for adequate intraoperative ligation of even the smallest veins is especially important when hepatectomies are performed with a controlled hypovolemic, hypotensive, low central venous pressure (CVP) anesthesia to avoid postoperative hemorrhage when the CVP increases during the rehydration phase. **Air embolus** is another severe life-threatening complication due to inadvertent laceration of the hepatic veins during hepatic parenchymal transection, with aspiration of air into the vena cava. This complication can be related to low CVP while parenchymal transection is performed. Hence, optimal controlled hypotension with a CVP of 0–1 H_2O has been proven to be the most effective anesthetic management in patients who undergo any form of hepatic resection (Melendez et al. 1998). The acute management of a patient who has sustained an air embolus is immediate steep Trendelenburg (head-down) position, with occlusion of the parenchymal transection site with a wet laparotomy gauze pack and aggressive support measures by the anesthetist. This complication can be effectively prevented by ensuring identification and proper ligation of all hepatic venous branches prior to transection. **Postoperative hepatic failure** continues to remain a severe and lethal complication following any form of major hepatectomy, principally due to the inability of the remnant liver to rapid hypertrophy and function. A preoperative indicator of this complication is the extent of healthy hepatic parenchyma that will remain after liver resection. It has been estimated that a non-cirrhotic healthy liver can tolerate a resection of 80 % of its volume (Blumgart et al. 1971). This regenerative capacity enables the remnant liver to functionally compensate within 2–3 weeks following resection and to

regenerate to approximately 75 % of the preoperative liver volume within 1 year's time. Unfortunately, a favorable outcome cannot always be assured in all patients. An estimated 1–2 % of all patients experience primary hepatic failure, or inability to regenerate sufficient functional liver, even in those with non-cirrhotic healthy liver (Ribero et al. 2007). The incidence of postoperative hepatic failure is primarily a concern when >50 % of the functional liver parenchyma will be removed. The most important preoperative evaluation is the extent of liver parenchyma involved with tumor and the consequent residual healthy liver following resection. For patients with normal parenchyma, in whom a liver less than 20 % of hepatic volume will remain as a remnant after resection, preoperative portal vein embolization is now routinely employed. This technique entails percutaneous transhepatic occlusion of the ipsilateral portal vein branch to the intended resection. Hypertrophy of the remaining liver occurs over the ensuing 4–6 weeks (Fig. 8.4). This technique has been shown to reduce the risk of postoperative hepatic failure following hepatectomy. For patients with cirrhosis or steatosis, it is recommended that portal vein embolization is undertaken for all resections encompassing 50 % of parenchyma or greater (Ribero et al. 2007). **Postoperative bile leak, biloma, bile collection, bile ascites, and biliary fistula** remain relatively common complications following major hepatic resection. The true overall incidence of these complications cannot be adequately described because definitions of these are often inconsistent. The overall requirement for percutaneous drainage or the delay in removing an intraoperatively placed drain for ongoing biliary drainage remains in the range of 10–20 % (Tanaka et al. 2002; Blumgart and Fong 2000; Paquet et al. 2000; Fong et al. 1996). In almost all of these cases, this drainage is self-limited with drain removal during the initial hospital stay or within 2–3 weeks after discharge, although ERCP and transampullary stent placement may be required to obtain resolution. **Biliary fistula** may also rarely occur, necessitating either percutaneous or endoscopic stent placement to facilitate closure (Fig. 8.5). **Tumor recurrence** following resection of malignancy is a significant problem and is integrally related to the pathology and width of resection margin of normal liver around the lesions(s), with margins of 1 cm of uninvolved parenchyma associated with optimal long-term disease-free survival, although sub-centimeter margins that are histologically clear do not preclude cure (Blumgart and Fong 2000). Development of further tumor metastases after metastasectomy arising from previously subclinical micrometastases is another limitation to successful surgical treatment emphasizing the necessity of precise preoperative radiological staging. Although these are not strictly complications per se, they are contingent on effective preoperative evaluation and surgical technique. **Coagulopathy, liver failure, infection,** and **systemic sepsis** are other potentially serious complications and may lead to **multisystem organ failure** and **death**.

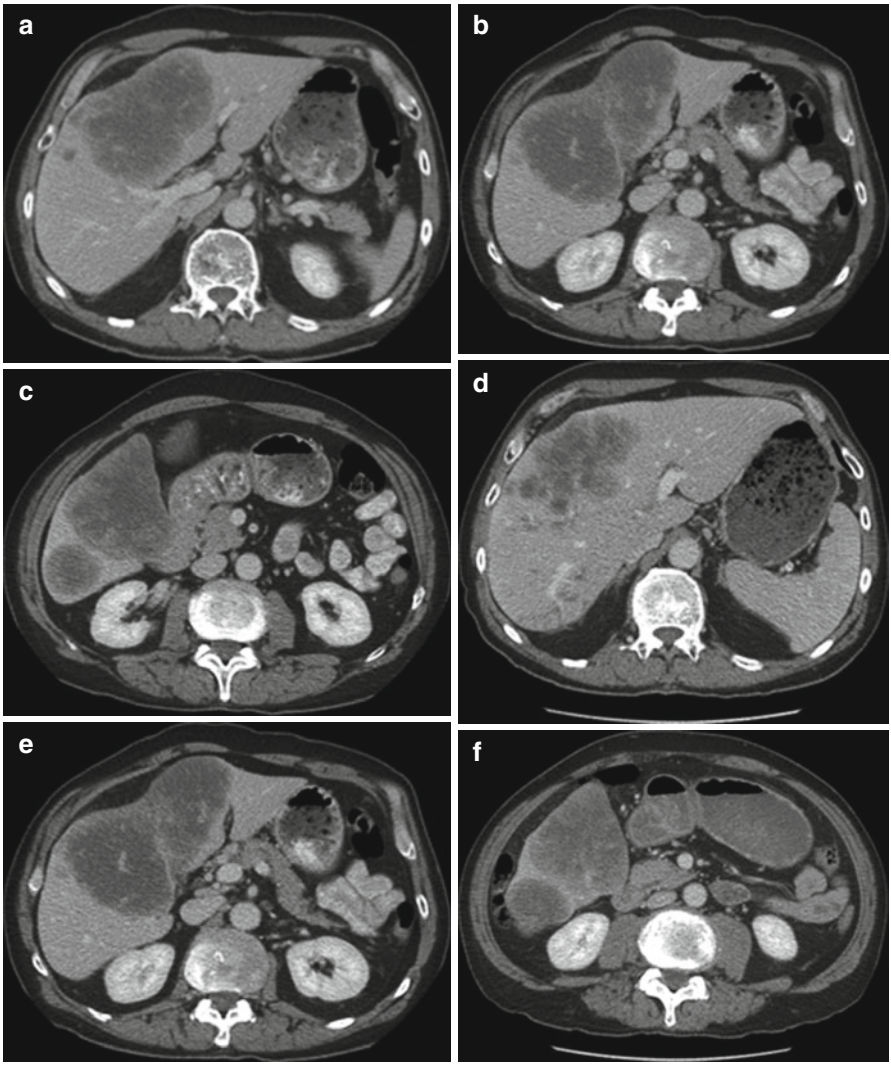

Fig. 8.4 (**a**, **b**, **c**) Sequential CT scans demonstrating a large central metastasis requiring extended right hepatectomy. Segments 2 and 3, the future liver remnant, constitute 18 % of the hepatic volume. (**d**, **e**, **f**) Sequential CT scans of the same patient 21 days following right portal vein embolization. There has been atrophy of the right lobe and hypertrophy of the left lobe. Segments 2 and 3 now constitute 31 % of the hepatic volume. Extended right hepatectomy was undertaken without complication, and the patient was discharged from the hospital on day 5

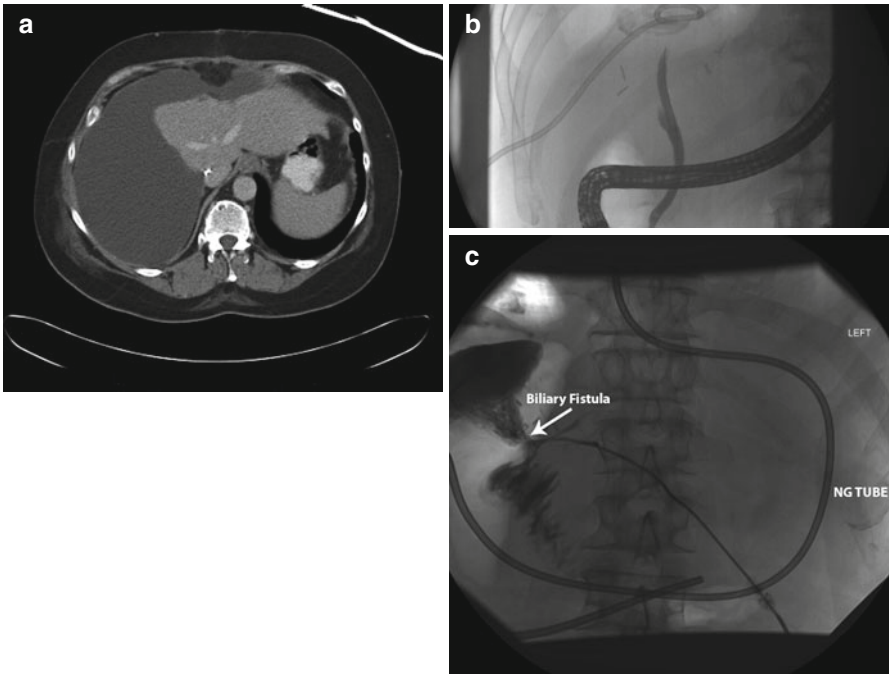

Fig. 8.5 (**a**) CT scan demonstrating a large parahepatic fluid collection following right hepatectomy. Percutaneous drainage was undertaken confirming a biloma. (**b**) Endoscopic retrograde cholangiopancreatography (ERCP) from the same patient showing non-filling of the proximal hepatic ducts confirming a stenosis of the common hepatic duct. (**c**) Percutaneous transhepatic cholangiogram showing a nasogastric tube in situ (NG tube) and contrast leak confirming a proximal biliary fistula. The patient was treated with a Roux-en-Y hepaticojejunostomy

Consent and Risk Reduction

Main Points to Explain

- Bleeding
- Infection* (local and systemic)
- Problems with GA
- Biliary Problems* (including biloma and biliary fistula)
- Tumor recurrence*
- Death*
- Further surgery; laparotomy*

*Depending on underlying pathology

Further Reading, References, and Resources

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Chapter 9
Pancreatic Surgery

Christopher S. Worthley and Brendon J. Coventry

General Perspective and Overview

The relative risks and complications vary according to the type of procedure performed and the nature of the pathology or underlying disease process. When complex pancreatic resection and anastomosis is required, the risks are usually increased. This is principally related to the surgical difficulty, ability to expose the region, blood supply, bleeding, pancreatitis, risk of tissue injury, and technical ease of achieving the resection and/or anastomosis. Risk of anastomotic leakage and failure usually carries significant risks of infection with associated risks of morbidity and even mortality.

Resections for malignancy often carry higher risks associated with problems with early diagnosis, incomplete resection due to adherence to surrounding major vessels, malnutrition, and immunosuppression.

The main serious complication is pancreatic **anastomotic leakage,** which can be minimized by the adequate mobilization, reduction of tension, the provision of adequate luminal drainage, and ensuring satisfactory blood supply to and inclusion of the mucosal edges within an anastomosis. Avoidance of tension at suture lines is imperative. Uncontrolled anastomotic leakage is associated with infection and may lead to **abscess formation**, **peritonitis,** and **systemic sepsis**. **Multisystem failure** and **death** remain serious potential complications of intestinal surgery with systemic infection. Multiple anastomoses, established infection, a soft or normal pancreas, and preexisting malnutrition are associated with increased risk of anastomotic

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leakage. **Hematoma formation** may arise from ooze from the extensive raw surfaces and this may predispose to infection. **Enteric, pancreatic, and biliary anastomotic leakage can all cause** significant problems.

Poor positioning on the operating table has been associated with increased risk of **deep venous thrombosis** and **nerve palsies**, especially in prolonged procedures.

A reduction in misunderstandings over complications or consequences from pancreatic surgery might be achieved by:

- Good explanation of the aims, risks, benefits, and limitations of the procedure(s)
- Sound planning considering the comorbidities, anatomy, access, alternatives, and technique
- Avoiding likely associated vessels and nerves
- Adequate clinical follow-up

With these aspects in mind, the information given in this chapter must be appropriately and discernibly interpreted and used.

Important Note
It should be emphasized that the risks and frequencies that are given here *represent derived figures*. These *figures are best estimates of relative frequencies across most institutions*, not merely the highest-performing ones, and as such are often representative of a number of studies, which include different patients with differing comorbidities, pathologies, and different surgeons. In addition, the risks of complications in lower- or higher-risk patients may lie outside these estimated ranges, and individual clinical judgement is required as to the expected risks communicated to the patient, staff, or for other purposes. The range of risks is also derived from experience and the literature; while risks outside this range may exist, certain risks may be reduced or absent due to variations of procedural variations. It is recognized that different patients, practitioners, institutions, regions, and countries may vary in their requirements and recommendations.

For risks and complications associated with full laparotomy (Chap. 2), biliary/duodenal surgery (Chap. 7), and other procedures, see the relevant chapters.

Distal Pancreatectomy

Description

General anesthesia is used. The aim is to mobilize and resect the distal part (tail) of the pancreas for removal of pathology, typically a tumor, pseudocyst, pancreatic

necrosis, or vascular abnormality. The procedure will often involve concomitant splenectomy, but splenic conservation may be possible. It does not require the same extent of dissection as resection of the head of the pancreas. The extent of the pancreatectomy can vary, such that a "distal" pancreatectomy may extend across to the right of the mid-body and as a "subtotal" pancreatectomy, even to include the neck and part of the uncinate process. The complexity, difficulty, and risk of complications increase with increasing extent of the pancreatic resection. Distal pancreatectomy can include resection of up to 60 % of the distal pancreas, and subtotal pancreatectomy may include up to 85 %. Distal pancreatectomy may be performed as part of the resection of disease arising in another adjacent organ, such as the stomach or colon, which will also usually have additional risks and complications related to the additional procedure. Various incisions may be used with this procedure, including a midline, transverse, or inverted "V" incision. A wound drain is usually used.

Anatomical Points

The spleen may have extensive adhesions to the abdominal wall, diaphragm, stomach, colon, and pancreas. These may make mobilization of the spleen and pancreatic tail difficult. The pancreas itself is relatively constant in its anatomy. The left ureter, kidney, and renal vessels lie posterior to the pancreatic tail. The splenic artery lies at the superior aspect of the pancreas and is relatively constant in position; however, the splenic vein is relatively tortuous and distally may lie above, over, behind, or within the pancreas. The junction of the superior mesenteric vein with the splenic vein to form the portal vein lies behind the mid-body of the pancreas and should not be injured. The superior mesenteric artery lies to the left of the superior mesenteric vein. The pancreatic duct is usually single within the tail but occasionally may be double (pancreas divisum), and these ducts may drain separately into the duodenum.

Perspective

See Table 9.1. Many of the complications are relatively minor in nature and related to wound infection and minor bleeding; however, major complications may occur, including intra-abdominal bleeding, intra-abdominal abscess, peritonitis, pancreatitis, pancreatic fistula, systemic sepsis, respiratory failure, renal failure, and multisystem organ failure, leading to prolonged intensive care and possibly mortality.

Major Complications

The major complication of distal pancreatectomy is **infection** usually related to **pancreatic leak** from the transected pancreatic duct. The leak rate can be

Table 9.1 Distal pancreatectomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	5–20 %
Subcutaneous/wound	5–20 %
Intra-abdominal/liver bed/pelvic	0.1–1 %
Liver (hepatitis; abscess)	0.1–1 %
Cholangitis	1–5 %
Systemic	0.1–1 %
Late postsplenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Anastomotic; raw surfaces	1–5 %
Portal, superior mesenteric, splenic vessels	0.1–1 %
Injury to vena cava/renal vessels	0.1–1 %
Gastrointestinal hemorrhage	1–5 %
Injury to the bowel or blood vessels	1–5 %
Gastric/duodenal/small bowel/colonic	
Splenic injury/removal[a]	>80 %
Bile leak/collection	20–50 %
Biliary fistula/stenosis	5–20 %
Insertion of T tube[a]	20–50 %
Unresectability of malignancy/involved resection margins[a]	Individual
Pancreatitis/pancreatic injury/pancreatic cyst/pancreatic fistula[a]	5–20 %
Anastomotic breakdown	1–5 %
Small bowel or gastro- or pancreaticocutaneous fistula[a]	1–5 %
Entero-pancreatic fistula	1–5 %
Intolerance of large meals (necessity for small frequent meals)	1–5 %
Diarrhea (neurogenic; enzyme deficiency)	1–5 %
Islet failure and diabetes (consequent insulin therapy)	5–20 %
Pancreatic failure and enzyme replacement	5–20 %
Coagulopathy	1–5 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	1–5 %
Mortality[a]	1–5 %
Rare significant/serious problems	
Bile/hepatic duct injury	0.1–1 %
Liver injury	0.1–1 %
Biliary obstruction (all causes)[a]	0.1–1 %
[Ischemia/stenosis]	0.1–1 %
Gastric/small bowel ischemia[a]	
(devascularization; SMA, coeliac ligation)*	0.1–1 %
Small bowel ischemia	0.1–1 %
Small bowel obstruction (early or late)[a] [ischemic stenosis/adhesion formation]	0.1–1 %
Nutritional deficiency – anemia, B12 malabsorption	0.1–1 %
Seroma/lymphocele formation	0.1–1 %
Vascular injury and false aneurysm formation	0.1–1 %

Table 9.1 (continued)

Complications, risks, and consequences	Estimated frequency
Renal/adrenal injury	0.1–1 %
Thoracic duct injury (chylous leak, fistula)	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Portal venous thrombosis[a]	0.1–1 %
Deep venous thrombosis	0.1–1 %
Operative cholangiogram[a]	
Dye reaction/cholangitis/pancreatitis/radiation exposure	<0.1 %
Biliary ascites	<0.1 %
Possibility of colostomy/ileostomy (very rare)[a]	<0.1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)[a]	5–20 %
Paralytic ileus[a]	>80 %
Wound dehiscence	0.1–1 %
Muscle weakness (atrophy due to denervation esp. subcostal incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Blood transfusion	<0.1 %
Wound drain tube(s)[a]	>80 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences

significantly reduced (10 % vs. 35 %) when the pancreatic duct is directly ligated*. With current interventional radiological drainage techniques, reoperation for infection is unusual. CT scan of the abdomen and pelvis should be used early for a suspected infected collection. Early intra-abdominal sepsis frequently manifests itself as **respiratory distress**. Another sequela of intra-abdominal sepsis is **intra-abdominal bleeding**. If fluid coming out of an intra-abdominal drain turns bloody, it may represent a sentinel bleed most commonly from a **pseudoaneurysm** that has developed from the stump of the splenic artery. Angiography is necessary as an emergency study with embolization or stenting as the therapeutic intervention of choice, if possible, based upon arterial anatomy. **Delayed gastric emptying** is another complication that can prolong hospitalization. Although frequently multifactorial in nature, causes should be sought out such as **intra-abdominal sepsis**, **electrolyte abnormalities**, pancreatitis, pancreatic leak, **abscess**, and technical problems. Placement of a feeding jejunostomy tube at the time of surgery can help manage this problem, but one must ensure that the distal gut is functioning adequately before feeding via this route. **A pancreatic fistula** can be a significant problem. **Respiratory infection and failure** are common difficulties, and **renal failure** is another possible complication, often secondary to sepsis. **Systemic infection** and **multisystem organ failure** may supervene and are major causes of morbidity, **prolonged hospitalization,** and **mortality**.

Consent and Risk Reduction

Main Points to Explain

- Infection
- Bleeding
- Risk of organ injury
- Risk of leakage/fistula
- Risk of stoma
- Risk of further surgery
- Risk of death

Pancreaticoduodenectomy (Including Whipple's Procedure)

Description

General anesthesia is used. The goal of pancreaticoduodenectomy is to remove tumors in the periampullary region, including the head of pancreas, typically retaining the distal pancreas. The operation proceeds in a clockwise fashion consisting of six steps. At each step resectability is assessed. One is not committed to the resection until the last step when the pancreas is divided. Step 1 is to perform a Cattell-Braasch maneuver and expose the superior mesenteric vein. In this step the right colon is mobilized and the mesenteric attachment to the retroperitoneum is divided from the terminal ileum to the ligament of Treitz. This frees up the third and fourth portions of the duodenum. The lesser sac is opened via the gastrocolic omentum and the transverse colon is separated from the duodenum and stomach. The inferior edge of the pancreas is dissected out, as is the superior mesenteric vein as it courses under the neck of the pancreas, avoiding traction on the gastrocolic vein. Step 2 is to perform an extended Kocher maneuver where the duodenum and head of pancreas are dissected off the vena cava and aorta. At the completion of this step, tumor involvement of the major vessels can be assessed, as well as the origin of the superior mesenteric artery. Step 3 is to perform the portal dissection. A cholecystectomy is performed. The common bile duct is encircled and divided. A frozen section analysis of the bile duct margin is performed; if positive, more bile duct can be removed. The gastroduodenal artery is then dissected out and divided after clearly identifying its origin from the common hepatic artery. The portal vein is identified directly under the gastroduodenal artery. The portal vein is freed up at the neck of the pancreas superiorly and the entire neck of the pancreas is mobilized off the vein, taking great care not to damage the small venous tributaries entering the right side of this structure. Step 4 is to divide the stomach. Where the stomach is divided depends on whether a pylorus-preserving procedure, an antral-preserving procedure, or a classical Whipple procedure with antrectomy is performed. Step 5 is to divide the small

bowel at the proximal jejunum. The ligament of Treitz is completely mobilized below the transverse mesocolon, and the small bowel, to be resected as part of the specimen, is rotated under the mesenteric vessels. Step 6 is to divide the pancreas in the region of the pancreatic neck. A frozen section analysis is performed over the pancreatic body margin, and if positive, additional pancreas is resected. Once the pancreas is divided, the superior mesenteric vein and portal vein are mobilized off the uncinate portion of the pancreas and divided along the medial border of the superior mesenteric artery. Extreme care is needed at this point as lateral traction on the head of pancreas may pull the superior mesenteric artery to the right side of the corresponding major vein. Reconstruction occurs in a counterclockwise fashion. Initially an end-to-side pancreaticojejunostomy is performed first, followed by the biliary anastomosis (usually an end-to-side choledochojejunostomy), and, finally, evidence leans towards performing a gastrojejunostomy in an antecolic fashion. It is thus distanced from the pancreas and may reduce the incidence of delayed gastric emptying. The pancreatic anastomosis can either be an invagination of the pancreas or a direct duct-to-mucosal anastomosis. The gastrojejunostomy can either be a loop or Roux-en-Y reconstruction. *Partial pancreatectomy* of the head of pancreas without duodenectomy is uncommon and restricted to situations where either benign disease is present or small tumors are localized to the head region only. *Total pancreatectomy* is uncommonly performed because of the severe endocrine and metabolic consequences that are often experienced and associated high morbidity and mortality. It may be used in some centers for multifocal secreting endocrine tumors, chronic pancreatitis, and intraductal papillary mucinous neoplasia, all of which are often associated with serious endocrine and metabolic disturbances as part of the disease processes. This may be performed with or without duodenectomy.

Anatomical Points

The major anatomical point that is important with pancreaticoduodenectomy is related to the hepatic arterial supply. Accessory or replaced right hepatic arteries arise off the superior mesenteric artery and course along the upper part of the uncinate, posterior and lateral to the common bile duct. Accessory or replaced left hepatic arteries arise off the left gastric artery and less commonly come into play during resection. Occasionally, the entire common hepatic trunk comes off the superior mesenteric artery. In this case it usually courses up in between the portal vein and the common bile duct. Usually these vessels can be preserved as part of the resection.

Perspective

See Table 9.2. Pancreaticoduodenectomy has been extensively studied in an attempt to minimize morbidity and mortality. There is currently no convincing data to suggest that preoperative biliary drainage will decrease complication rates or that one

Table 9.2 Pancreaticoduodenectomy (including Whipple's procedure) estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	5–20 %
Subcutaneous/wound	5–20 %
Intra-abdominal/liver bed/pelvic	0.1–1 %
Liver (hepatitis; abscess)	0.1–1 %
Cholangitis	1–5 %
Mediastinitis[a]	<0.1 %
Systemic	0.1–1 %
Late postsplenectomy sepsis (vaccination)	<0.1 %
Bleeding/hematoma formation[a]	
Wound	1–5 %
Anastomotic; raw surfaces	1–5 %
Portal, superior mesenteric, common hepatic, splenic vessels	0.1–1 %
Injury to vena cava/renal vessels	0.1–1 %
Gastrointestinal hemorrhage	1–5 %
Injury to the bowel or blood vessels	1–5 %
Gastric/duodenal/small bowel/colonic/renal/adrenal	
Bile leak/collection	20–50 %
Biliary fistula/stenosis	5–20 %
Postoperative acute pancreatitis	2–30 %
Pancreatic leak/fistula	5–40 %
Small bowel obstruction (early or late)[a] [ischemic stenosis/ adhesion formation]	1–5 %
Diabetes (consequent insulin therapy)	>80 %
Pancreatic enzyme replacement	>80 %
Unresectability of malignancy/involved resection margins[a]	Individual
Anastomotic breakdown	5–20 %
Enterocutaneous fistula[a]	1–5 %
Diarrhea (neurogenic; enzyme deficiency)	5–20 %
Nutritional deficiency – anemia, B12 malabsorption	5–20 %
Seroma/lymphocele formation	20–50 %
Thoracic duct injury (chylous leak, fistula)	20–50 %
Coagulopathy	1–5 %
Reflux esophagitis/pharyngitis/pneumonitis	1–5 %
Delayed gastric emptying	20–50 %
Bilious vomiting	5–20 %
Dumping syndrome	5–20 %
Early dumping (vasomotor)	
Late dumping (osmotic)	
Intolerance of large meals (necessity for small frequent meals)	50–80 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	5–20 %
Mortality[a,b]	5–20 %
Rare significant/serious problems	
Aspiration pneumonitis[a]	0.1–1 %
Portal venous thrombosis[a]	0.1–1 %
Deep venous thrombosis[a]	0.1–1 %

Table 9.2 (continued)

Complications, risks, and consequences	Estimated frequency
Biliary obstruction[a]	0.1–1 %
Bile/hepatic duct injury	0.1–1 %
Liver injury	0.1–1 %
Bile duct ischemia/stenosis[a]	0.1–1 %
Gastric/small bowel ischemia	
(Devascularization; SMA, coeliac artery injury)[a]	0.1–1 %
Jejunal fistula	0.1–1 %
Biliary ascites	<0.1 %
Operative cholangiogram	
Dye reaction/cholangitis/radiation exposure	<0.1 %
Possibility of colostomy/ileostomy[a]	<0.1 %
Less serious complications	
Pain/tenderness[a] [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)	5–20 %
Paralytic ileus[a]	>80 %
Wound dehiscence	0.1–1 %
Muscle weakness (atrophy due to denervation esp. subcostal incision)	1–5 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Nasogastric tube[a]	1–5 %
Blood transfusion	<0.1 %
Wound drain tube(s)[a]	1–5 %
Biliary tube-related complications (if used)	
Dislodgement of T tube	1–5 %
Blockage of T tube	0.1–1 %
Persistent biliary fistula (after removal; cholangio-cutaneous)	0.1–1 %
T-tube cholangiogram	
Dye reaction/cholangitis/pancreatitis/radiation exposure	<0.1 %

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences
[b]Mortality can depend on patient selection, disease stage, surgeon experience, hospital volume/support, and comorbidities

type of gastric or one type of pancreatic anastomosis is better than any other in minimizing complications. Extended lymph node dissections and portal vein resections can be performed with similar morbidity as standard procedures, but without obvious improvements in long-term survival. Octreotide has not been convincingly shown to decrease pancreatic fistula rates in randomized prospective clinical trials. Several studies have examined the effect of institutional volume on patient outcomes. The Memorial Sloan Kettering Cancer Center group (1995) found that in 1972 patients, high-volume centers in New York State had significantly less mortality (4 % vs. 12.3 %) than low-volume centers. High volume was defined as greater than 40 cases per year and surprisingly 75 % of the cases in New York State were performed in low-volume centers. Similar studies and findings have been reported in other US, Canadian, and Dutch centers. The definitions of volume varied, but

mortality rates from pancreaticoduodenectomy in very low (0–1 procedures per year) and in low-volume (1–2 procedures per year) hospitals were three- to fourfold higher than in hospitals performing more than five pancreaticoduodenectomies per year. The largest differential in mortality between very low-volume (17.6 %) and high-volume (3.8 %) centers is seen for pancreaticoduodenectomy. The safety of the procedure has improved overall, and minor complications are common, often related to the wound; major complications are listed below.

Major Complications

The major complication of pancreaticoduodenectomy is **infection** usually related to **pancreatic leak** from the pancreaticojejunal anastomosis. With current interventional techniques, reoperation for infection is unusual. Early aggressive search for sources of infection must include a low threshold for obtaining a CT scan of the abdomen and pelvis. Early intra-abdominal sepsis frequently manifests itself as respiratory distress. Another sequela of intra-abdominal sepsis is **intra-abdominal bleeding**. If fluid coming out of an intra-abdominal drain turns bloody, it may represent a sentinel bleed most commonly from a **pseudoaneurysm** that has developed from the stump of the gastroduodenal artery. Angiography is necessary as an emergency study with stenting of the common hepatic artery or embolization of the gastroduodenal stump as the therapeutic interventions of choice, depending on the arterial anatomy. **Delayed gastric emptying** is another complication that can prolong hospitalization. Although frequently multifactorial in nature, correctible causes should be sought, such as intra-abdominal sepsis, electrolyte abnormalities, anastomotic ulceration or stenosis, acute pancreatitis, and technical problems. Placement of a feeding jejunostomy tube at the time of surgery can help make this problem more manageable, providing that the more distal gut is functioning adequately. **Biliary**, **jejunal, or pancreatic fistulae** can be significant problems. **Respiratory infection and failure** are common difficulties, and **renal failure** is another possible complication, often secondary to sepsis. **Systemic infection** and **multisystem organ failure** may supervene and are major causes of morbidity, **prolonged hospitalization,** and **mortality**.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of organ injury
- Risk of stoma
- Risk of further surgery
- Risk of death

Open Cyst-Gastrostomy

Description

General anesthesia is used. The aim is to establish drainage of a pancreatic pseudocyst through the posterior wall of the stomach, via an upper midline incision. Should there be evidence of sinistral (left sided) venous hypertension from occlusion of the splenic vein, consideration should be given to splenectomy or preoperative splenic arterial embolization to reduce subsequent severe hemorrhagic problems. The anterior wall of the stomach is opened to expose the posterior wall, which is usually draped over the posteriorly placed pancreatic pseudocyst. Previous imaging has usually defined the position of the pseudocyst in relation to the posterior aspect of the stomach, to allow planning of the site of the incision through the back wall of the stomach and to avoid vascular injury. Needle aspiration into the cyst is often useful to locate the pseudocyst and to avoid major vessels. An incision is made through the stomach into the pseudocyst wall, which may be quite thick, to enter the cavity of the pseudocyst to aspirate the contents. The pseudocyst cavity can be gently explored with the finger, to breakdown any loculations and complete the drainage, avoiding significant vessels. A disk of stomach wall and pseudocyst wall should be excised to make a wider opening. The pseudocyst wall is then sutured to the posterior stomach wall to avoid intraperitoneal leakage and anastomotic bleeding. A large-bore (20–24 FrG) Foley balloon catheter may be inserted and brought out through the anterior stomach incision and abdominal wall. Alternatively, no drain may be used and the anterior stomach, then the abdominal wall, closed.

Anatomical Points

The colon, small bowel, liver, and omentum may overlie the stomach and make access difficult. Although these organs are at risk, generally these can be displaced to enable the procedure to be performed. Pectus excavatum or other deformities, including obesity, may also make the procedure more challenging. Although the pseudocyst usually displaces the major vascular structures, the portal vein, splenic vessels, and superior mesenteric artery are all closely related and potentially at risk.

Perspective

See Table 9.3. Despite the extensive list, open cyst-gastrostomy is often associated with few complications. Infection is perhaps the most common problem, usually effectively treated with antibiotics. The main problems are leakage of gastric contents, or pancreatic pseudocyst contents into the abdomen causing peritonitis, and possible abscess formation.

Table 9.3 Open cyst-gastrostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	5–20 %
Subcutaneous/wound	5–20 %
Intra-abdominal/liver bed/pelvic	1–5 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Wound, stomach, cyst wall, major vessels, spleen	
Delayed gastric emptying	1–5 %
Stenosis of cyst-gastrostomy and recurrence of pseudocyst	5–20 %
Rare significant/serious problems	
Anastomotic breakdown	0.1–1 %
Injury to the bowel, organs, or blood vessels	0.1–1 %
Gastric/duodenal/small bowel/colonic/liver/renal/adrenal	
Gastro- or pancreaticocutaneous fistula	0.1–1 %
Small bowel obstruction (early or late)[a] [ischemic stenosis/adhesion formation]	0.1–1 %
Pancreatitis/pancreatic injury[a]	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Mortality[a,b]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)[a]	5–20 %
Paralytic ileus[a]	50–80 %
Wound dehiscence	0.1–1 %
Incisional hernia formation (delayed heavy lifting/straining)	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	1–5 %
Nasogastric tube[a]	1–5 %
Blood transfusion	<0.1 %
Wound drain tube(s)[a]	Individual

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences
[b]Mortality can depend on patient selection, disease stage, surgeon experience, hospital volume/support, and comorbidities

Major Complications

Occasionally, where used, the balloon of a Foley catheter may migrate distally and can lead to **stomach outlet obstruction**. The cyst-gastrostomy opening can stenose or close and lead to **failure of drainage** or **pseudocyst recurrence**. Separation of the stomach from the anterior abdominal wall may result in **intraperitoneal leakage** of stomach contents and peritonitis, with or without abscess formation or generalized sepsis. Separation of the posterior stomach from the pseudocyst can result in similar complications. Dehiscence of the stomach wound and **free perforation** are rare. **Wound infection** and **abscess formation** are not uncommon. **Systemic sepsis** is infrequent, but may be severe. It may be exacerbated by comorbidities and can lead to **multisystem organ failure** and **death**.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of organ injury
- Risk of recurrence
- Risk of further surgery
- Risk of death

Laparoscopic Cyst-Gastrostomy

Description

General anesthesia is used. The aim is to establish drainage of a pancreatic pseudocyst through the posterior wall of the stomach, via a laparoscopic approach. Ports are inserted and gas is insufflated in the usual way. The procedure can be performed through the anterior and posterior walls of the stomach, as per the open approach, or by direct access to the pseudocyst, posterior to the stomach. Previous imaging has usually defined the position of the pseudocyst in relation to the posterior aspect of the stomach. This allows planning of the site of the incision through the back wall of the stomach, so avoiding vascular injury and leakage. Needle aspiration may be useful to locate the pseudocyst and any major vessels. An incision is made through into the pseudocyst wall, which may be quite thick, to enter the cavity of the pseudocyst and aspirate the contents. The pseudocyst cavity can be explored with a probe, breaking down any loculations and completing the drainage into the stomach. A disk of stomach wall and pseudocyst wall may be excised to make a wider opening. The pseudocyst wall is then sutured or stapled to the posterior stomach wall to create an internal fistula/sinus with the stomach.

Anatomical Points

The colon, small bowel, liver, and omentum may overlie the stomach and make access difficult. Although these organs are at risk, generally these can be displaced to enable the procedure to be performed. Pectus excavatum or other deformities, including obesity, may also make the procedure more challenging. Although the pseudocyst usually displaces the major vascular structures, the portal vein, splenic vessels, and superior mesenteric artery are all closely related and potentially at risk.

Perspective

See Table 9.4. Despite the extensive list, laparoscopic cyst-gastrostomy is often associated with few complications. Infection is perhaps the most common problem, usually effectively treated with antibiotics. The main problems are leakage of gastric contents, or pancreatic pseudocyst contents into the abdomen causing peritonitis, and possible abscess formation. Additional potential complications from laparoscopy include gas embolism, conversion to open surgery, and vascular and bowel injury.

Table 9.4 Laparoscopic cyst-gastrostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	5–20 %
Subcutaneous/wound	5–20 %
Intra-abdominal/liver bed/pelvic	1–5 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Wound, stomach, cyst wall, major vessels, spleen	
Stenosis of cyst-gastrostomy and recurrence of pseudocyst	5–20 %
Delayed gastric emptying	1–5 %
Conversion to open operation	1–5 %
Rare significant/serious problems	
Anastomotic breakdown	0.1–1 %
Injury to the bowel, organs or blood vessels	0.1–1 %
Gastric/duodenal/small bowel/colonic/liver/renal/adrenal	
Gastro- or pancreaticocutaneous fistula	0.1–1 %
Small bowel obstruction (early or late)[a] [ischemic stenosis/adhesion formation]	0.1–1 %
Pancreatitis/pancreatic injury[a]	0.1–1 %
Gas embolus	0.1–1 %
Pneumothorax	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Mortality[a,b]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)[a]	5–20 %
Paralytic ileus[a]	50–80 %
Wound dehiscence	0.1–1 %
Port-site hernia formation	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	0.1–1 %
Nasogastric tube[a]	1–5 %
Blood transfusion	<0.1 %
Wound drain tube(s)[a]	Individual

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences
[b]Mortality can depend on patient selection, disease stage, surgeon experience, hospital volume/support, and comorbidities

Major Complications

Occasionally, where used, the balloon of a Foley catheter may dislodge and can lead to **leakage**. The cyst-gastrostomy opening can stenose or close and lead to **failure of drainage** or **pseudocyst recurrence**. Separation of the posterior stomach from the pseudocyst can result in **intraperitoneal leakage** of stomach and pseudocyst contents, with or without abscess formation or **generalized sepsis**. **Wound infection** is not uncommon. Bleeding from the anastomosis may be more difficult to control than with an open procedure. **Gas embolism** is a very rare, but potentially devastating and lethal complication of gas insufflation during laparoscopy. **Injury to bowel and blood vessels** is also associated with the laparoscopic approach, however, is reduced by an open cutdown method for port insertion. **Systemic sepsis** is infrequent but may be severe, also related to the underlying condition(s), and can lead to **multisystem organ failure** and death.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding
- Risk of organ injury
- Risk of recurrence
- Gas embolism
- Risk of open surgery
- Risk of death

Endoscopic Cyst-Gastrostomy

Description

Sedation with oral local anesthetic spray is often used, but general anesthesia may be used. The aim is to endoscopically establish a communication between the posterior stomach wall and the pseudocyst with the help of endoscopic ultrasound. The endoscope is turned posteriorly inside the stomach and a “cystotome” or needle knife is used to create a stab incision through the posterior stomach into the pseudocyst cavity. The pseudocyst wall should be <1 cm in thickness. An endoscopic stent(s) (preferably 10 French) is inserted over a guide wire to drain the pseudocyst. The stent(s) is left in place for 6–8 weeks or until the pseudocyst resolves on repeat CT scans.

Anatomical Points

The colon, small bowel, liver, and omentum may overlie the stomach and make access more difficult. Although these organs are at risk, generally these can be displaced to enable the procedure to be performed. Pectus excavatum or other deformities, including obesity, may also make the procedure more challenging. Abnormalities of the mouth or upper gastrointestinal tract, including previous surgery, may make access difficult. Although the pseudocyst usually displaces the major vascular structures, the portal vein and the common hepatic, gastroduodenal, splenic, and superior mesenteric vessels are all closely related and potentially at risk.

Perspective

See Table 9.5. Despite the extensive list, endoscopic cyst-gastrostomy is often associated with few complications. Pseudocyst infection is perhaps the most common problem. It is more likely should the cyst contain necrotic debris. It is usually treated effectively with intravenous antibiotics and close observation. Other serious problems include leakage of gastric or pancreatic pseudocyst contents into the retroperitoneum or peritoneal cavity, causing peritonitis and possibly abscess formation. Additional risks of esophageal/gastric perforation or teeth injury from the endoscopy can occur but are very infrequent.

Major Complications

Occasionally, **leakage** can occur from the posterior stomach or pseudocyst. The cyst-gastrostomy opening can stenose or close and lead to **failure of drainage** or **pseudocyst recurrence**. Separation of the posterior stomach from the pseudocyst can result in **intraperitoneal leakage** of stomach and pseudocyst contents, with or without abscess formation or **generalized sepsis**. **Bleeding** may occur. **Injury to the teeth** can be a serious complication with cosmetic and functional implications and the risk of aspiration. **Esophageal perforation** is a rare but a potentially devastating complication that should be repaired immediately; however, if missed, it can lead to mediastinitis and systemic sepsis. **Systemic sepsis** is infrequent but may be severe, exacerbated by comorbidities and leading to **multisystem organ failure** and **death**.

Consent and Risk Reduction

Main Points to Explain

- Risk of leakage/fistula
- Infection
- Bleeding

- Risk of mouth/teeth Injury
- Risk of perforation/leakage
- Risk of recurrence
- Risk of open surgery
- Risk of death

Table 9.5 Endoscopic cyst-gastrostomy estimated frequency of complications, risks, and consequences

Complications, risks, and consequences	Estimated frequency
Most significant/serious complications	
Infection[a] overall	5–20 %
Subcutaneous/wound	5–20 %
Intra-abdominal/liver bed/pelvic	1–5 %
Systemic	0.1–1 %
Bleeding/hematoma formation[a]	1–5 %
Wound, stomach, cyst wall, major vessels	
Stenosis of cyst-gastrostomy and recurrence of pseudocyst	5–20 %
Delayed gastric emptying	1–5 %
Conversion to open operation	1–5 %
Repeat procedure	5–20 %
Rare significant/serious problems	
Injury to the mouth, teeth, pharynx, or larynx	0.1–1 %
Stomach/esophageal perforation and leakage[a]	0.1–1 %
Anastomotic breakdown	0.1–1 %
Injury to the bowel, organs, or blood vessels	0.1–1 %
Gastric/duodenal/small bowel/colonic/liver/renal/adrenal	
Gastro- or pancreaticocutaneous fistula	0.1–1 %
Small bowel obstruction (early or late)[a] [ischemic stenosis/adhesion formation]	0.1–1 %
Pancreatitis/pancreatic injury[a]	0.1–1 %
Pneumoperitoneum	0.1–1 %
Pneumothorax	0.1–1 %
Aspiration pneumonitis	0.1–1 %
Multisystem organ failure (renal, pulmonary, cardiac failure)[a]	0.1–1 %
Mortality[a,b]	0.1–1 %
Less serious complications	
Pain/tenderness [rib pain (sternal retractor), wound pain]	
Acute (<4 weeks)	>80 %
Chronic (>12 weeks)[a]	5–20 %
Paralytic ileus[a]	0.1–1 %
Wound dehiscence	0.1–1 %
Port-site hernia formation	0.1–1 %
Wound scarring (poor cosmesis/wound deformity)	0.1–1 %
Nasogastric tube[a]	1–5 %
Blood transfusion	<0.1 %
Wound drain tube(s)[a]	Individual

[a]Dependent on underlying pathology, anatomy, surgical technique, and preferences
[b]Mortality can depend on patient selection, disease stage, surgeon experience, hospital volume/support, and comorbidities

Further Readings, References, and Resources

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