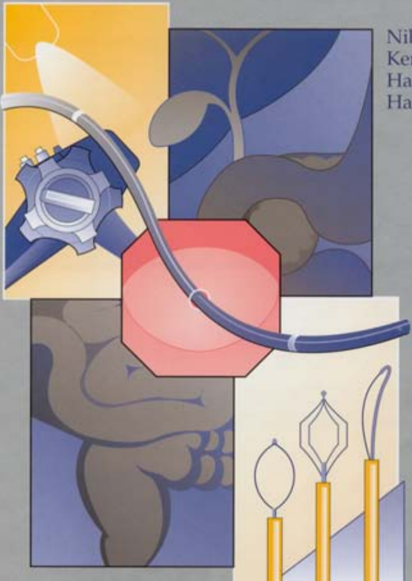
Therapeutic Endoscopy

Color Atlas of Operative Techniques for the Gastrointestinal Tract



Nib Soehendra
Kenneth F. Binmoeller
Hans Seifert
Hans Wilhelm Schreiber

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Nib Soehendra, M.D.

Professor
Director
Department of Endoscopic Surgery
University Hospital Eppendorf
Hamburg, Germany

Kenneth F. Binmoeller, M.D.

Deputy Director
Department of Endoscopic Surgery
University Hospital Eppendorf
Hamburg, Germany

Hans Seifert, M.D.

Department of Endoscopic Surgery
University Hospital Eppendorf
Hamburg, Germany

Hans Wilhelm Schreiber, M.D.

Professor
Department of General Surgery
University Hospital Eppendorf
Hamburg, Germany

Translated by Kenneth F. Binmoeller, M.D.

551 color illustrations
by Franziska von Aspern

Thieme
Stuttgart · New York · 1998

Library of Congress Cataloging-in-Publication Data

Soehendra, Nib:
[Praxis der therapeutischen Endoskopie. English]
Therapeutic endoscopy color atlas of operative techniques for the gastrointestinal tract / Nib Soehendra, Kenneth F. Binmoeller, Hans Seifert, Hans Wilhelm Schreiber : translated by Kenneth F. Binmoeller : color illustraions by Franziska von Aspern.
p. cm.
Includes bibliographical references and index.
ISBN 3-13-108261-5 (G. Thieme). – ISBN 0-86577-638-5 (Thieme Medical Publishers)
1. Gastrointestinal system–Endoscopic surgery–Atlases.
I. Binmoeller, Kenneth F. II. Schreiber, Hans Wilhelm. III. Seifert, Hans. IV. Title.
[DNLM: 1. Gastrointestinal Diseases–surgery–atlases.
2. Surgery, Endoscopic–methods–atlases. WI 17 5681p 1998] RD540.S5913 1998
617.5'53–dc21
DNLM/DLC
for Library of Congress 97-28201
CIP

This book is an authorized and updated translation of the German edition published and copyrighted 1997 by Georg Thieme Verlag, Stuttgart, Germany. Title of the German edition: *Praxis der therapeutischen Endoskopie: Operative Technik im Gastrointestinaltrakt.*

Rüdigerstrasse 14
D-70469 Stuttgart, Germany

Thieme Medical Publishers, Inc.
381 Park Avenue South
New York, NY 10016 U.S.A.

Illustrations by Franziska von Aspern, Hamburg

Cover design by Martina Berge, Erbach/Ernsbach

Typesetting by:
primustype R. Hurler GmbH
D-73274 Notzingen
typeset on Textline/Linotronic 330

Printed in Germany by Staudigl-Druck
D-86609 Donauwörth

ISBN 3-13-108261-5 (GTV, Stuttgart)
ISBN 0-86577-638-5 (TMP, New York) 1 2 3 4 5

Preface

This book seeks to portray the realistic therapeutic capabilities of endoscopy in its day-to-day practice. It is based on many years of professional endoscopic accomplishments, scientific studies, personal experience, and the outcome of critical interdisciplinary teamwork. It reflects the current state of diagnostic and interventional gastrointestinal endoscopy and its related responsibilities.

Each chapter covering a therapeutic procedure is categorized into the following key segments: General definition of the clinical entity, indications, prerequisites, instruments, technique, and procedural limitations and complications.

An informed and cooperative patient, a correct diagnosis and indication, and meticulous, skillful technique are critical to the success of the endoscopic procedure. Thorough knowledge of the endoscopic anatomy and pathological conditions is also a fundamental prerequisite.

We used original anatomic-endoscopic drawings to portray the technical concepts and details of the procedure. These are didactically more informative than photos or sketches based on photos. The drawings provide a synthesis of the endoscopist's view and the technical approach and interpretation. The text is concise and the legends to the figures highly detailed. The contents of the book aspire to translate the precise spoken word into a lucid form.

We wish to thank our coworkers Gudrun Pagel, Dr. Frank Thonke, Sabine Bohnacker, Uwe Seitz, and Dr. Vo C. Nam for their dedicated support. We also wish to express thanks to the many guests from inland and overseas who provided interesting and valuable dialogue. We thank the publisher, Albrecht Hauff, and the coworkers at Thieme, in particular Achim Menge, Silvia Buhl, and Rolf Zeller. They have accommodated our wishes and our efforts with consideration and have provided the book with a generous endowment. Thanks and recognition are also due to our illustrator, Franziska von Aspern; her combination of subject knowledge and artistic talent made the translation of endoscopic reality into pictorial images possible. Her skill was decisive to the success of this book.

Nib Soehendra, M.D.
Kenneth F. Binmoeller, M.D.
Hans Seifert, M.D.
Hans Wilhelm Schreiber, M.D.

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1

Foreign Body Extraction

General

A variety of foreign bodies may accidentally or intentionally enter the gastrointestinal (GI) tract. In about 90% of cases, however, they spontaneously pass out through the GI tract. The remaining 10% comprise sharp, pointed, or bulky objects, which can cause local trauma or chemical damage to the mucosa. Nearly all such foreign bodies can be extracted with a flexible endoscope.

Indications

An emergency indication for endoscopic extraction is an impacted foreign object. Acute obstruction of the esophageal lumen can cause aspiration pneumonitis or pressure on the esophageal wall resulting in perforation and mediastinitis. Foreign objects can become impacted in the esophagus at the three physiologic levels of narrowing: the cricopharyngeal sphincter, the aortic arch, and diaphragmatic hiatus. Objects that reach the stomach and are likely to pose a risk of mechanical or toxic injury should also be removed without delay. In addition, objects that remain in the stomach for more than 72 hours should undergo early endoscopic extraction since their spontaneous passage is unlikely. A bezoar requires debulking by endoscopic fragmentation to facilitate its removal.

Prerequisites

Prior to endoscopic extraction of a foreign body, information regarding the type, form, and size of the foreign body is required to plan the strategy of removal and to select the instruments to be used.

A plain radiograph of the upper GI tract may not always adequately localize the foreign body, and therefore a contrast study may be necessary. If a perforation is suspected, a water-soluble contrast agent like Gastrografin is preferred. The colon may also require evaluation with a contrast enema study. If an esophageal foreign body is suspected, then a plain X-ray of the chest should also include the neck as it is not unusual for foreign bodies to impact at the cricopharyngeal sphincter.

Children and uncooperative adults often require general endotracheal anesthesia to carry out the procedure safely and successfully.

Instruments

Apart from pediatric and therapeutic upper endoscopes, the endoscopic armamentarium should include a variety of forceps (crocodile, rat-tooth, etc.), snares, Dormia baskets, and a long overtube.

Technique

An overtube is recommended when removing pointed or sharp objects to avoid damage to the esophagus and pharynx. Small or slippery objects should also be removed through an overtube. It is safest to insert the overtube over a guidewire, using an appropriately sized bougie (generally 45 French) as an obturator (see Chapter 7, Fig. 96). If the foreign body occludes the lumen completely and prevents guidewire placement, then the overtube can be preloaded over the endoscope and pushed into place after the endoscope has been inserted across the pharynx. In such a case, a therapeutic gastroscope should be used to reduce the step formation between the endoscope and the overtube.

Extraction from the Esophagus

(Fig. 1–6)

Fig. **1a,b** Extraction of a coin from the esophagus.
a In children, a coin often impacts at the level of the cricopharyngeal sphincter.

b A coin with an elevated edge is easy to grasp and extract with the rat-tooth forceps. Coins with a smooth edge can be grasped with rubber-coated prongs.

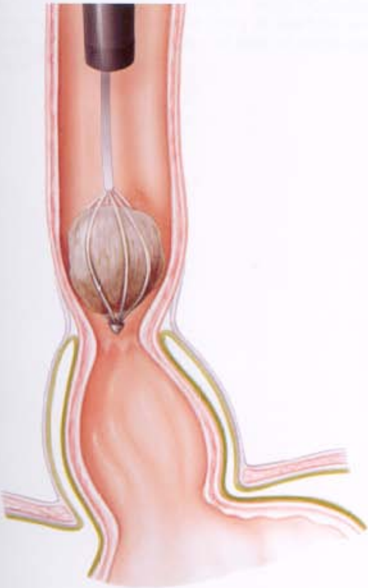


Fig. **2** A solid food bolus or a fruit seed can be removed with a Dormia basket. These foreign bodies impact typically just proximal to peptic strictures.

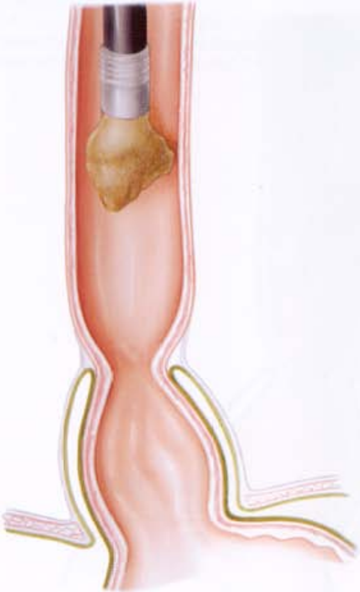


Fig. **3** A soft food-bolus (e.g., meat) can also be removed with simple endoscopic suction, which can be enhanced by applying a cylinder attachment to the tip of the endoscope (same device as used for variceal rubber-band ligation). Another alternative is to use the large-channel (6 mm) therapeutic gastroscope.

a

b

Fig. **4a**,**b** The technique of pushing an esophageal bolus into the stomach is principally hazardous. If used, this technique must be performed with extreme caution.
a The endoscopic view is centered on the bolus. Gentle pressure is applied to advance the bolus.
b Forceful advancement can result in perforation, particularly if the bolus is situated proximal to a stricture. The endoscope may also be displaced laterally and may thus perforate the esophageal wall.

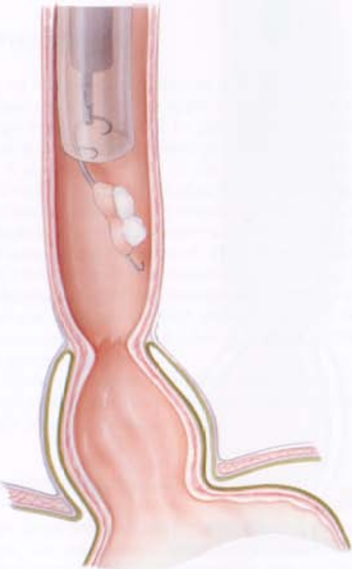


Fig. **5** Dentures with sharp hooks should be removed through an overtube. A rat-tooth forceps, polypectomy snare, or Dormia basket can be used for their retrieval.

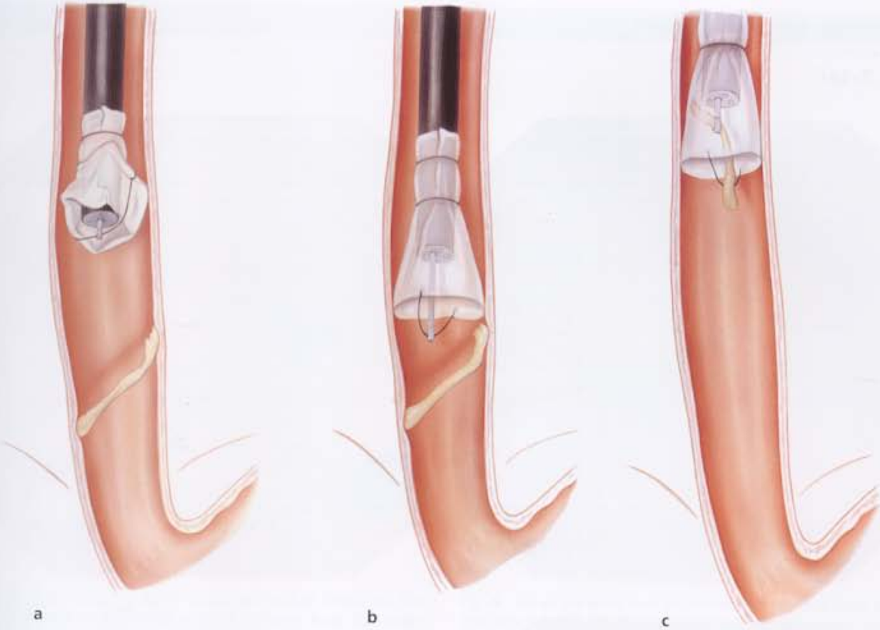


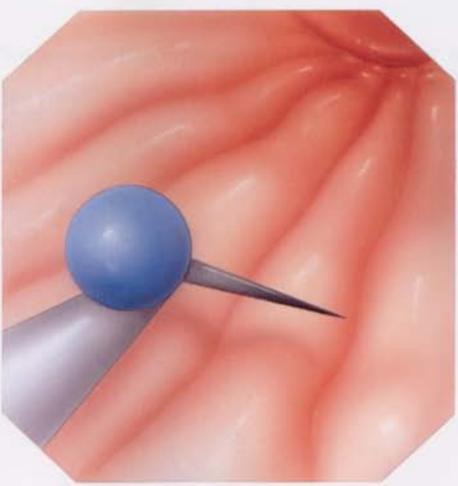
Fig. **6a–c** Extraction of a bone.
a Chicken or fish bones tend to lodge horizontally in the esophagus. An alternative to using an overtube is to attach a plastic parachute cover (piece of latex or silicon glove) at the tip of the endoscope.
b The plastic parachute is opened with the aid of a thread and air insufflation.
c An accessible portion of the foreign body is grasped and cautiously mobilized from the esophageal wall with a forceps, retracted into the parachute, and then extracted.

Extraction from the Stomach

(Fig. 7–16)

a

b



c

Fig. **7a–c** Extraction of a pin from a stomach filled with food.
a The foreign body can be localized under fluoroscopy and subsequently retrieved with a foreign-body forceps or a tripod grasper.
b An approach that can avoid the need for fluoroscopy is to first clear the stomach of food with the 6-mm channel endoscope. Alternatively, turning the patient into the right lateral position will shift the stomach contents from the fundus to the antrum, thus enabling visualization of the pin.
c The pin is grasped directly below the head with the polypectomy snare.

Fig. **8** Short pins can be removed without an overtube. The snare should be extended a good distance from the endoscope to allow sufficient mobility of the pin during removal, minimizing the risk of laceration. A small Dormia basket can also be used for this maneuver.

Fig. **9** Small batteries warrant immediate removal because of the high risk of local and systemic toxicity. The smooth surface can be grasped with a basket. Alternatively, a snare with a retrieval net attached can be used (see **Fig.230f**). An overtube should be used since the battery may dislodge during passage through the hypopharynx and lodge in the trachea.

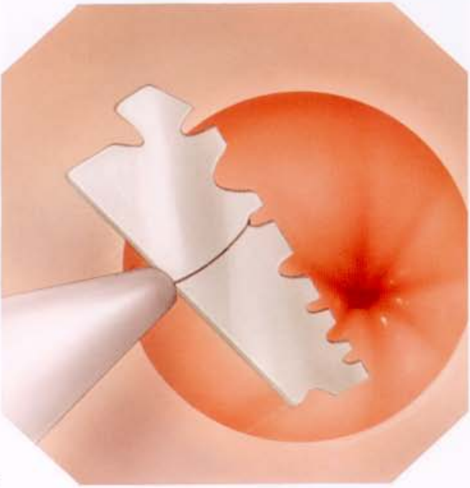
Fig. **10** Marbles necessitate prompt removal because of the toxicity of their color coating. The Dormia basket is used to engage spherical objects like marbles.

a

b

Fig. **11a**,**b** Prisoners sometimes swallow open safety pins together with food (e.g., bread) as a manipulative measure for secondary gain.
a Endoscopic extraction requires the use of a long overtube.

b The safety pin is grasped with the rat-tooth forceps. The endoscope is withdrawn together with the pin into the overtube and removed.



a

b

Fig. **12a–b** Razor blades (usually broken in half) are usually swallowed by prisoners, psychotic or mentally retarded people.
a Extraction is performed with an overtube to protect the esophagus.

b The blade is securely grasped with a rubber-coated forceps.

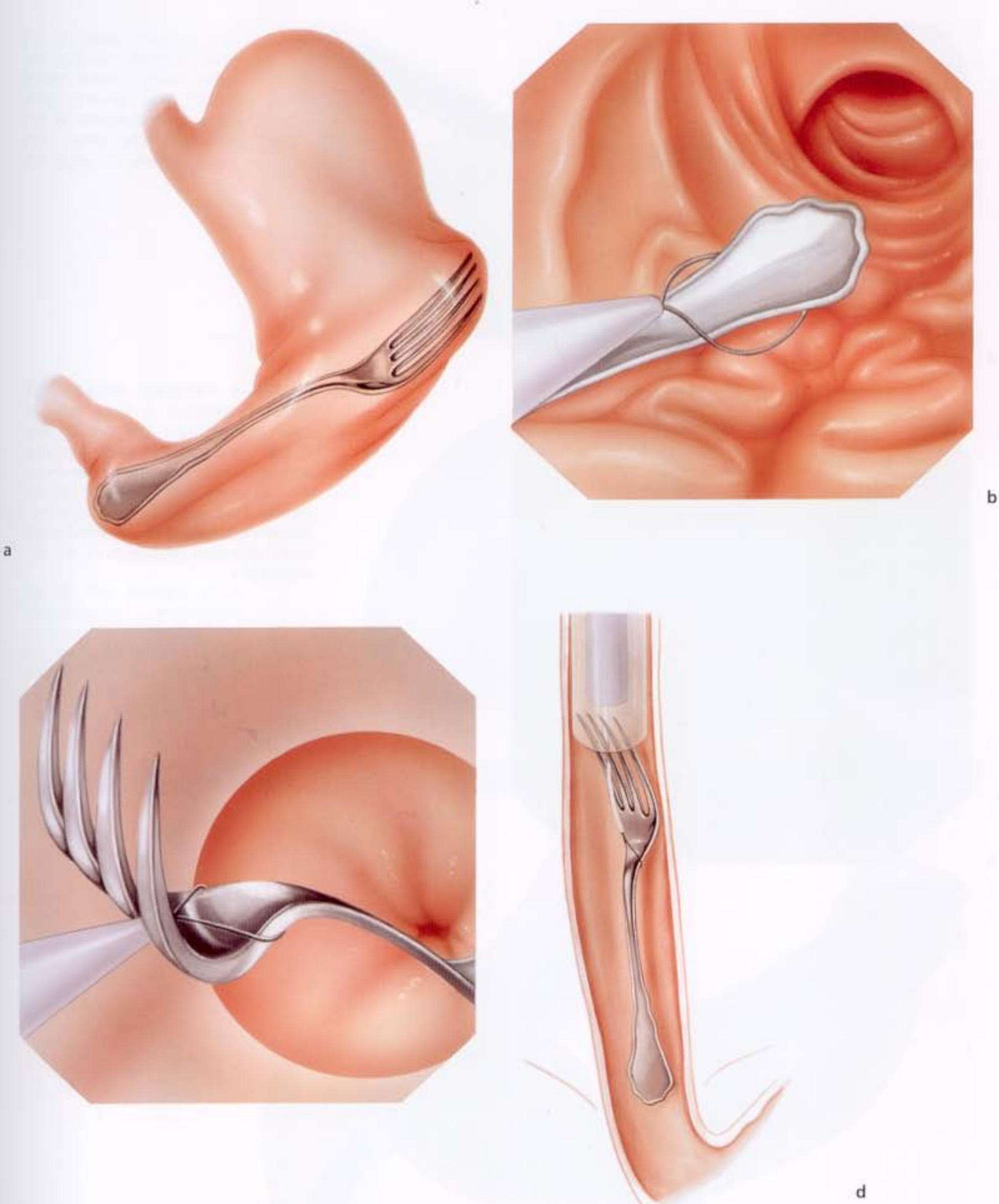


Fig. **13a–d** Cutlery items are also commonly swallowed by prisoners and psychotic patients. Spoons are sometimes used to induce vomiting during which they are accidentally swallowed.
a A fork is horizontally lodged in the stomach. The prongs press into the stomach wall.
b It is easier to approach the fork from the handle end, then to slide the snare up to the prongs.
c,d The pronged end of the fork is pulled into the overtube for a safe removal.

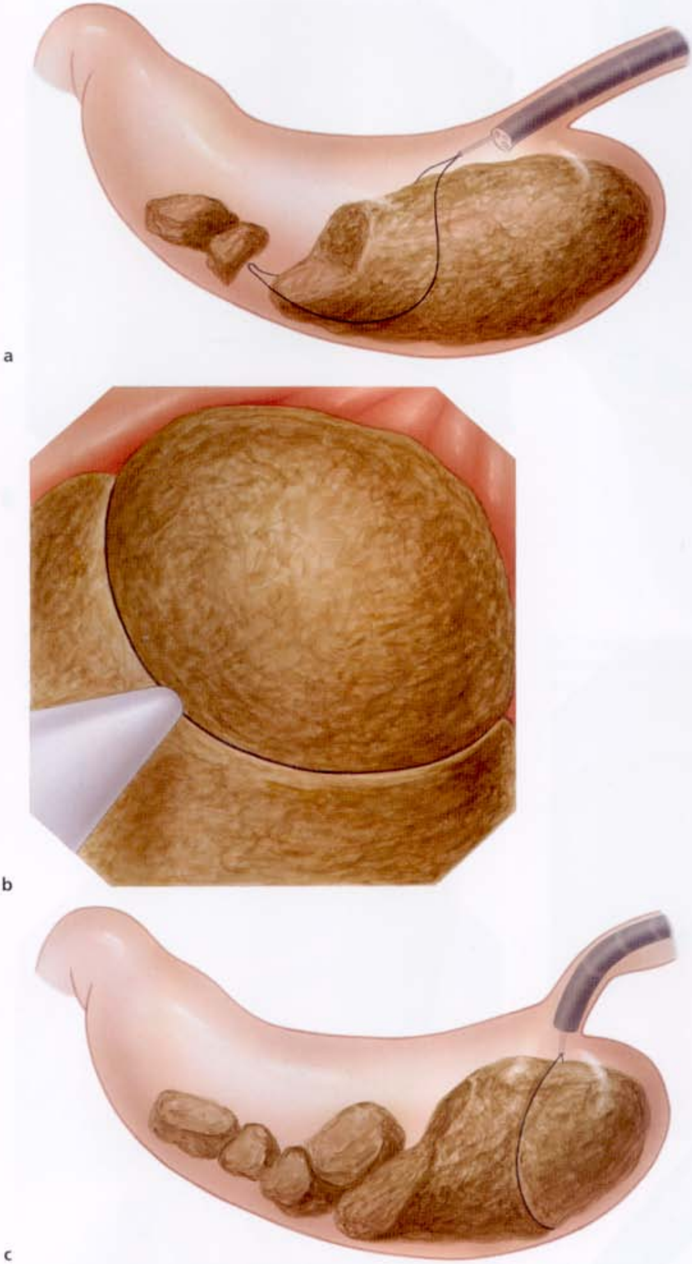


Fig. **14a–c** Piecemeal reduction of large phytobezoar. A large snare is used to fragment the bezoar into smaller pieces so that these can pass spontaneously. Trichobezoars are more difficult to remove. Clumps of hair are removed with a rat-tooth forceps. Preliminary placement of an overtube will avoid repeated intubation of the cricopharynx.

Fig. 15 Body packers may smuggle illicit drugs by swallowing them in plastic wrappings or tubes. Such packets can be removed with a snare, care being taken to avoid damaging the wrapping.

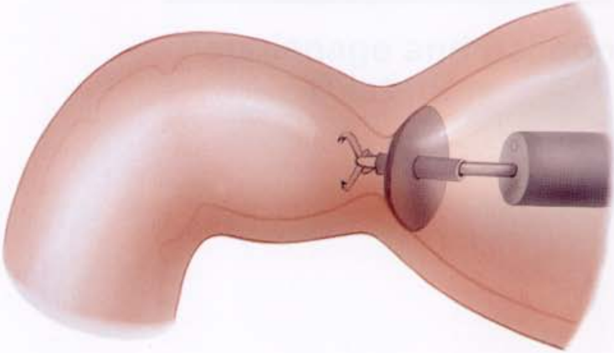


Fig. 16 The buttress of a percutaneous endoscopic gastrostomy (PEG) can get lodged in the pylorus or the duodenum. Extraction is possible with a snare or rat-tooth forceps (shown here).

Extraction from the Rectum

(Fig. 17)

Fig. 17 Foreign bodies inserted into the rectum (carrots, cucumbers, vibrators) can usually be removed with a large snare.

Complications

Perforation is the most serious complication that can result from endoscopic foreign-body extraction. This usually occurs when removal is difficult or requires excessive force. As a rule, objects obstructing the esophageal lumen should not be pushed into the stomach. Sharp or pointed objects that can lacerate the mucosa should always be removed through an overtube.

Injury to the GI wall, whether due to pressure necrosis, a tear, or a difficult extraction, should be promptly investigated with a radiographic contrast study using a water-soluble contrast agent to rule out a perforation. The possibility of a delayed perforation caused by tissue necrosis should also be kept in mind. Dietary restrictions and acid-suppressive or mucosa-protective drug therapy may be indicated, and the patient (or responsible next of kin) should be informed about the risk of delayed perforation.

The risk of a foreign body aspiration during extraction also deserves emphasis. Apart from using an overtube, endotracheal intubation is recommended for patients at increased risk for aspiration. This also includes the patient who is not fasting and particularly if intravenous sedatives are administered prior to the endoscopic procedure.

2

Bougienage and Balloon Dilatation

General

Bougienage or pneumatic dilatation is commonly performed for the treatment of benign and malignant strictures of the esophagus, and occasionally for pyloric or colonic strictures. Biliary and pancreatic duct strictures are also amenable to dilatation. Repeated dilatation is usually necessary to achieve a satisfactory long-term therapeutic result.

Indications

The main indication is a benign, fibrotic stricture of the esophagus. The etiology is usually peptic (recurrent reflux esophagitis) or postoperative (anastomotic stricture). Bougienage is also often indicated prior to stent placement for malignant strictures of the esophagus or bile duct. Benign strictures of the bile duct (postoperative, sclerosing cholangitis) and pancreatic duct (chronic pancreatitis, posttraumatic) are candidates for bougienage or pneumatic dilatation if the stricture is short (see Chapter 11, Biliary Stent Drainage, and Chapter 12, Pancreatic Duct Stenting and Stone Extraction). Stenoses in other locations (pylorus, rectum, colon, or GI and biliodigestive anastomoses) are less common indications that require a further workup before general recommendations can be made. The role of endoscopic dilatation for strictures of chronic inflammatory diseases such as Crohn's disease and diverticulitis needs to be assessed on a patient-to-patient basis, taking into account the endoscopic and radiographic findings and the risk-benefit ratio as compared with surgical options.

Pneumatic dilatation is an alternative to surgical cardiomyotomy for the treatment of achalasia. Repeated dilatations are usually required. Intramural injection of botulinum toxin is an endoscopic alternative that may achieve results similar to those of pneumatic dilatation.

Prerequisites

A preliminary radiographic contrast study is recommended to provide an anatomic "road map." A small-diameter gastroscope is used for the initial evaluation. Biopsies are obtained to determine the nature of the stricture. Since a negative biopsy does not rule out malignancy, repeat biopsies may be required after dilatation before a stricture can be labeled as benign.

The majority of benign strictures require repeated sessions of dilatation over a prolonged period of time. Patient education and compliance are therefore important requirements of endoscopic therapy. Patient compliance can be enhanced by minimizing the level of procedural discomfort. Most dilatation procedures can be performed under intravenous sedation on an outpatient basis. Procedures are initially repeated at 3- to 4-day intervals and then at 2- to 3-week intervals.

Perforation is the most common and dangerous complication that can follow bougienage or pneumatic dilatation. Appropriate patient selection, correct choice of instruments, and a cautious technique are the key factors in avoiding perforation.

Instruments

The most widely used bougies for esophageal dilatation are the flexible Savary-Gilliard bougies made of PVC (polyvinyl chloride). These come in diameters ranging from 5–20 mm. Bougies made of stiffer plastic material may occasionally be required for extremely tight or infiltrating strictures.

The diathermic needle knife, the argon plasmacoagulator, or the Nd:YAG laser can be used to incise fibrotic ring strictures.

TTC (through-the-channel) balloon dilators can be inserted through the biopsy channel of the endoscope and are available in diameters ranging from 6–25 mm. Larger balloon dilators with diameters of 30, 35, and 40 mm, which are used for the treatment of achalasia, are inserted over a guidewire. An alternative to the balloon dilator is a balloon that is attached to the end of the endoscope. In contrast to balloon dilators, which are made of low-compliance plastic polymers, the balloon attached to the endoscope is made of latex rubber and consists of three layers.

Biliary and pancreatic duct strictures can be dilated with Teflon dilators or hydrostatic balloons (see Chapter 11, Biliary Stent Drainage).

Bougienage of strictures initially entails the placement of an Eder-Puestow guidewire across the stricture through the biopsy channel of the endoscope. The wire is available with or without calibrations, the former wire being mandatory if dilatation is performed without fluoroscopy. Hydrophilic guidewires commonly used for the biliary and pancreatic ducts (260 cm long, 0.035 or 0.038 in, J-shaped tip) are also used for negotiating long, tight, and tortuous strictures.

A pediatric endoscope (outer diameter of 5.3 or 7.9 mm) may be necessary to pass a tight or difficult stricture (e.g., for endoscopic guidewire placement prior to bougienage).

Technique

Bougienage should always be performed over a guidewire. Therefore, proper placement of the guidewire is the key to a successful and safe procedure. Balloon dilatation with smaller TTC balloons are performed under direct endoscopic guidance. The choice of the balloon or size of the dilator depends upon the tightness of the stricture. This can be judged by the radiologic and endoscopic appearance of the stricture and the resistance encountered during passage through the stricture.

Placing the Guidewire

If the stricture can be negotiated with the endoscope, guidewire placement is performed directly under endoscopic guidance. Sometimes, the guidewire itself may assist the passage of the endoscope through the stricture (Fig. **18a-d**). Stiffened by the guidewire, the distal end of the endoscope can be cautiously maneuvered through the stricture.

If the stricture cannot be negotiated with the endoscope, the guidewire has to be inserted under fluoroscopic guidance. A hydrophilic biliary guidewire is recommended for angulated or otherwise difficult strictures (Fig. **19**). Once a pathway is established, different techniques can be used to dilate the stricture (Figs. **20, 21, 22**).


a


b

Fig. **18a–d** Endoscopic guidewire placement.
a Most strictures can be negotiated with a 5.3-mm or 7.9-mm pediatric endoscope. If the lumen is seen but resistance is encountered during passage, a guidewire is used to assist the passage of the endoscope. The flexible spring-loaded end of the Eder-Puestow wire is advanced from the endoscope and carefully inserted a short distance in the lumen of the stricture. The metal wire stiffens the endoscope tip and serves as a guide for the endoscope.
b The endoscope is maneuvered through the stricture.

Fig. **18c** and **d** ▶

c

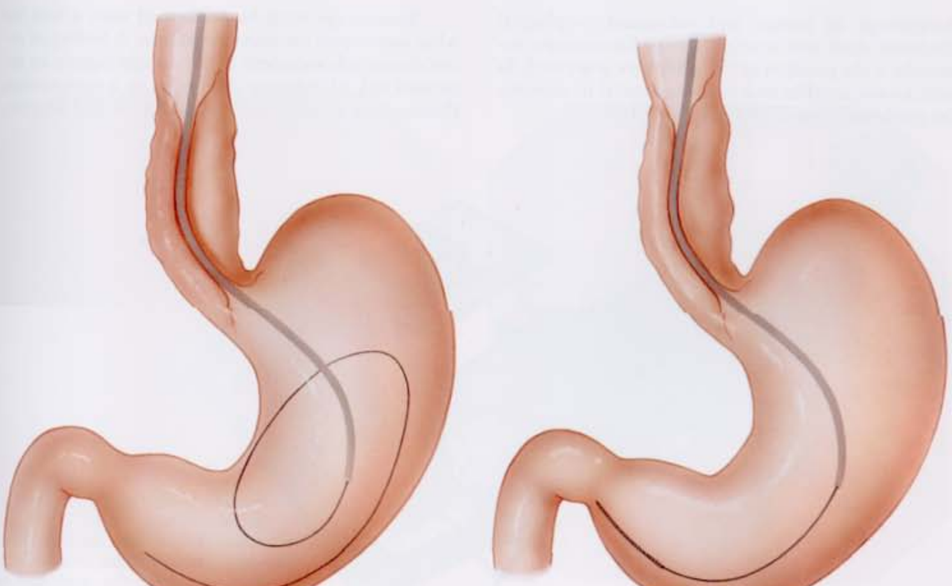
d

Fig. **18c** The guidewire is positioned in the antrum. The endoscope is then gradually withdrawn under vision, allowing the wire to bend along the greater curvature.

d The guidewire is simultaneously advanced as the endoscope is withdrawn. The distal and proximal borders of the tumor are recorded.

Fig. **19** High-grade stricture (residual lumen less than 5 mm) that cannot be negotiated with a pediatric endoscope. Using fluoroscopy, a hydrophilic biliary guidewire (260 cm long, 0.035 or 0.038 in, J-shaped tip) is negotiated through the long and tortuous stricture.

Fig. **20** Dilatation over a hydrophilic guidewire is possible with small diameter bougies (up to 30 French). The stricture should be inspected after dilatation with a small-diameter endoscope to rule out deeper tears.



a

b

Fig. **21a–b** The hydrophilic guidewire, which is not as stiff as the metal guidewire, is not suited for bougienage of tight or infiltrating strictures.
a A radiopaque 9-French catheter is inserted over the hydrophilic guidewire, through which the hydrophilic wire is exchanged for the more rigid Eder-Puestow wire.
b Bougienage is performed over the Eder-Puestow wire under fluoroscopic guidance.

Fig. **22** Bougienage of a pin-hole stricture carries a substantial risk of perforation. An alternative approach is to insert a small-diameter (9 French) feeding tube through the stricture over a guidewire and to leave it inside for a period of several days. The stricture will spontaneously dilate. Bougienage can then be performed in the standard manner.

Bougienage

Bougienage of benign and malignant esophageal strictures does not strictly require fluoroscopy, especially if the position of the guidewire is secured. In such a case, a calibrated wire is essential to monitor the guidewire's position (Figs. 23, 24).

Bougienage must be performed with a feel for what constitutes excessive resistance. A feeling of recoil during advancement of the bougie signals an increased risk of inducing deep tears or a perforation. Fluoroscopy is not a substitute for careful bougie-

Fig. **23** Bougienage requires the assistance of two nurses. One nurse, positioned at the patient's head, keeps the oropharynx clear of secretions and holds the guidewire securely at the mouthpiece. The other nurse provides instrumental assistance to the endoscopist. Continuous monitoring by pulse oximetery is mandatory for procedures performed under intravenous sedation.

nage and may even provide a false sense of security and divert the endoscopist's attention away from the feel of resistance encountered.

Perforation typically occurs during passage of the first bougie, and hence the first bougienage is the most crucial. As a rule, it is always better to err on the side of a smaller-sized bougie. The bougie sizes for subsequent dilatations can then be judged depending upon the resistance encountered during the first bougienage. A stenosis that can be easily passed with a 7.9-mm pediatric endoscope usually permits passage of a 10-mm bougie with safety.

After the first session of dilatation is completed, the stricture should be inspected endoscopically to determine the local effect. This can be quite variable. In the case of fresh postoperative strictures, malignant stenoses or strictures pretreated with radiotherapy or chemotherapy, the tissues are usually fragile and therefore more prone to developing deep tears or even a perforation. The endoscopic finding after the first dilatation determines the planning of subsequent therapy (intervals, bougie size).

There are two general rules to be followed during bougienage: the bougie size should not be increased by more than 1 mm if resistance is encountered, and no more than three consecutive dilatations should be performed in one session ("rule of three"). Bougienage of up to 14 mm is usually the end point of treatment; however a 12.8-mm dilatation is often sufficient to palliate dysphagia.

Fig. **24** Bougienage is generally performed without fluoroscopy. The extent of the stricture is first determined endoscopically. The bougie is then advanced until the stenosis is passed, which is indicated by a feeling of give and also by the length of the bougie inserted. Markings along the calibrated guidewire also provide a reference point for the exact position.

a

b

Fig. **25a–b** Bougienage can be performed under fluoroscopic or endoscopic control.

a Bougienage of a benign esophageal stricture under endoscopic guidance.

b The response can be immediately evaluated endoscopically after each bougienage.

Balloon Dilatation

Balloon dilatation is usually indicated in functional strictures like achalasia and for benign strictures that cannot be adequately dilated by a bougienage. In contrast to the latex rubber balloon that is fitted on the endoscope, the TTC balloon dilators that are made from low-compliance plastic polymers inflate to a predetermined shape and diameter after inflation up to a preset pressure. Hence, it is essential that the correct balloon diameter be selected prior to dilation to minimize the risk of perforation.

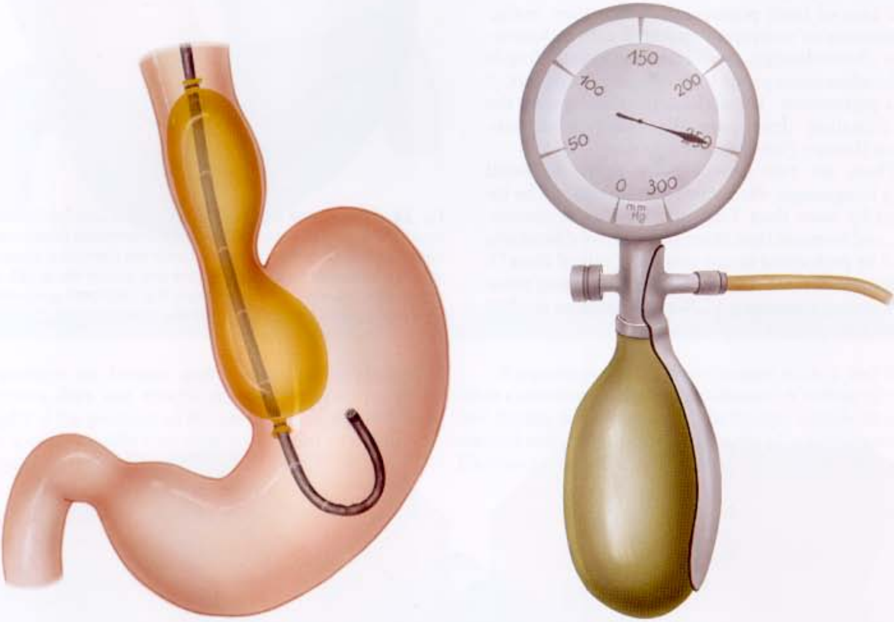


Fig. **26** Pneumatic dilatation for achalasia. The latex rubber balloon is attached to the distal end of the endoscope above the bending section. Dilatation is performed under direct endoscopic vision in the retroflexed position. Fluoroscopy is not required for this technique. The balloon is inflated to 250 mmHg for 60 seconds to disrupt the muscle of the lower esophageal sphincter.

a

b

Fig. **27a–b** Pneumatic dilatation of the cardia for achalasia using an over-the-guidewire balloon dilator (initial treatment with a 30-mm balloon).

a The balloon is advanced over an endoscopically inserted guidewire that lies along the greater curvature of the stomach. Radiopaque markings at the proximal and distal ends of the balloon allow precise positioning of the balloon at the cardia. "Waist formation" of the balloon occurs at the cardia as the balloon is inflated with air.

b Successful disruption of the lower esophageal sphincter causes the waist to disappear.

Fig. **28** Hydrostatic dilatation of a benign pyloric stenosis with the TTC balloon dilator (diameters of 15–25 mm are commonly used). The balloon is cautiously advanced into the stenotic pylorus under direct vision. Fluoroscopy is not required. Waist formation of the balloon and its obliteration can be easily seen through the transparent balloon.

Endoscopic Incision of Stenotic Rings

A benign stricture due to a concentric fibrous ring can be incised with either the needle-knife papillotome or the argon plasma-coagulator.

a

b

Fig. **29a–b** Stenotic fibrous ring in the esophagus.
a The ring is incised with the needle knife.
b The incision is performed with pure cutting current at three equidistant points (Mercedes Benz cut).

Fig. **30** Incising a fibrotic stricturous ring with the argon plasma-coagulator (a laser can also be used).

a

b

Fig. **31a–b** Fibrous ring at a rectal anastomosis (performed with an EEA stapler).
a Incision using the diathermic needle knife.
b Dilatation with the hydrostatic balloon, which can be used alone or following stricture incision. Combining dilatation with an incision is probably safer, as dilatation alone may cause unilateral tearing.

■ Complications

Deep tears and perforations are the most common complications of bougienage and dilatation. They can usually be avoided by adhering to fundamental rules of good technique, which are: careful study of the anatomy of the stricture on contrast radiographs before endoscopic dilatation, correct placement of the guidewire, and a careful, gradual dilatation. The last point, which deserves particular emphasis, means a gradual dilatation over several sessions is preferable to an aggressive dilatation in a single session. Esophageal dilatation up to 12.8–14 mm will usually require several sessions.

If perforation is suspected on the basis of clinical symptoms (abdominal or retrosternal pain), a water-soluble contrast study should be performed. A careful endoscopic examination without air insufflation may also help to identify a deep tear or perforation. Immediate surgery is indicated for a symptomatic perforation, but conservative treatment with total parenteral nutrition and systemic antibiotics is a reasonable alternative if the patient is minimally symptomatic and does not show any signs of mediastinitis or peritonitis. The patient at high risk for surgery can be treated with either an esophageal plastic stent or a coated expandable metal stent to seal off a perforation.

3

Esophageal Stent Placement

General

Esophageal stenting palliates obstructive symptoms caused by tumors of the esophagus and the cardia. Stent placement not only relieves dysphagia, thus enabling oral nutrition, but also prevents aspiration pneumonitis. Tracheoesophageal fistulae, too, can cause similar complications. The major advantage of stent placement over other palliative treatments is the prompt relief of dysphagia.

Indications

The primary indications are dysphagia and tracheoesophageal fistulae due to advanced, unresectable, or inoperable tumors of the esophagus and cardia. Less common indications are strictures at other sites, such as the distal stomach or rectum, that fulfill criteria in which palliative surgery is either not feasible or too hazardous.

Prerequisites

A fundamental prerequisite for stent placement is that the patient's symptoms should correspond well with the findings of radiologic imaging and endoscopic evaluation (including endosonography and bronchoscopy).

The inner diameter of the stent has obvious bearing on the type of diet tolerated by the patient. It is important however, to recognize that peristalsis—an important component of swallowing—is impaired by the tumor as well as the stent. Thus, a larger stent diameter may not necessarily enhance the patient's ability to swallow. A reasonable goal of treatment is the ability to swallow a soft pureed diet, for which an inner stent diameter of 10 mm (outer diameter of around 12 mm for plastic stents) usually suffices. Larger diameter stents increase the risk of procedural complications, especially during passage through the hypopharynx.

Arguments in favour of using expandable metal stents, which are significantly more costly than plastic stents, are based on several assumptions regarding shortcomings of plastic stents. Plastic stent placement has been reported to be associated with high perforation rates, partly due to extensive bougienage prior to stenting. Furthermore, their use for esophageal tumors involving the cervical esophagus is considered to be contraindicated. Various modifications in the design and insertion technique of plastic stents described below address these shortcomings.

Stent placement requires preliminary dilatation of the tumor stenosis. To avoid perforation, bougienage should be performed gradually and, if necessary, in several sittings.

Instruments

A variety of plastic (silicon, latex, Tygon) and expandable metal stent designs are available for the treatment of tumors obstructing the esophagus and/or cardia (Fig. 32).

Stents may have to be modified in special anatomic situations. In the cervical esophagus, for example, the funnel should be relatively short and a smaller diameter stent should be selected (outer diameter of less than 10 mm) to avoid or minimize foreign body sensation and tracheal compression. In cases of a fistula, a wider funnel may be required to seal off the fistula (this can be achieved by adding a second funnel). Attaching silicone flaps to the distal end of the stent can prevent proximal migration of stents that are positioned across the cardia (Fig. 33). The silicone flaps and a second funnel are fixed to the stent with a fast-acting glue.

Expandable metal stents are necessary when the malignant stenoses are at sites that cannot be adequately treated by plastic stents. These include strictures in the distal stomach, rectum, and anastomotic sites. Coated expandable stents have the advantage of preventing tumor ingrowth and are therefore better suited for sealing off fistulae.

Fluoroscopy is not mandatory for the stent insertion. The stent is advanced together with an introducer bougie over an endoscopically placed Eder-Puestow guidewire. Stents with an internal diameter of 10 mm are inserted over a 29-French bougie, and pushed with a 14-mm calibrated pusher tube

Fig. 32 Tygon plastic stent with a short funnel. From right to left: outer diameters of 9, 12, and 14 mm providing internal diameters of 7, 10, and 12 mm. The midsized stent is most commonly used. The smallest stent is used primarily for high-grade strictures in the cervical esophagus (e.g., recurrent tumor at the anastomosis after esophagectomy).

(Fig. 34). Having positioned the stent, the bougie is replaced with a 5.3-mm or 7.9-mm pediatric endoscope through the pusher tube to confirm the stent position.

Fig. 33 Stent with a second funnel to enlarge the funnel diameter. Silicone flaps have been added to the distal end.

Fig. 34 Instruments for stent placement: bougie with the Eder-Puestow guidewire, transparent pusher tube with markings in centimeters, and a plastic stent.

■ Technique

The upper and lower borders of the tumor are recorded from the incisor teeth. The stent length should be approximately 5 cm longer than the endoscopically measured extent of the tumor. Stents placed for upper esophageal tumors do not require distal flaps since the upper esophageal sphincter prevents migration. The stent also does not need to extend across the cardia. In contrast, tumors involving the lower third of the esophagus require stents that extend beyond the cardia. To prevent proximal migration, flaps are attached to the distal end of the stent.

A strong thread is attached to the funnel so that the stent can be withdrawn proximally to correct the position or, in the event of an emergency during the procedure, to remove the entire stent.

The stent is loaded onto the bougie together with the pusher tube. It is important that both the stent and pusher tube fit snugly over the bougie without any step formation. Silicone oil is smeared on the bougie to reduce friction and to enable easy removal of the bougie after stent placement (Fig. 35).

Stent insertion resembles bougienage. The stent, pusher tube, and bougie are held together and inserted as one assembly over the Eder-Puestow wire.

Fig. 35 Stent insertion unit. The stent and pusher are fed over the bougie, forming one unit that can be inserted over the guidewire. The stent and pusher have approximately the same inner diameter and thus fit snugly over the bougie. This ensures that the stent and pusher tube are not displaced during insertion. Furthermore, a step formation between stent and bougie is eliminated, which minimizes the risk of tissue laceration. The bougie is lubricated with silicone oil to facilitate its removal after stent insertion.

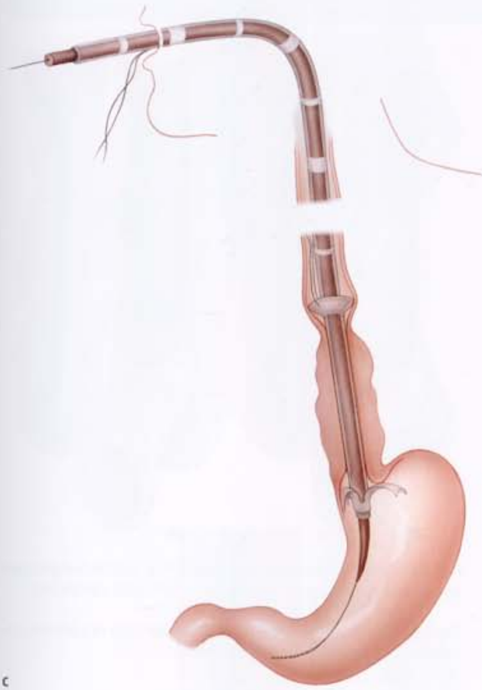
Positioning of the stent is guided by the centimeter markings on the pusher tube. The markings allow precise positioning of the stent across the tumor stenosis, obviating the need for fluoroscopy. The pusher tube is advanced to a predetermined level, defined by the level where the funnel should lie (approximately 1 cm above the upper border of the tumor).

After the stent is positioned, the bougie and guidewire are removed. Secretions from the stomach that reflux back into the pusher tube are suctioned out to prevent aspiration. A 5.3-mm or 7.9-mm pediatric endoscope is then inserted through the pusher tube to verify that the stent fully bridges the tumor stenosis. The thread and the pusher tube are then removed (Fig. **36**).

Preliminary bougienage prior to stent placement can be performed on an outpatient basis. After stent placement, the patient should be monitored overnight in the hospital. If the postprocedural course is unremarkable, fluids can be orally administered after the effect of intravenous sedation wears off. Severe postprocedure pain or symptoms suggesting perforation should be investigated with a Gastrografin study.

Fig. **36** Technique of stent insertion.
a After the malignant stricture has been dilated with bougies, an endoscopy is done to note the upper and lower borders of the tumor and place the Eder-Puestow guidewire across the stenosis.
b The endoscope is gradually withdrawn as the guidewire is simultaneously advanced.
c The bougie-stent-pusher-unit is inserted over the guidewire similar to bougienage. The pusher and thread (affixed to the stent) are held together with the bougie in one hand, and the guidewire is held with the other hand. The procedure is interrupted if excessive resistance is encountered, signaled by a tendency for the pusher tube to recoil. If this occurs, a repeat dilatation has to be performed or a smaller stent inserted.
d After the stent is inserted, the bougie is removed along with the guidewire. Friction between the bougie and stent may cause the stent to be pulled back, hence it is important that the position of the stent be maintained with the pusher. The 5.3-mm or 7.9-mm pediatric endoscope is then inserted through the pusher to confirm proper placement of the stent. The esophageal wall can also be inspected through the transparent pusher to ensure that major injury to the wall has not occurred. Secretions from the stomach refluxing back through the stent are suctioned.
e The retroflexed view of the cardia shows the flaps at the distal end of the stent positioned below the cardia.
f The endoscope is withdrawn through the stent, pausing at the upper rim of the funnel to verify its position above the tumor stenosis. The thread is then removed while the stent is held with the pusher tube. The pusher tube is finally disconnected from the stent funnel and withdrawn together with the endoscope. During withdrawal, the esophageal wall is again inspected to exclude injury.

a b



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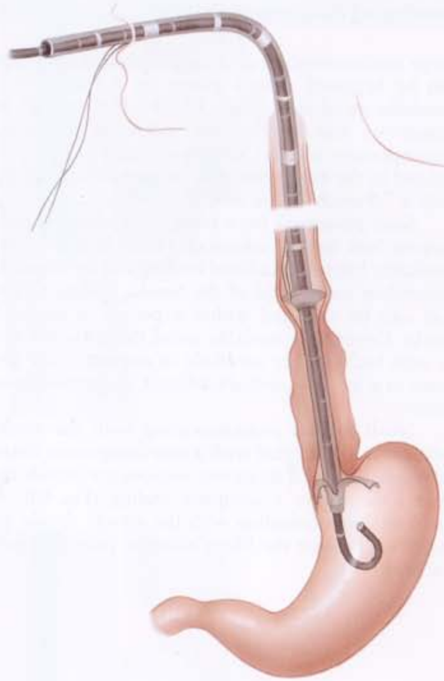

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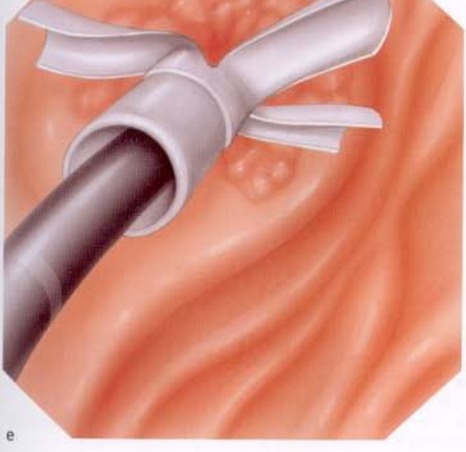

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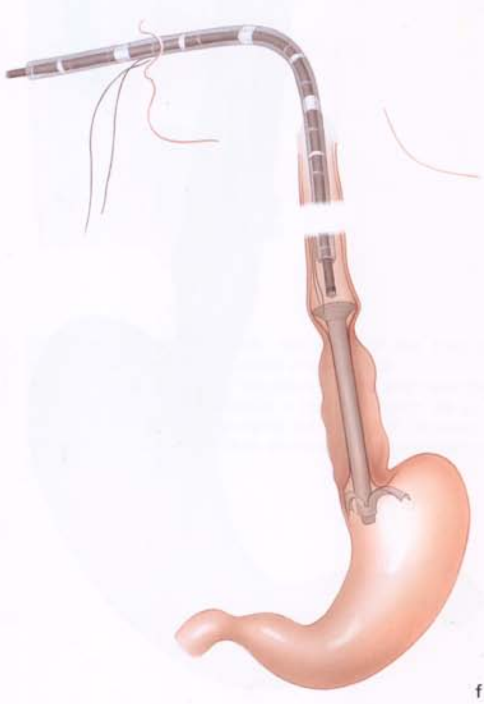


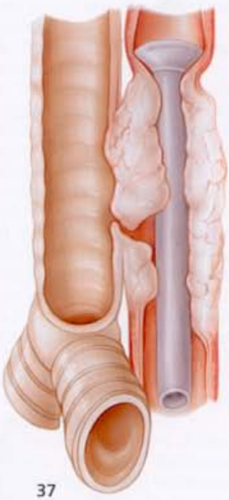
f

Sealing of Esophageal Fistulae

Large tracheoesophageal or esophagopleural fistulae can be bypassed with a plastic or a covered expandable metal stent (Figs. 37, 38). If a stricture is absent—as may be the case following radiation, chemotherapy, or after surgery—a stent can be suspended in the esophagus and anchored transnasally with a 7-French Teflon tube (Fig. 39).

Stent placement for a fresh postoperative anastomotic leak has the advantages that the leak is immediately bypassed and oral feeding can be resumed. Depending on the size of the fistula, sealing of the leak can be expected within a period of about 2 weeks. Covered expandable metal stents should not be used because they are likely to migrate in the absence of a stricture and are difficult or impossible to remove.

Small fistulae communicating with the mediastinum can be treated with a two-component fibrin adhesive. Repeated treatment sessions are usually required to achieve a complete sealing (Fig. 40). A fistulous communication with the airway should be excluded, because the fibrin adhesive may spill into the lung.



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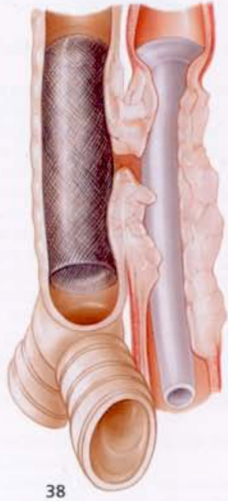

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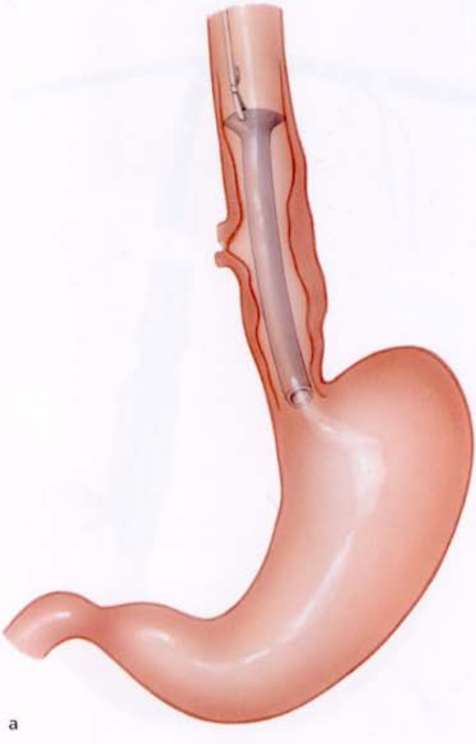
Fig. **37** Stent placement to close off a tracheoesophageal fistula in a patient with a stenotic esophageal carcinoma.

Fig. **38** Large tracheoesophageal fistulae may require the additional placement of a tracheal stent.



a

b

Fig. **39a,b** A stent suspended by transnasal anchorage to close off an esophageal fistula in the absence of a stenosis.
a A stent with a wide funnel is implanted. A 7-French Teflon tube is fixed to the funnel.
b The Teflon tube is passed transnasally and is anchored by looping it around the ear and fixing it to the cheek.

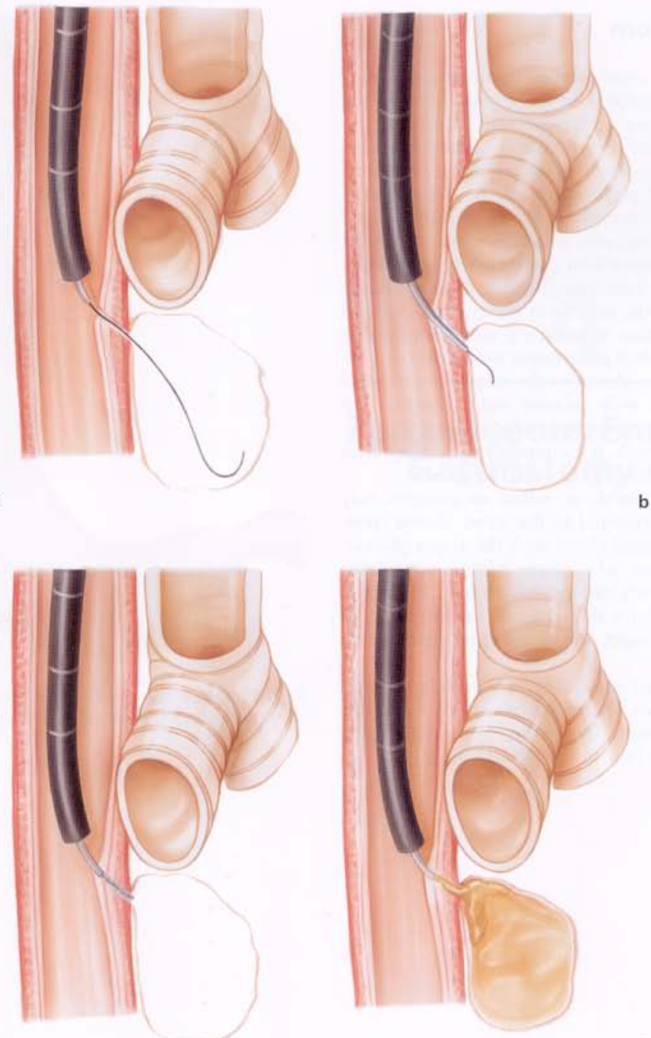


Fig. **40a–d** Fibrin adhesive sealing of an esophagomediastinal fistula.
a The site of the fistula is located and the tract is cannulated with a 0.035-in hydrophilic guidewire.
b A Universal catheter (see Chapter 11, Biliary Stent Drainage) is passed into the fistulous tract over the guidewire.
c The wire is exchanged for a cytology brush. Withdrawing the universal catheter slightly, the lining of the tract is scrubbed with the brush to create a raw surface.
d The Universal catheter is repositioned in the tract, and the brush is removed. Fibrin adhesive is injected through the universal catheter (both components are injected in sequence). Repeated injections of the fibrin adhesive can be performed at 1- to 2-day intervals.

Complications

Perforation, the most severe complication, may occur during bougienage or stent placement. In the event of perforation, stent placement should be performed to bridge the site of the tear. Surgery becomes mandatory if the patient develops septic complications. The risk of perforation can be minimized if bougienage is performed in a cautious, graduated manner. The endoscopist must be sensitive to the threshold of resistance that can be safely tolerated.

Bleeding is a rare complication that is usually self-limiting once the stent is in place. Proximal and distal stent migration is usually a late complication that can happen when progressive tumor necrosis occurs resulting in loosening of the stent. Plastic stents can be extracted with relative ease, whereas expandable metal stents are mostly irretrievable.

Tumor ingrowth is commonly observed after placement of noncovered expandable stents.

Tumor overgrowth or reflux esophagitis may cause restenosis proximal to the stent. Tumor overgrowth can be treated either with the argon plasma-coagulator or laser (the argon plasma-coagulator should be used with expandable stents). If there is sufficient space above the stenosis, the stent can be exchanged for a longer one or a second stent can be placed (Fig. 41).

Reflux-induced strictures can be dilated with thin-caliber bougies. One must be careful not to dislodge the stent during bougienage; use of a bougie with a short tip is best in this situation.

Fig. **41** Tumor overgrowth. The simplest solution is the placement of a short second stent above the first.

4

Percutaneous Endoscopic Gastrostomy (PEG)

General

Percutaneous endoscopic gastrostomy (PEG) is the intentional formation of a gastrocutaneous fistula for the purpose of enteral feeding. It has gained widespread popularity because it is technically easy, rapid, and safe. It is preferable to nasoenteral feeding tubes for long-term enteral feeding.

Indications

PEG is primarily indicated in patients who are unable to swallow. The causes are usually neurogenic impairment or obstructive tumors of the oral cavity. Less commonly, PEG may be indicated for nutritional support of the undernourished patient with gross anorexia.

Prerequisites

Percutaneous transgastric nutrition requires a patent bowel. This can usually be determined from the patient's history. Gastric outlet obstruction should be ruled out on an upper GI endoscopy. Residual food or secretions in the stomach or duodenum in the fasting patient signal the possibility of outlet obstruction. Stenoses in the oropharynx and esophagus may require a preliminary bougienage.

An absolute prerequisite for PEG is a close contact between the anterior wall of the stomach and the abdominal wall. Interposed viscera are excluded by transillumination through the abdominal wall with the endoscope. Hepatomegaly can also impede PEG and is excluded by physical examination.

Portal hypertension increases the risk of bleeding during PEG and should consequently be watched out and tested for.

Preoperative broad spectrum antibiotics are generally recommended as a prophylaxis against infection. The abdomen is prepared and draped as for an abdominal operation.

The key to avoiding complications is proper postoperative care—especially during the first week—until the parietal and visceral peritoneum have fully adhered. Tube feeding can be started on the same day as placement if the tube is properly positioned and anchored.

Instruments

Gastrostomy sets differ according to the technique used. The pull technique is the most commonly used. In general, a 15-French feeding tube is adequate for instilling commercially available enteral nutrition preparations.

Most PEG tubes have an internal bolster measuring approximately 2.5 cm in diameter and can be fixed to the abdominal wall by an adjustable external bolster.

Antiseptic solution, scalpel, gauze dressing, and various adaptors for the feeding tubes are usually supplied in most commercially available kits. A special 110-cm-long 9-French tube is also available for placement in the jejunum (percutaneous endoscopic jejunostomy).

PEG is performed using a standard diagnostic gastroscope with a 2.8-mm working channel. The thread can be grasped with a biopsy forceps or polypectomy snare. A rat-tooth forceps is necessary for placing a jejunal feeding tube.

Technique

In the more popular pull technique, the PEG tube is pulled through the oropharynx with the aid of an attached thread that pulls it out through the stomach and abdominal wall. Using the push technique, the tube is percutaneously inserted directly into the stomach over a guidewire. Although the push technique is a more direct approach, it requires serial dilatation of the puncture tract to allow insertion of the PEG tube and is thus more complicated and involves more risk than the pull technique.

The procedure begins with a standard esophagogastroduodenoscopy in the left lateral position. Stomach contents are cleared with endoscopic suction.

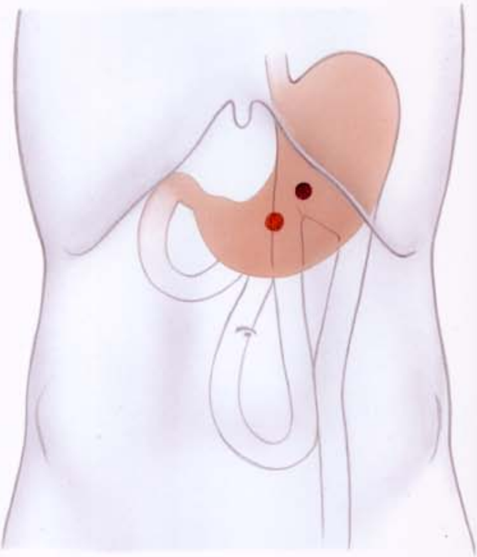
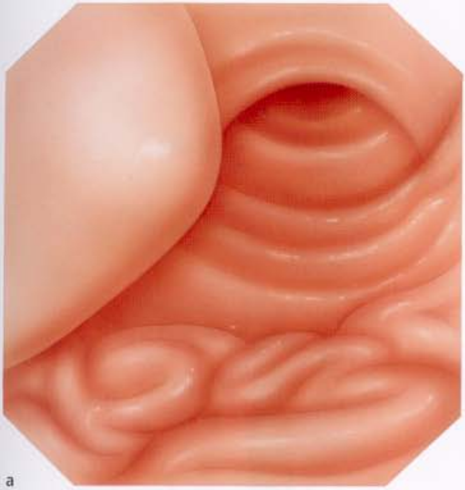


Fig. **42** Assuming normal GI anatomy, the puncture site is approximately 2–3 fingerbreaths under the left costal margin in the paramedian line. In the patient with a Billroth II operation, the puncture site is along the left costal margin.



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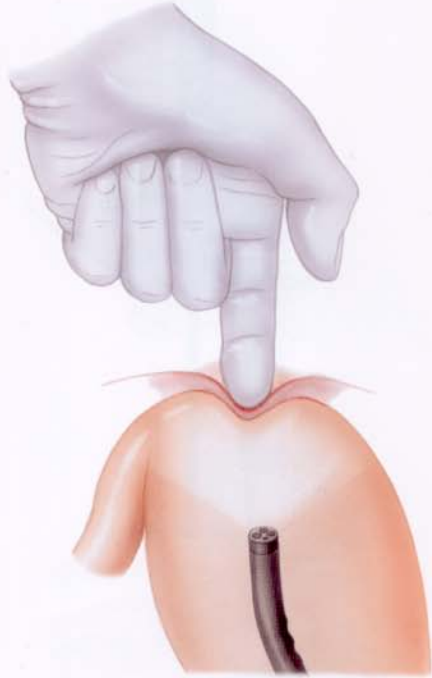

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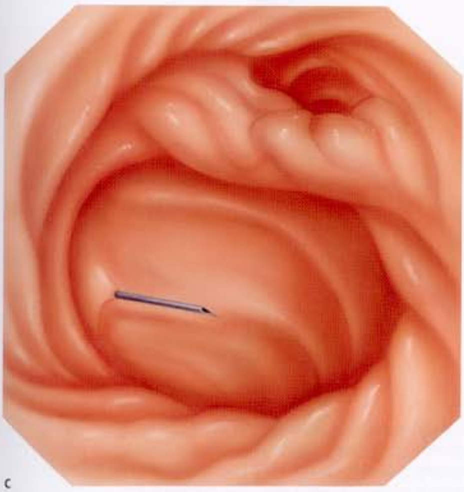


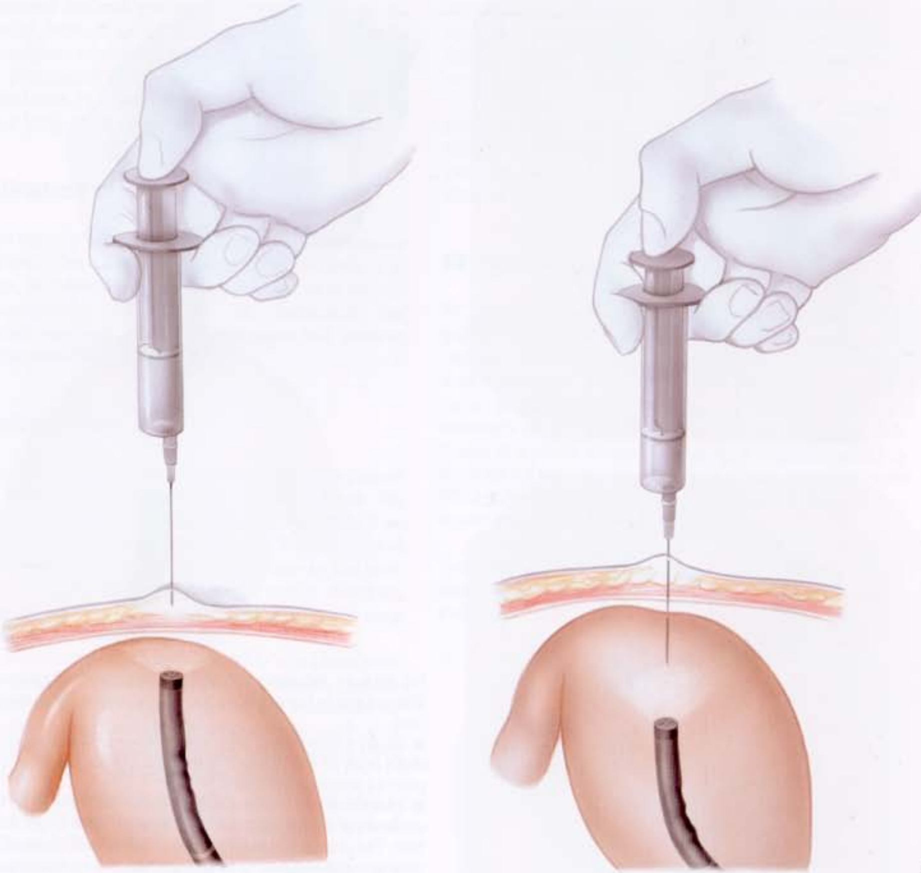
c

Fig. **43a–c** Selecting the site for percutaneous gastrostomy. The patient is turned from the left lateral to the supine position.

a Given a normal anatomy, the anterior wall of the antrum or distal body of the stomach is the best site for placement of the percutaneous gastrostomy.

b Exact location of the puncture site is determined by a combination of endoscopic transillumination and finger indentation. The stomach is maximally insufflated with air to allow the stomach and abdominal wall to come in close apposition with each other.

c In the patient with a previous gastrectomy, the residual stomach usually lies behind the left costal margin, making transillumination or finger indentation difficult. A trial puncture using a thin cannula can be performed to determine the appropriate site for the gastrostomy. The needle may have to be angled under the rib to gain access to the stomach. If the stomach cannot be punctured, one can try to access the efferent jejunal loop for an enterostomy.



a b

Fig. **44a,b** Injection of a local anesthetic agent and trial puncture at the site of transillumination.

a An anesthetic agent is injected into the layers of the abdominal wall up to the peritoneum.

b A trial puncture into the stomach is performed with the same needle to ascertain the optimal site for gastrostomy. The needle is oriented perpendicular to the abdominal wall. As the needle is advanced, the endoscopist watches for needle penetration of the stomach wall. The stomach wall is anesthetized as the needle is withdrawn.

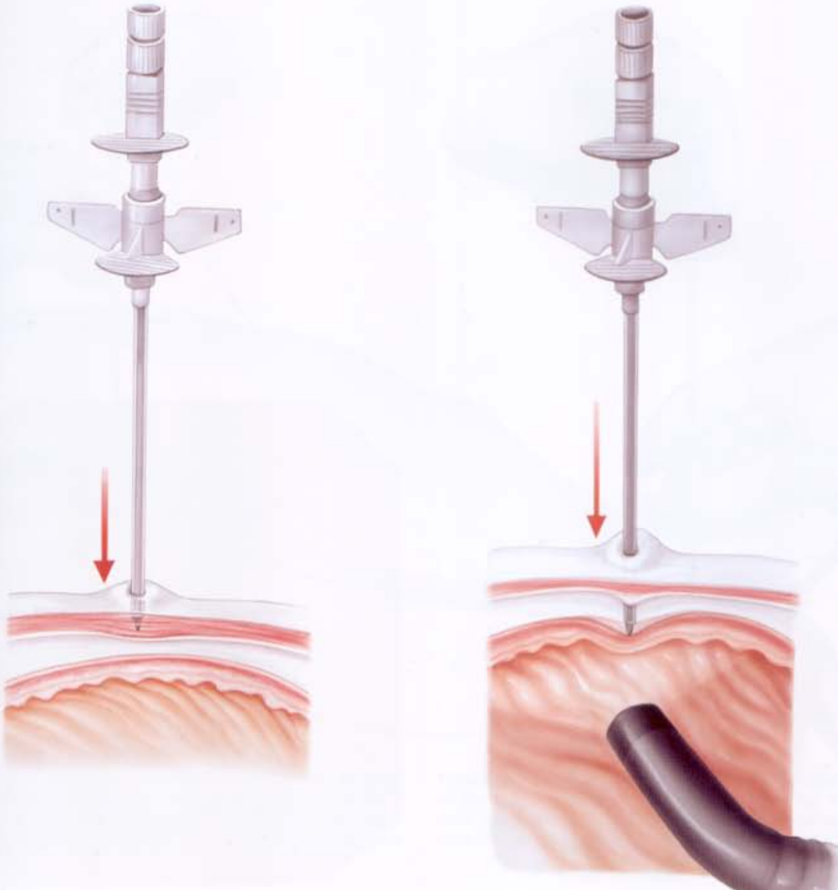


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Fig. **45a,b** Stomach wall puncture with the sheathed needle.
a Oriented perpendicular to the abdominal wall, the sheathed needle is first introduced into the abdominal wall. The needle must be held firmly within its sheath, because there is a tendency for the needle to be pushed back during penetration.

b Having penetrated the abdominal wall, the sheathed needle is gently advanced against the anterior wall of the stomach to produce a visible indentation. The endoscopist maintains gastric insufflation and looks for any mucosal vessels lying in the puncture path; if present, these are avoided by changing the needle direction. The sheathed needle is then pushed into the stomach lumen.

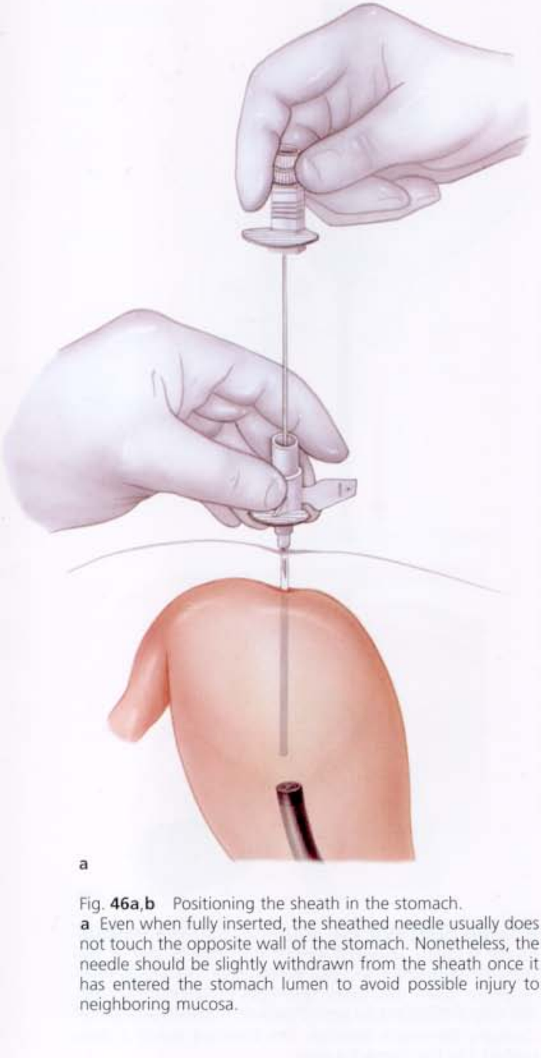

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Fig. **46a**,**b** Positioning the sheath in the stomach.
a Even when fully inserted, the sheathed needle usually does not touch the opposite wall of the stomach. Nonetheless, the needle should be slightly withdrawn from the sheath once it has entered the stomach lumen to avoid possible injury to neighboring mucosa.

b The needle stylet is removed once the sheath is securely positioned in the stomach lumen. The endoscopist then passes an opened polypectomy snare around the tip of the sheath to catch the thread as soon as it is inserted.

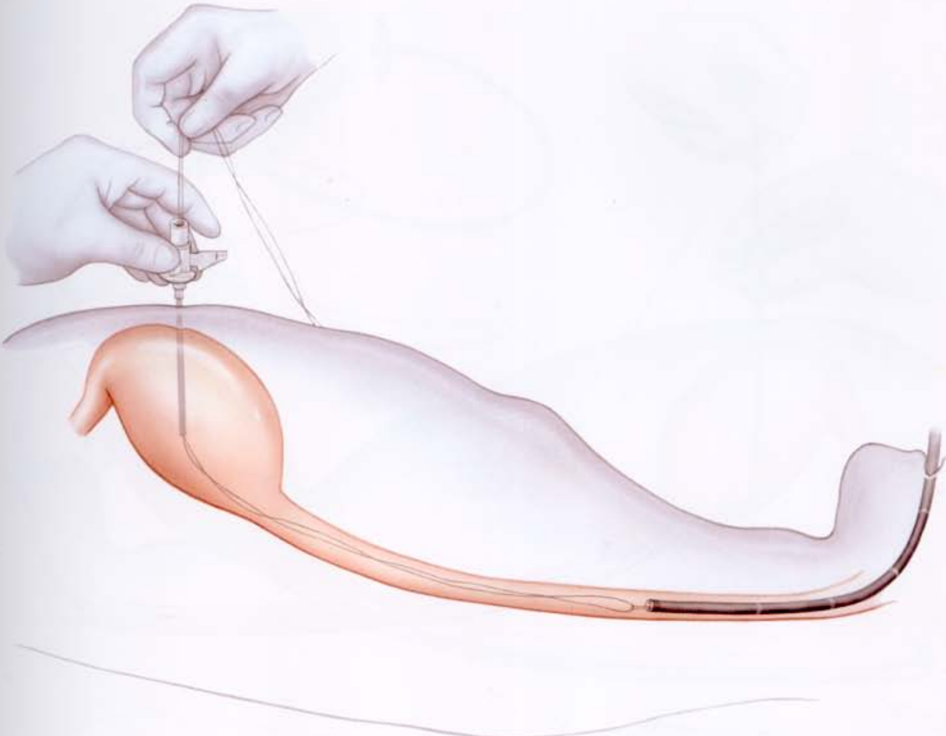

Fig. **47** Alternatively, a biopsy forceps can be used to grasp the thread. Once the thread has been grasped, the forceps is retracted slightly into the working channel, and the endoscope is withdrawn along with it. It is important that withdrawal of the thread is accompanied by simultaneous feeding of the thread through the sheath in the anterior abdominal wall. The sheath is manually held at the abdominal wall to prevent it from slipping back.

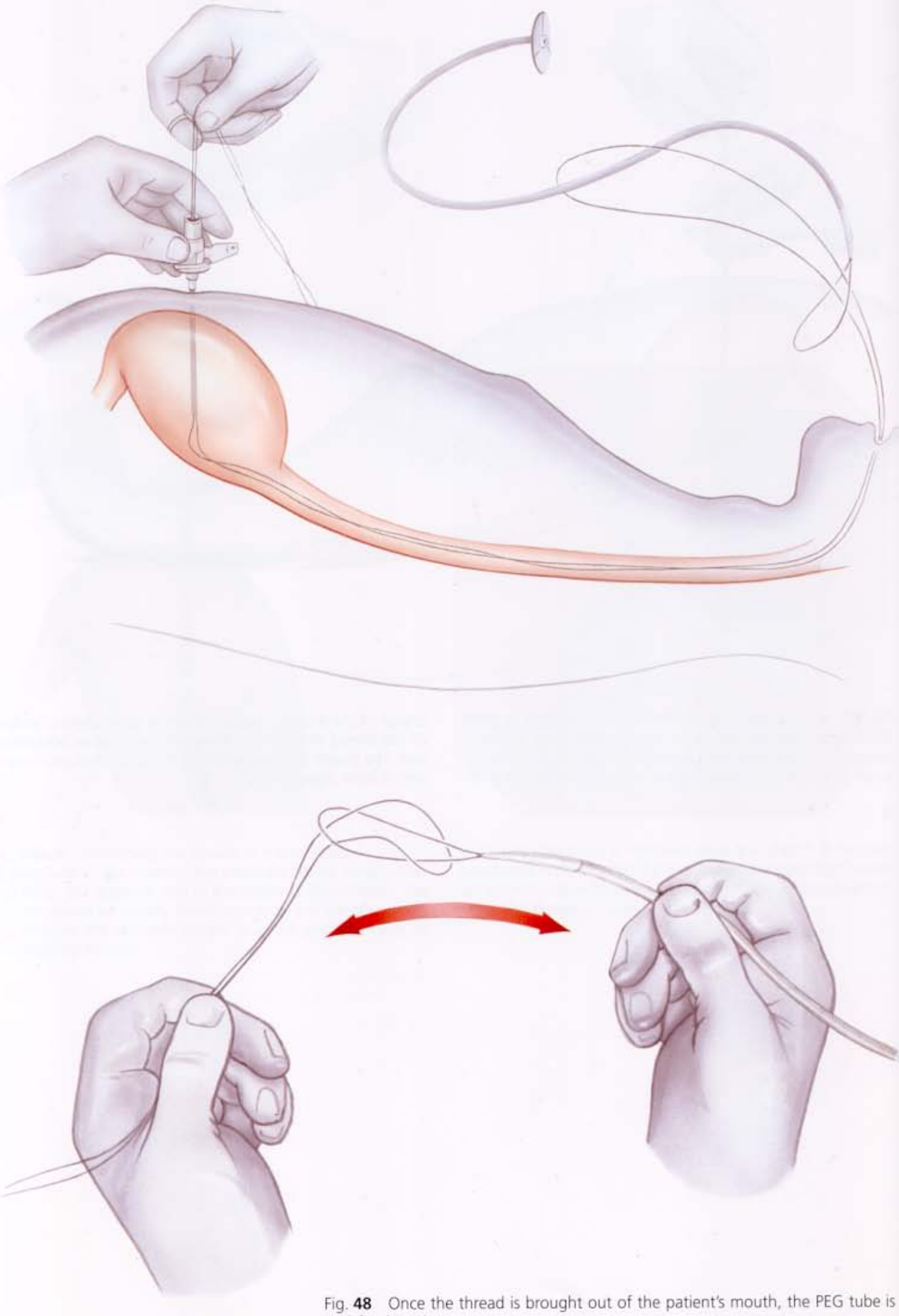

Fig. **48** Once the thread is brought out of the patient's mouth, the PEG tube is tied firmly to it.

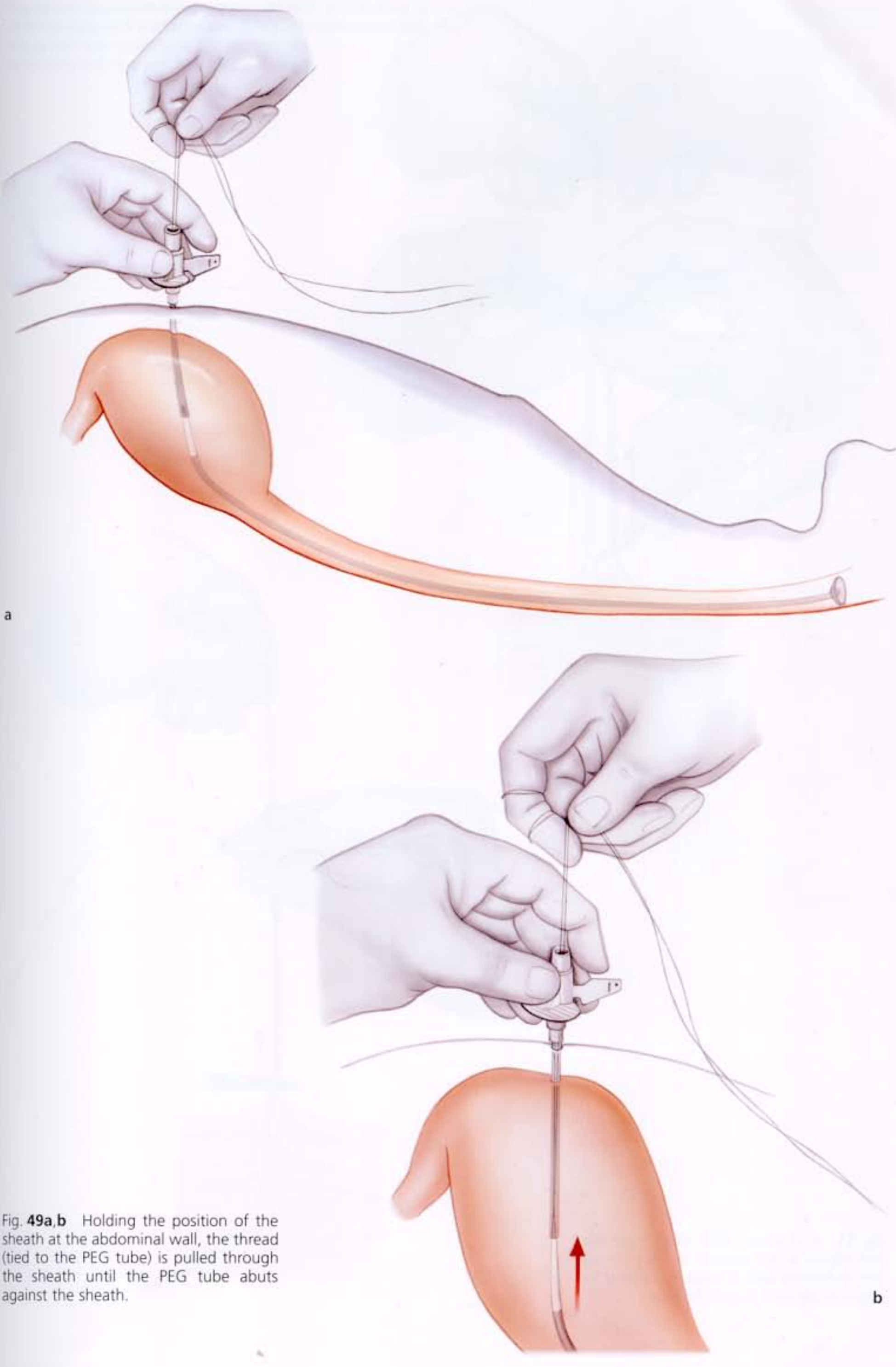

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Fig. **49a**,**b** Holding the position of the sheath at the abdominal wall, the thread (tied to the PEG tube) is pulled through the sheath until the PEG tube abuts against the sheath.

Fig. **50** At this point the sheath and thread are withdrawn together. The tapered end of the gastrostomy tube dilates the tract as the tube is pulled out through the abdominal wall.

Fig. **51** A 15-French PEG tube usually does not require a skin incision to pass through the abdominal wall. A surgical grasping forceps can be used to pull the tube.

Fig. **52** Obese patients may require a small skin incision to facilitate pulling of the PEG tube through the abdominal wall.

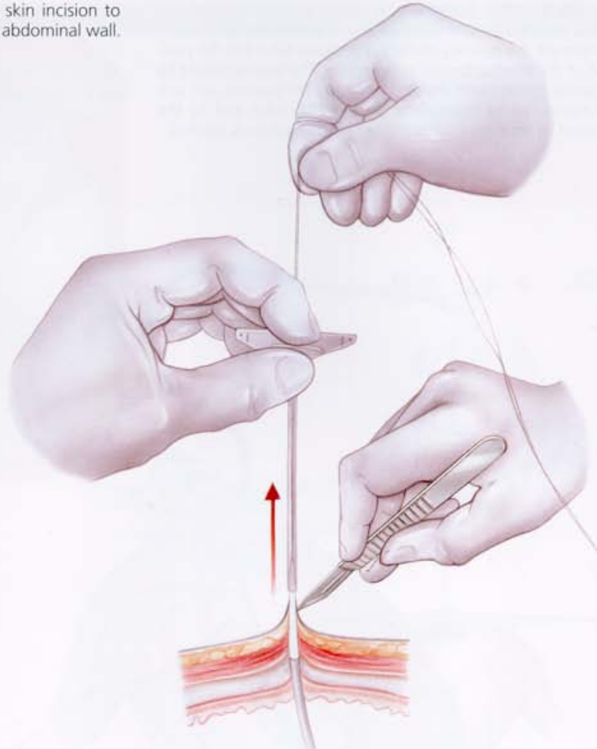
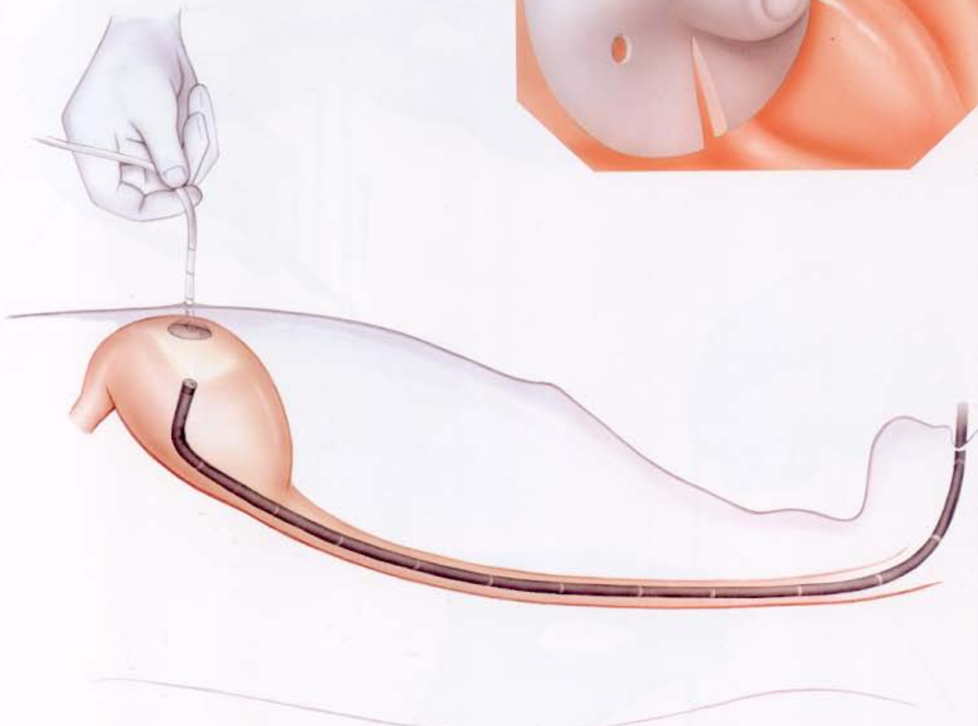


Fig. **53a,b** After placement, it is not always necessary to check the PEG tube endoscopically. If a repeat endoscopy is performed, the patency of the gastrostomy tube and the position of the internal bolster are checked. The bolster should be in gentle contact with the stomach wall. The position can also be monitored by calibrations on the PEG tube and by the amount of resistance encountered when traction is applied.

b



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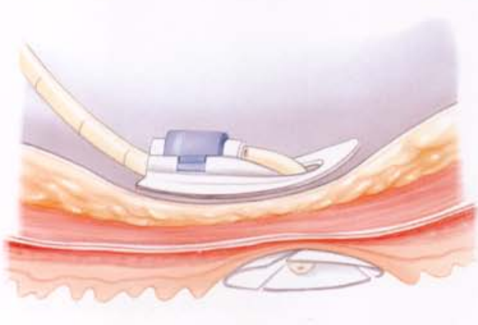


Fig. **54** The external bolster should be applied firmly enough to keep the gastric and abdominal walls in close apposition.

Placement of a Jejunostomy Tube Through a PEG

Patients with impaired gastric emptying are at a risk of reflux-associated aspiration pneumonitis. This subset of patients should be considered for placement of a jejunostomy tube through a PEG (Fig. 55).

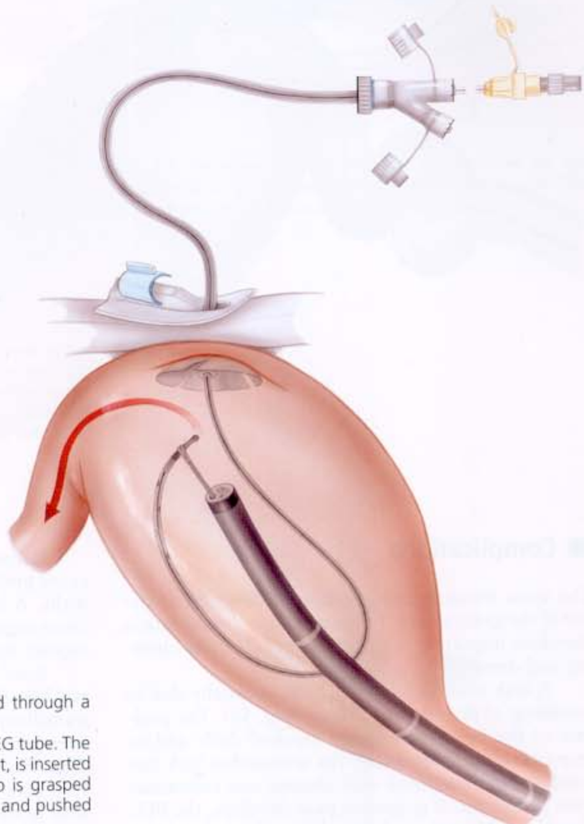


Fig. 55 A 9-French jejunostomy tube is inserted through a 15-French PEG.
a A Y-adapter is first attached to the end of the PEG tube. The jejunostomy tube, furnished with a stiffening stylet, is inserted through the Y-adapter into the stomach. The tip is grasped with a rat-tooth forceps under endoscopic vision and pushed through the pylorus deep into the jejunum.

Fig. 55 b ►

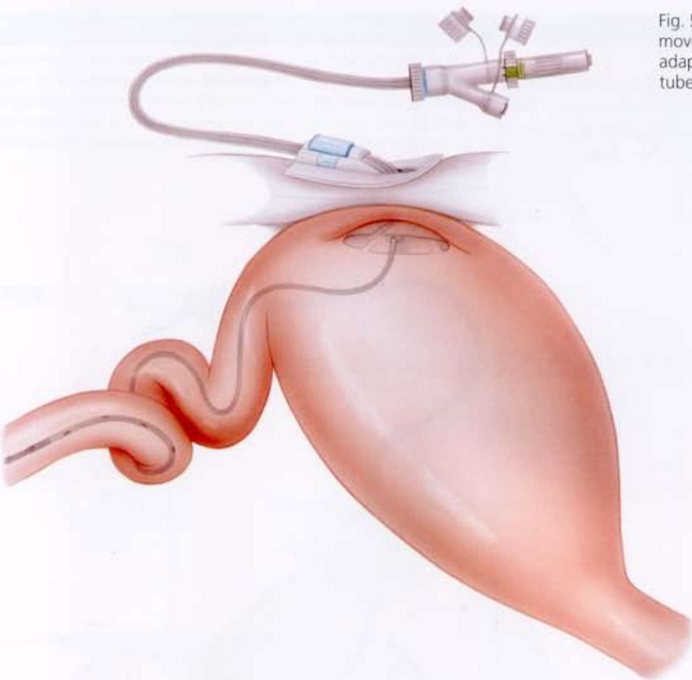


Fig. **55b** The stiffening stylet is removed after placement. An appropriate adapter is attached to the jejunostomy tube.

■ Complications

The most frequent complication is infection at the site of the gastrostomy. Postprocedural wound care is therefore important and should include daily cleaning and dressing.

A leak around the stomal site is usually due to loosening of the external bolster (Fig. 56). The position of the bolster should be checked daily and its grip tightened if necessary. An unattended leak can result in an abdominal wall abscess and sometimes even peritonitis. If epigastric pain develops, the PEG should not be used until complete sealing of the leak is verified endoscopically and radiologically (by water-soluble contrast instillation).

Excessive tension between the two bolsters can cause pressure necrosis of the abdominal or stomach walls. A bolster that digs into the wall can also become engulfed by reactive granulation tissue that will require surgical removal (Fig. 57).

Rare complications include internal lacerations and bleeding. These are related to failure to identify transillumination, an oblique angle of puncture, or attempting the procedure in a restless patient (Figs. 58, 59). Contiguous seeding of a tumor is a very rare complication that can occur in patients with head and neck or esophageal tumors.

PEGs should always be removed endoscopically because the internal bolster may cause bowel obstruction.

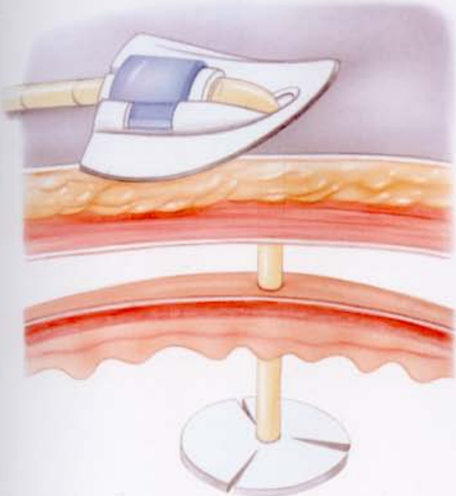


Fig. **56** The external bolster has loosened. This may occur spontaneously or during changing of the dressing and can lead to serious complications in the early postprocedure period before the connection between the stomach and abdominal wall has sealed. A free leak into the peritoneal cavity will cause peritonitis.

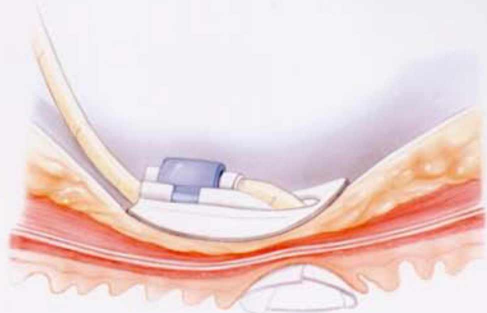


Fig. **57** Excessive tension between the bolsters on the abdominal or stomach walls can cause pressure necrosis. This can be avoided with proper postprocedure care.

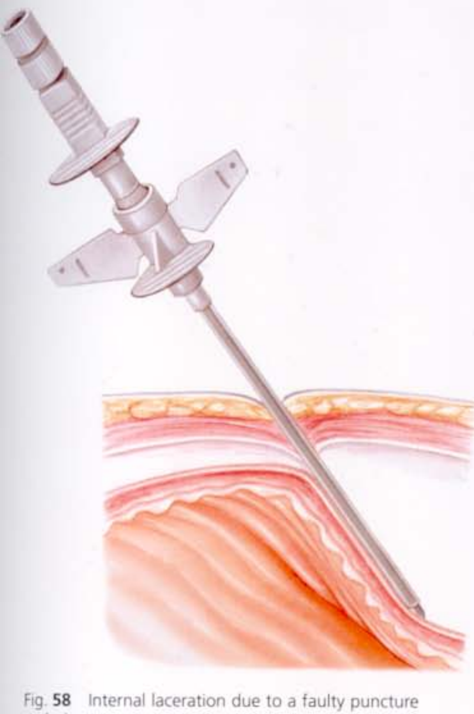


Fig. **58** Internal laceration due to a faulty puncture technique.

Fig. **59** The sheath may dislocate during a sudden spell of retching or coughing. This can be avoided by manually securing the position of the sheath.

5

Enteral Tube Placement

General

Tubes are endoscopically placed into the jejunum either to enable enteral feeding or to decompress the small bowel. A tube can also be inserted into the colon to decompress it.

Indications

A jejunal tube is indicated for enteral feeding when gastric emptying is impaired because of mechanical obstruction or a motility disorder. Long-term jejunal feeding warrants a PEG through which the feeding tube is inserted.

A jejunal tube is also indicated for small bowel decompression in patients with unclear intestinal obstruction (e.g., ileus in the early postoperative phase). Tube decompression of the colon is indicated for colonic pseudo-obstruction.

Prerequisites

Bowel decompression should not be an excuse for postponing a necessary operation. This applies particularly to mechanical intestinal obstruction. Distal propagation of the Dennis tube requires at least some peristaltic activity. In the setting of a complete adynamic ileus, a Dennis tube is no better than a nasogastric tube. Endoscopic decompression of colonic pseudo-obstruction is indicated when the risk of surgery is considered to be prohibitively high.

Instruments

A pediatric gastroscope (outer diameter of 5.3 mm or 7.9 mm) is used to position a guidewire for over-the-wire insertion of an enteral tube. A therapeutic gastroscope with a 3.7-, 4.2-, or 6-mm working channel is used for through-the-scope placement of enteral tubes.

A variety of enteral tubes are available:
- Feeding tube: 250 cm long, 9 French, with adapter
- Dennis tube for small bowel decompression: 210 cm long, 16-French triple-lumen tube with a balloon at the tip
- Colonic decompression tube: 130 cm long, 24-French polyethylene tube inserted over a 300-cm long, 7-French radiopaque Teflon delivery catheter

Accessories required are Teflon-coated stainless steel and hydrophilic guidewires (400 cm long, 0.035 in) and a large rat-tooth forceps to grasp and advance the Dennis tube into the duodenum.

Technique

The through-the-scope technique is the easiest and fastest method of placing feeding tubes. A 9-French feeding tube, stiffened with a 0.035-in Teflon-coated guidewire, can be inserted through a gastroscope with a 3.7-mm working channel (Fig. **60**). Over-the-wire placement is done if a large channel gastroscope is not available or if a stenosis prevents its passage. After the guidewire is inserted, the feeding tube is fed over the wire under fluoroscopy (Fig. **61**).

The Dennis small-bowel decompression tube is too thick for through-the-scope placement. It is first introduced transnasally into the stomach. After the endoscope is passed into the stomach, the tip of the tube is grasped with a rat-tooth forceps and pushed deep into the duodenum. The balloon of the tube is then inflated with 60 mL of air to prevent the tube from migrating backward as the endoscope is withdrawn. About 15 mL of air must remain in the balloon to allow it to be carried distally with peristalsis. An abdominal film is taken 8 hours later to check the position of the tube tip. The tube usually advances by about 10 cm every 2 hours. Low intermittent suction is applied to decompress the small bowel (Fig. **62**).

Colonic decompression is performed with a 14-French catheter, which can be inserted through the 6.0-mm working channel endoscope. A larger catheter will require insertion over an endoscopically placed guidewire (Fig. **63**).

Complications

The tube itself or the forceps can injure the mucosa. The tube can sometimes get entangled through excessive looping, but this is rare. Reflux esophagitis can sometimes occur after long-term tube placement.

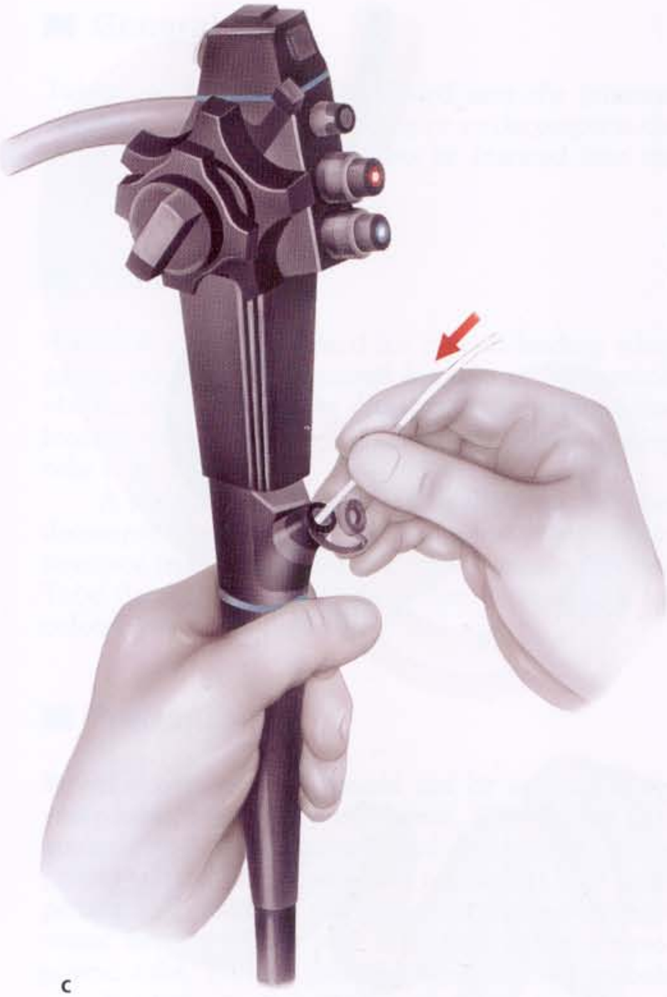
a

b

Fig. **60a–d** Endoscopic placement of a jejunal tube.
a The endoscope and tube are generously smeared with a lubricant. The gastroscope with a 3.7-mm working channel is passed into the duodenum. A 0.035-in Teflon-coated wire is used to stiffen the tube. Caution is taken that the wire does not extend beyond the end of the tube since it can injure the bowel wall.

b The feeding tube is advanced under direct vision into the jejunum. The wire is then withdrawn until it lies about 5 cm beyond the endoscope. This will prevent the tube from kinking.

Fig. **60c–e** ▶



c

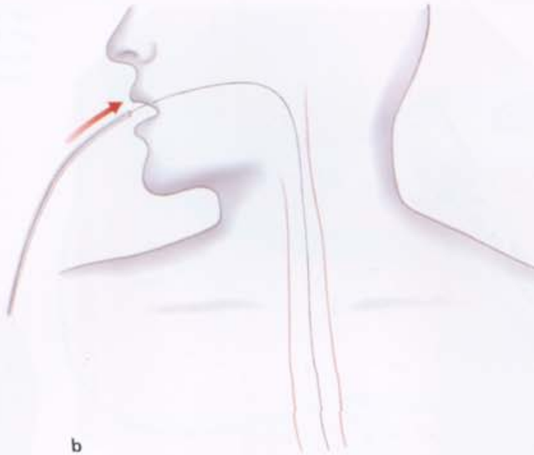
d

e

Fig. **60c,d** The endoscope is slowly withdrawn by the endoscopy assistant while the tube is simultaneously advanced by the endoscopist. The wire is also intermittently withdrawn to maintain its position 5 cm distal to the endoscope.

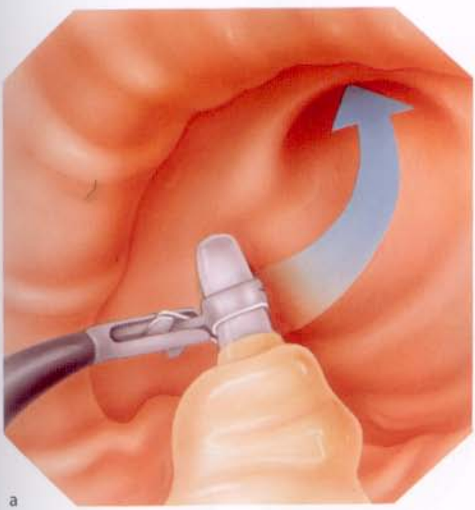
e The tube is then rerouted through the nose and connected to an adapter.

a



b

Fig. **61a,b** Over-the-guidewire placement of a jejunal tube under fluoroscopy. This technique is used if a large-caliber endoscope is not available or a stenosis in the esophagus, stomach, or duodenum prevents its passage.
a A 0.035-in hydrophilic wire, 400 cm long, with a J-shaped tip is inserted through a pediatric gastroscope (outer diameter of 5.3 or 7.9 mm) and advanced into the jejunum under fluoroscopy.
b After the endoscope is removed, the tube is then fed over the wire under fluoroscopic control. The tube is then brought out through the nose and attached to an appropriate adapter.



a

b

Fig. **62a–g** Endoscopic placement of a Dennis tube.
a The Dennis tube is first introduced transnasally into the stomach. Since the stomach is usually filled with retained fluid, it is important that its contents are suctioned out through the tube to prevent aspiration. A therapeutic gastroscope with a 3.7-mm working channel is then passed into the stomach. In the event that the Dennis tube cannot be inserted into the esophagus, the endoscope can be used to tow the tube along. Using a rat-tooth forceps, the tube is grasped in the oral cavity and directed under vision into the esophagus.
b The large rat-tooth forceps is used to push the tube into the pylorus. It is best to grasp the tube from the left side with the forceps.

c

d

Fig. **62c,d** The tube is progressively advanced into the duodenum by repeatedly grasping and pushing the tube several centimeters at a time. Caution must be exercised that the forceps completely releases the tube and does not accidentally pull the tube back. Sufficient length of the tube has to be pushed into the stomach to prevent tension on the tube. This needs to be done carefully as friction between the endoscope and tube tends to cause a loop formation in the pharynx.

e

f

Fig. **62e** The tube is advanced as far beyond the duodenal C loop as possible.

f Before removing the endoscope, the balloon is filled with 60 mL of air. This will prevent the tube from slipping back as the endoscope is withdrawn. If there is excessive traction on the tube, the tube can be grasped in the stomach with the rat-tooth forceps and held in position as the endoscope is slowly withdrawn.

Fig. **62g** After the endoscope is removed, the balloon is first completely evacuated and then 15 mL of air is reinstilled. The tube is looped and anchored to the patient's forehead. Low intermittent suction is applied to decompress the small bowel.

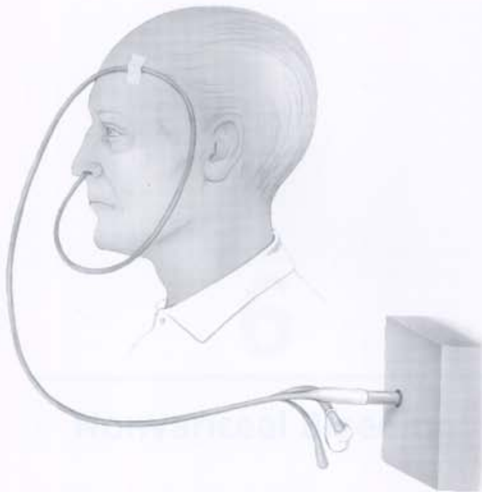


Fig. **63** Endoscopic-radiologic placement of a colonic decompression tube. A 7-French radiopaque Teflon catheter 300 cm long is inserted through the endoscope working channel over a 0.035-in hydrophilic wire into the proximal colon. A 24-French colonic decompression tube is then inserted over the Teflon catheter, under fluoroscopic control.

6

Nonvariceal Bleeding

General

Endoscopic treatment of nonvariceal bleeding is a well-established and effective alternative to surgery in appropriately selected patients. The endoscopic approach has several advantages over surgery: the treatment can be combined with diagnostic endoscopy, it is inherently less invasive, and it can be performed rapidly. Nonetheless, endoscopic treatment does have its limitations. Timely recognition of a condition requiring surgical intervention is as important as mastering endoscopic hemostatic techique.

Indications

Endoscopic treatment is indicated for actively bleeding arterial or venous lesions and also for nonbleeding visible vessels because of their high risk of rebleeding.

Some bleeding lesions are unlikely to respond to endoscopic treatment and should be preferentially treated by surgery. A deep duodenal ulcer on the posterior wall eroding into the gastroduodenal artery, or a large and deep gastric ulcer eroding into a major artery (splenic or hepatic artery) are examples (Fig. **64**). Even when not actively bleeding, these lesions should be immediately treated surgically. Chronic ulcers with an indurated base can hinder the proper application of endoscopic hemostatic methods (e.g., hemoclipping). Endoscopic treatment of diffusely bleeding lesions, such as extensive colonic arteriovenous malformations, usually has only a temporary effect. The decision whether to persist with endoscopic treatment or to advise an operation depends upon the patient's clinical condition and surgical risk.

Fig. **64** Endoscopic view of a large penetrating ulcer along the posterior wall of the duodenal bulb eroding into the gastroduodenal artery. Surgical treatment is indicated.

Prerequisites

Hemodynamic and respiratory stabilization of the patient is a fundamental prerequisite before performing emergency endoscopy. Ideally, an anesthesiologist should be present to evaluate and monitor the patient. The threshold for performing an endotracheal intubation in the actively bleeding patient should be low. Apart from providing ventilatory support, endotracheal intubation will prevent aspiration of the gastric contents.

Intravenous sedation should be avoided in the hemodynamically compromised patient. Faced with a life-threatening GI bleed, most patients are cooperative once the reason for withholding sedation is explained.

The endoscopic procedure is begun with a quick diagnostic survey of the upper GI tract to locate the source and determine the severity of bleeding. A systematic approach is important. Bleeding from esophageal varices is looked for first, then the cardia is inspected for a Mallory-Weiss tear. The antrum and duodenal bulb are next evaluated for peptic ulcer bleeding. Then, the remainder of the stomach is examined. Blood in the fundus of the stomach can be shifted into the antrum by turning the patient into the right lateral position (Fig. **65**). Bleeding from a Dieulafoy ulcer, subcardial varices, or the postbulbar region is notoriously difficult to locate and should be specifically looked for.

If a source of bleeding is not found in the upper GI tract, the patient should undergo colonoscopy. If there is no medical contraindication, the bowel is prepared with a lavage solution, preferably administered through a nasogastric tube.

It is important to precisely document the topographic location of the source of bleeding in case repeat endoscopic intervention or surgery is required (Fig. **66**). When localizing a source of bleeding in the colon, one should specify the segment (rectum, sigmoid colon, descending colon, transverse colon, ascending colon, and cecum) and its relationship to important anatomic landmarks such as the anus, hepatic/splenic flexures, and the ileocecal valve.

Fluoroscopy may sometimes be required if endoscopic landmarks are equivocal. A submucosal injection of india ink adjacent to the bleeding site is a valuable method of marking the site of bleeding if surgical treatment is to be considered (see Chapter 15, Polypectomy in the Colon).

The experience and skill of the endoscopist is a critical factor for procedural success. The endoscopist should not only be well versed with techniques used for hemostasis, but also be able to recognize the limitations of these techniques. If endoscopic hemostasis is not successful within a reasonable period of time, the patient should be sent for emergency surgery without delay. Repeated, unsuccessful attempts at achieving hemostasis may deprive the patient of an opportunity to undergo timely surgery. Transient hemostasis may be equally detrimental since the patient is less likely to survive a second bleed, particularly if the patient represents a high surgical risk.

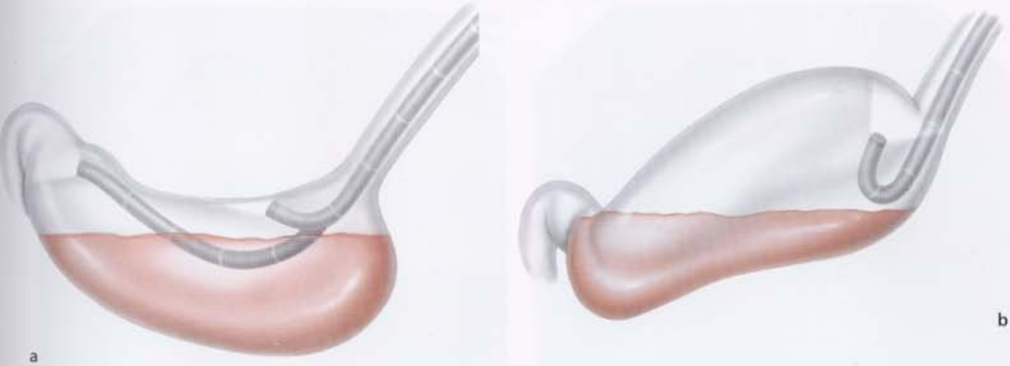


Fig. **65a,b** Gastroscopy in the blood-filled stomach.
a with the patient in the left lateral position, blood tends to collect in the fundus and along the greater curvature. Thus only the lesser curvature and duodenum can be properly examined endoscopically.
b Turning the patient into the right lateral position shifts the fundal contents into the antrum, thus enabling examination of the fundus and greater curvature.

■ Instruments

Endoscopic hemostasis should preferably be performed with a 3.7- or 4.2-mm channel therapeutic gastroscope to allow blood and secretions to be suctioned through the working channel alongside an accessory instrument. The therapeutic gastroscope also has the advantage of an auxiliary inlet for a water-pump attachment. The pump can be activated with a foot pedal, which produces a jet stream of water for targeted irrigation.

A special 6.0-mm channel gastroscope is recommended for the rapid clearance of blood clots from the stomach using suction alone. If this instrument is not available, a Dormia basket can be used to beat (rapid opening and closing of the basket) and thereby fragment a large blood clot to a size that can be suctioned through the working channel of a therapeutic gastroscope.

Instruments for at least two methods of hemostasis should be available on the instrument trolley. The possibility of variceal bleeding should also be kept in mind. Injection catheters and hemostatic solutions (e.g., diluted epinephrine, cyanoacrylate tissue adhesive) should be at hand. An additional suction unit should be available for oropharyngeal suction.

■ Technique

A variety of endoscopic modalities are available to treat nonvariceal GI bleeding:

Thermal:
- Monopolar coagulation
- Bipolar coagulation (BICAP)
- Argon plasma coagulation
- Heater probe coagulation
- Laser coagulation

Fig. **66** Topographic anatomy of the stomach: 1. cardia, 2. fundus, 3. body, 4. antrum, 5. pylorus with adjoining duodenal bulb.

Nonthermal:
- Injection method
- Hemoclips

The above modalities can achieve an initial hemostasis in 90% or more of cases. Arterial bleeding is known to recur, however, in up to 25% of cases. As rebleeding is often associated with a high mortality, the goal of endoscopic therapy should be to achieve a definitive hemostasis at the time of the index bleed. Of all the listed modalities, application of hemoclips appears to be the best suited for the treatment of an arterial bleeding. In contrast to the other modalities, hemoclips provide a direct, mechanical hemostasis without injuring the neighboring tissues. The risk of rebleeding is therefore minimized.

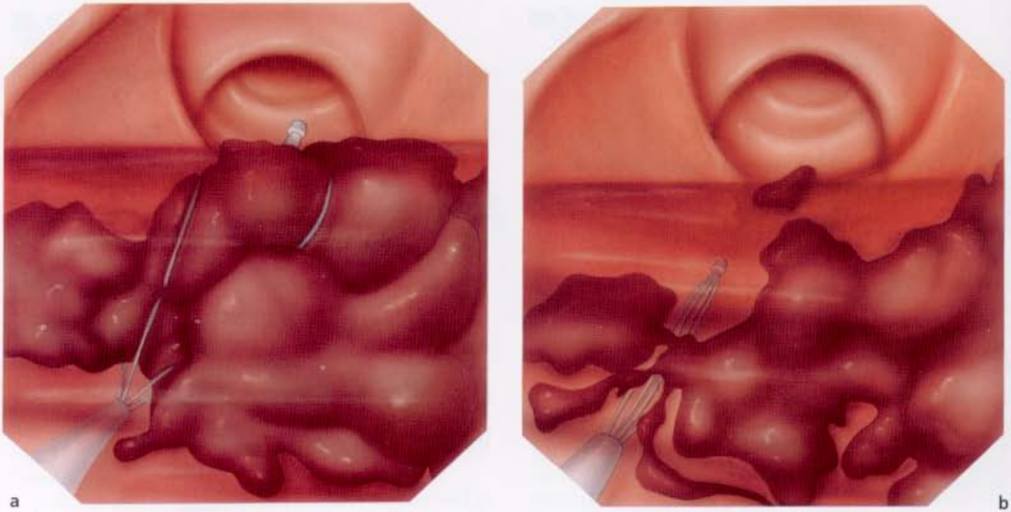


Fig. **67a,b** Dormia-basket–assisted removal of blood clots from the stomach.
a Large blood clots are broken up by rapidly opening and closing the basket. Fragmented clots are suctioned through the therapeutic gastroscope.
b Protracted beating with the basket will partially liquefy the clot fragments.

Hemoclip

Hemoclip application, similar to surgical ligation of a bleeding vessel, can achieve a prompt and permanent hemostasis. Proper identification of the bleeding vessel is, however, a prerequisite.

Diffuse bleeding (oozing) without an identifiable vessel is not an ideal indication for this treatment modality (Fig. 68).

Proper loading of the hemoclip onto the applicator is important for successful clip appication (Fig. 69). The endoscopy assistant should be familiar with the use of the clip apparatus. Since multiple clips may be required in case of a torrential bleed, two clip applicators and a second assistant to reload the device should be available.

The technique of hemoclip application depends upon the local anatomy. This includes the location, size, and consistency of the ulcer base, and the orientation and course of the bleeding vessel. Since the clip applicator usually comes out at the 8-o'clock position in the endoscopic field, lesions at this or the 2-o'clock position are easiest to access. Rotation of the endoscope shaft is usually enough to bring the lesion into these positions. Postpyloric posterior wall ulcers, however, are often problematic because of their tangential access and the limited space available for maneuvering the endoscope.

The size and consistency of the ulcer base usually determines whether the vessel should be clipped directly or indirectly (Figs. 70, 71). Direct application of the clip to the vessel is the best way to achieve a reliable and definitive hemostasis. The orientation of the clip on the blood vessel depends upon the course of the vessel (Fig. 72). The technique of indirect application is to grasp and approximate the margins of the ulcer with the vessel clamped within.

The orientation of the clip prongs is adjusted by rotating the handle (Fig. 73).

■ Complications

Endoscopic manipulation itself can initiate bleeding from a nonbleeding visible vessel or increase the severity of bleeding. Injection of diluted epinephrine around the vessel stump prior to endoscopic treatment can prevent this.

The thermal and injection methods of hemostasis can cause tissue injury. Sclerosing agents can induce necrosis of the wall, which can result in a perforation, particularly if a deep ulcer is injected. Clips have not been found to cause any clinically relevant complications.

Fig. **68** Oozing from a small prepyloric ulcer situated on the anterior wall. The ulcer, tucked between surrounding edema, is barely visible and could be easily overlooked. There is no visible vessel. Injection with diluted epinephrine (1: 20 000) is the treatment of choice to achieve hemostasis.

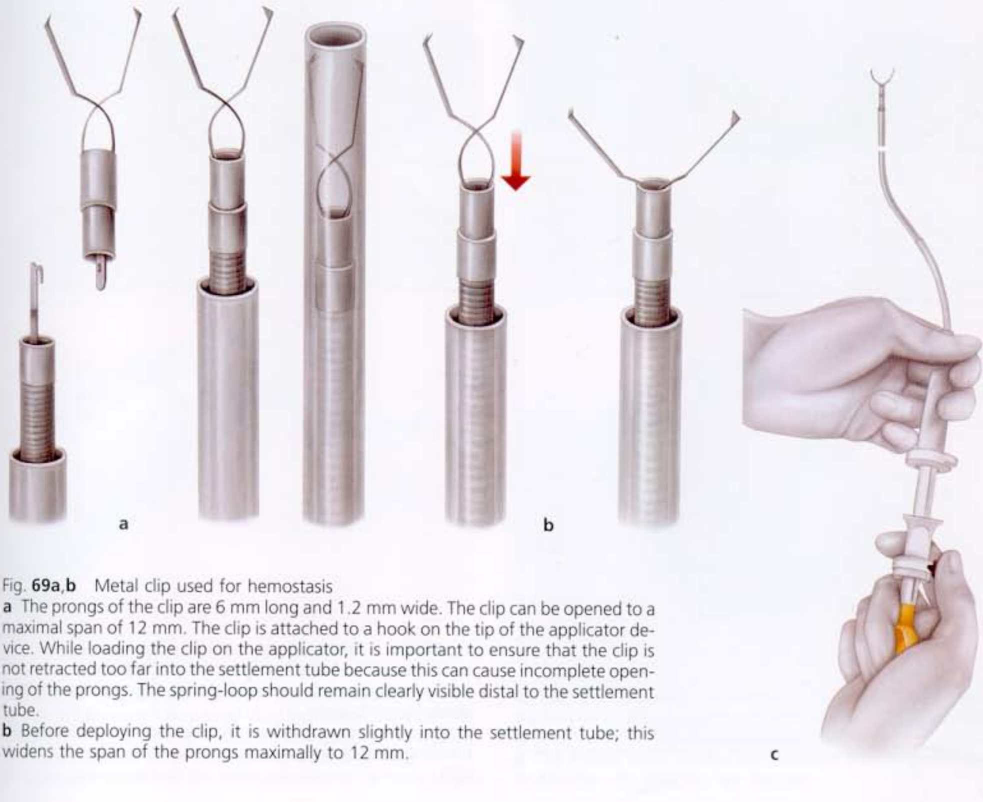


Fig. **69a**,**b** Metal clip used for hemostasis
a The prongs of the clip are 6 mm long and 1.2 mm wide. The clip can be opened to a maximal span of 12 mm. The clip is attached to a hook on the tip of the applicator device. While loading the clip on the applicator, it is important to ensure that the clip is not retracted too far into the settlement tube because this can cause incomplete opening of the prongs. The spring-loop should remain clearly visible distal to the settlement tube.
b Before deploying the clip, it is withdrawn slightly into the settlement tube; this widens the span of the prongs maximally to 12 mm.

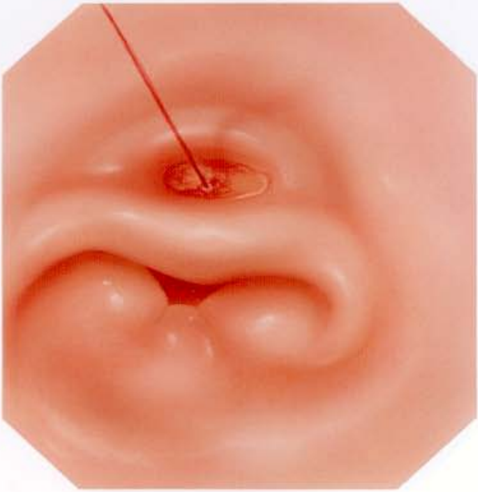


Fig. **70** Small prepyloric ulcer with a spurting bleed from a relatively small artery. Hemostasis can be achieved by grasping the ulcer margins and approximating the edges along with the vessel.

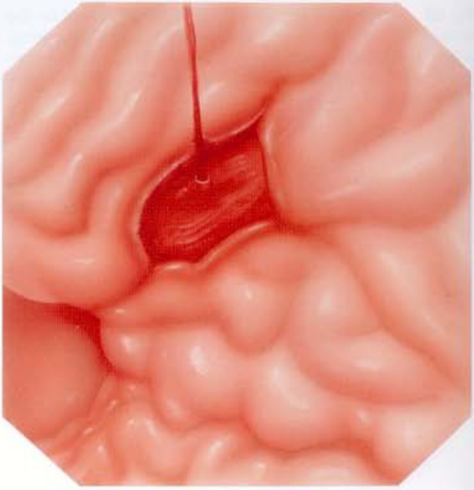
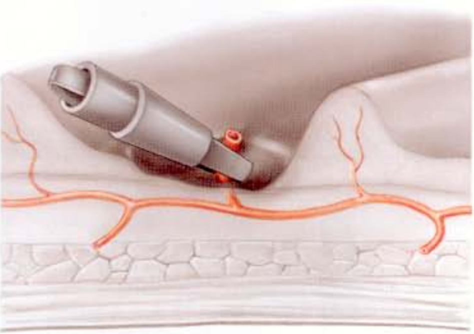
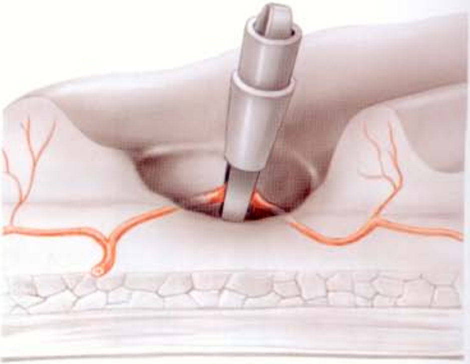


Fig. **71** Larger, indurated ulcer in the body of the stomach. The vessel has a larger diameter and can be clipped directly.



a



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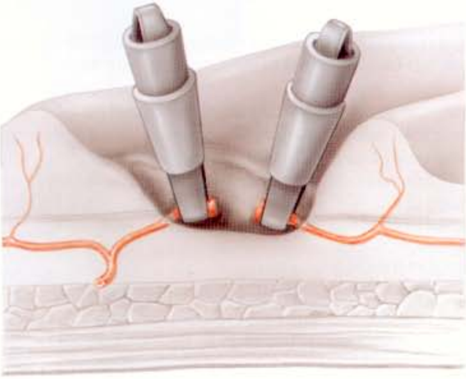


c

Fig. **72a–c** Clip application for a bleeding vessel.
a The eroded vessel protrudes in a vertical fashion.
b The partially eroded vessel traverses the ulcer base with a single bleeding point.
c The completely eroded vessel traverses the ulcer base with bleeding at both ends.

Fig. **73** The orientation of the prongs can be changed by rotating the handle of the applicator. The prongs should be oriented perpendicular to the course of the vessel.

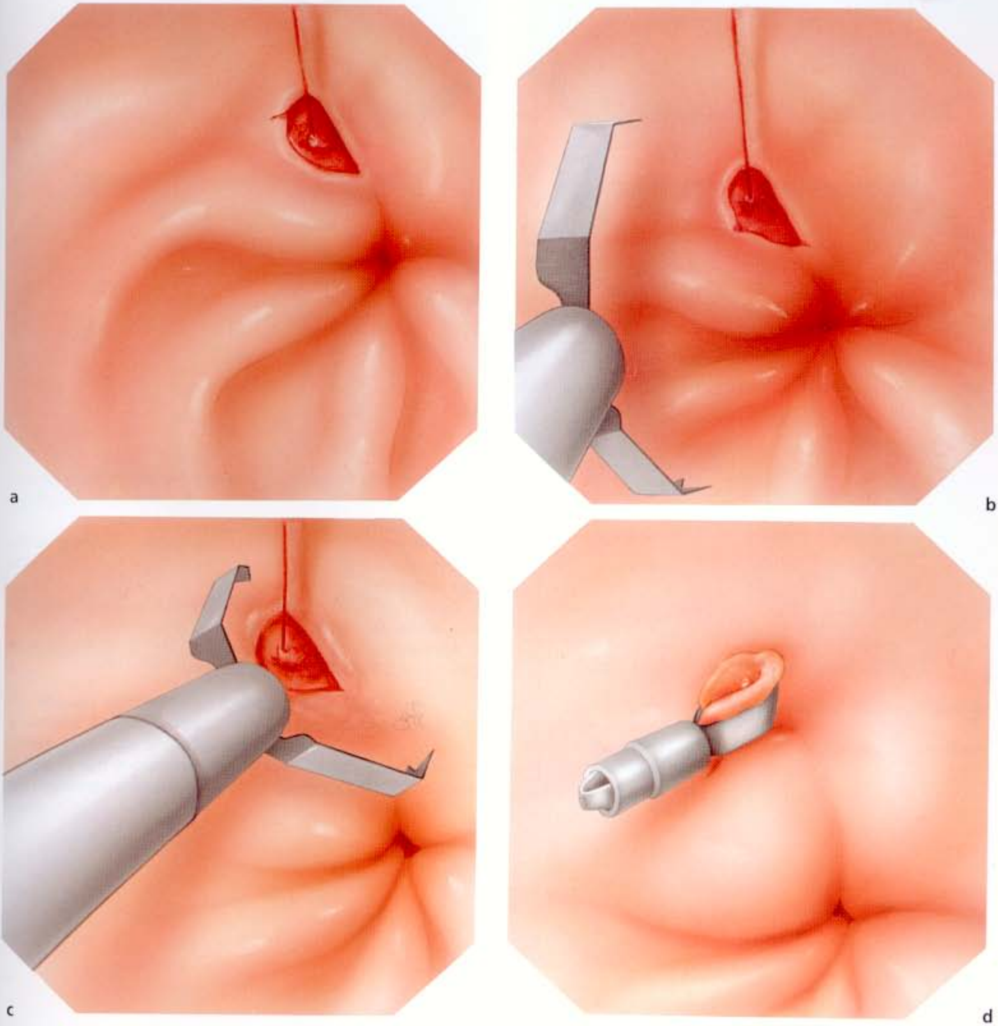
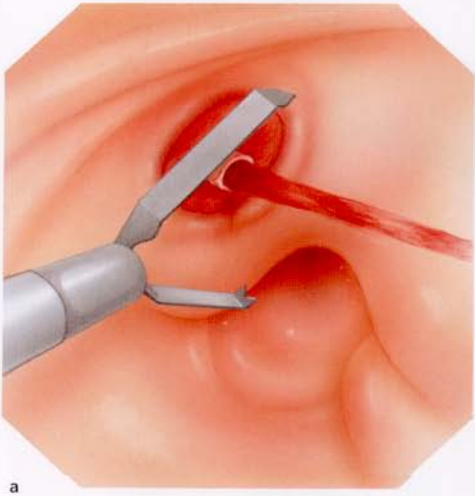
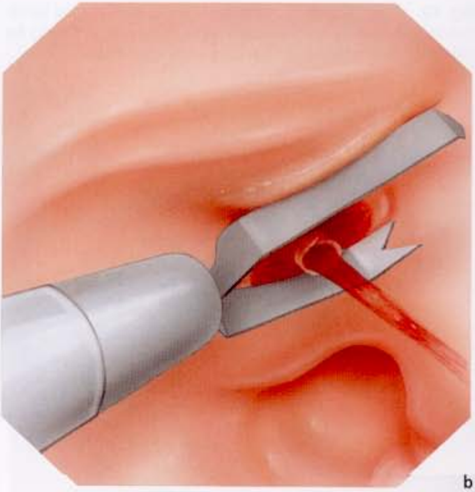


Fig. **74a–d** Hemostasis in a small acute prepyloric ulcer.
a Arterial spurting from a small ulcer located on the lesser curvature. The ulcer lies in the axis of the endoscopic accessory.
b The orientation of the opened hemoclip is vertical.
c Clockwise rotation of the applicator orients the prongs horizontally. Advancing the endoscope and the applicator device, the hemoclip prongs are pressed firmly against the outer margins of the ulcer, and the clip is slowly closed.
d The ligated vessel sandwiched between the margins of the acute ulcer. The bleeding has stopped.



a



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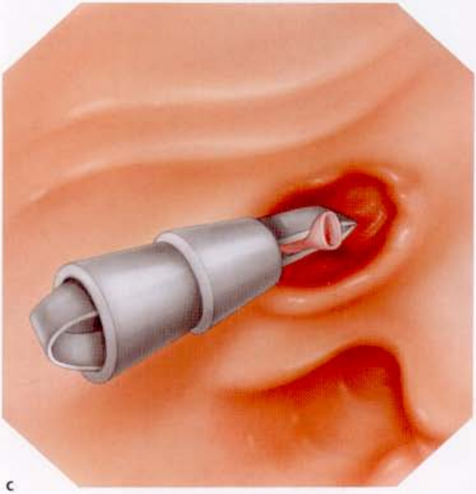


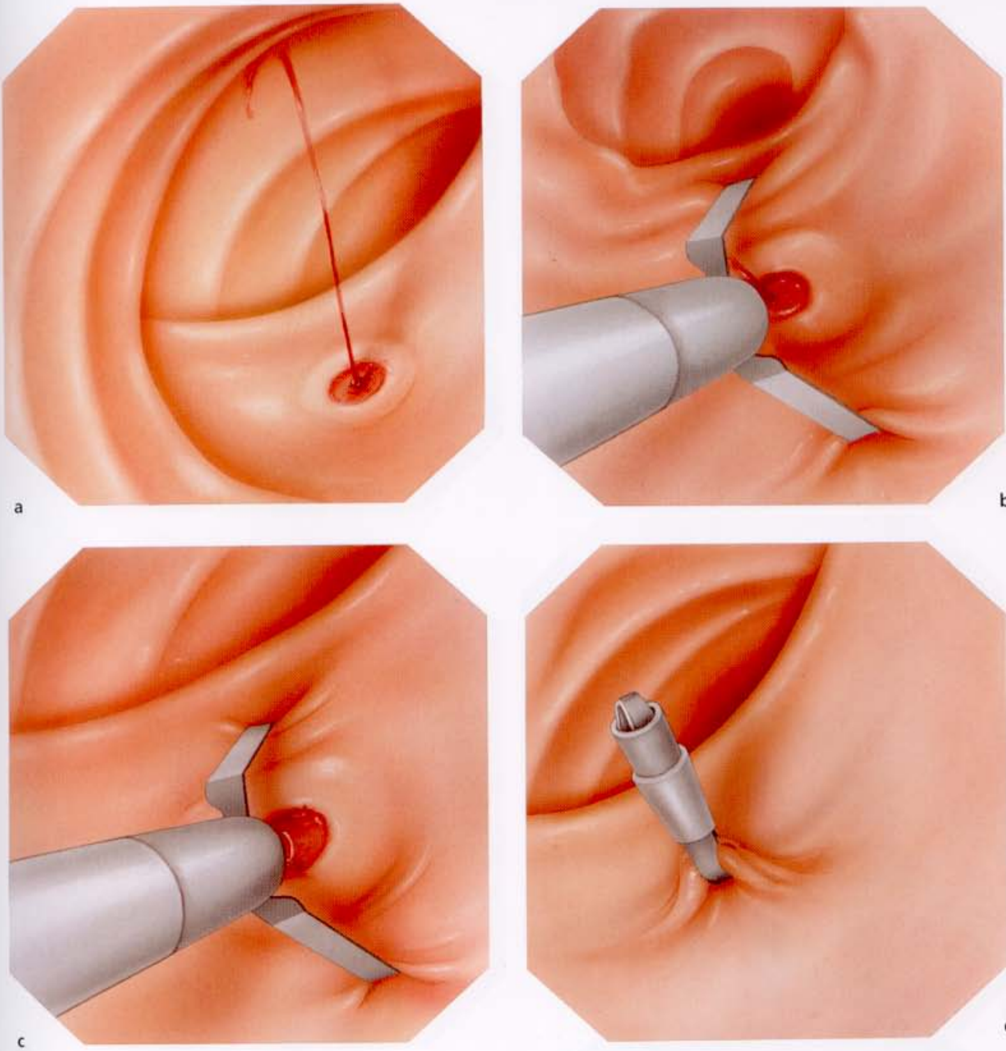
c

Fig. **75a–c** Hemostasis of arterial bleeding from a chronic prepyloric ulcer. The ulcer base is indurated and is therefore difficult to grasp with the clip.

a The ulcer base is approached tangentially. The prongs of the opened clip are oriented parallel to the ulcer base around the bleeding vessel.

b As the clip is closed, the clip is pressed against the wall to ensure that the vessel is grasped within the jaws.

c Appearance after the clip is closed. The vessel is caught in the clip and the bleeding has stopped.



a b c d

Fig. **76a–d** Hemostasis in a small acute bulbar ulcer
a Arterial bleeding from a small ulcer located along the greater curvature of the duodenal bulb.
b The ulcer is approached from above. The jaws of the prongs are positioned at opposing ends of the mucosal margins of the ulcer.
c As the clip is closed, suction is applied to draw tissue between the prongs.
d The vessel is sandwiched between the ulcer margins. Bleeding has stopped.

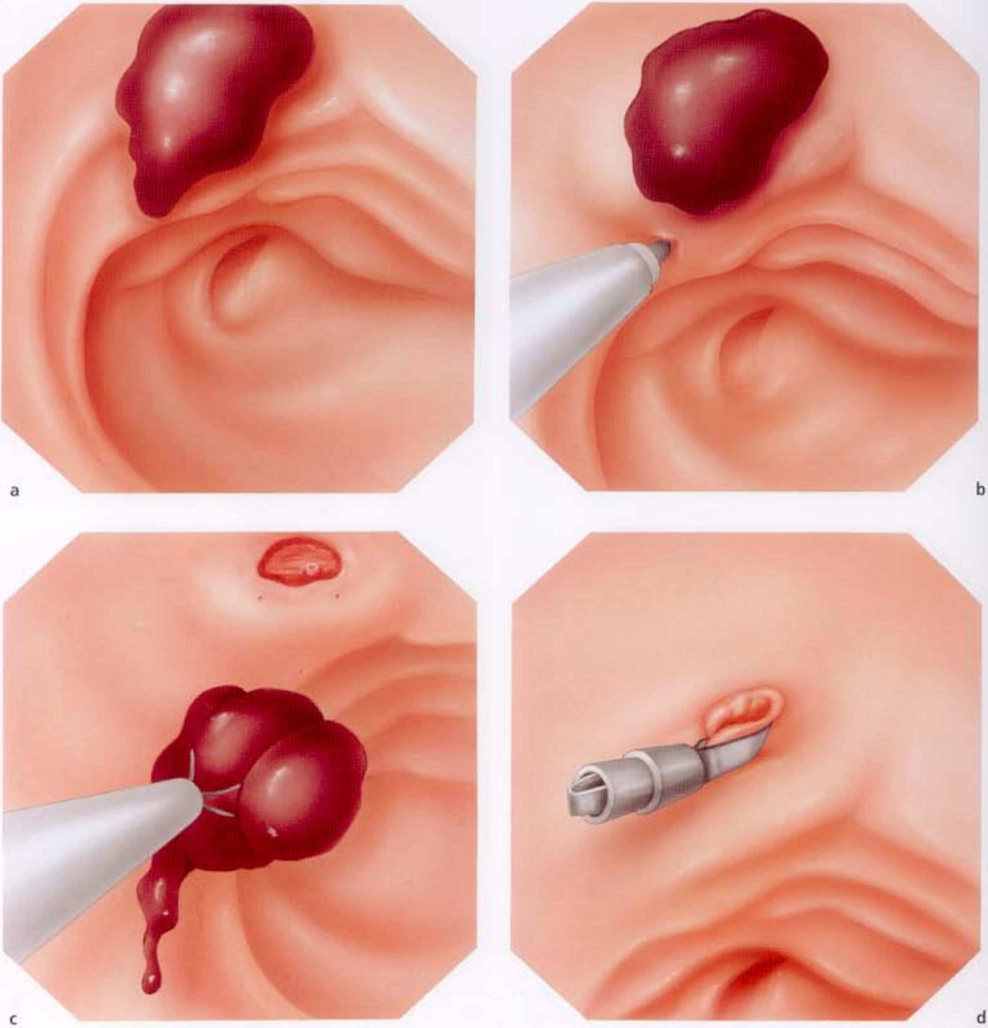
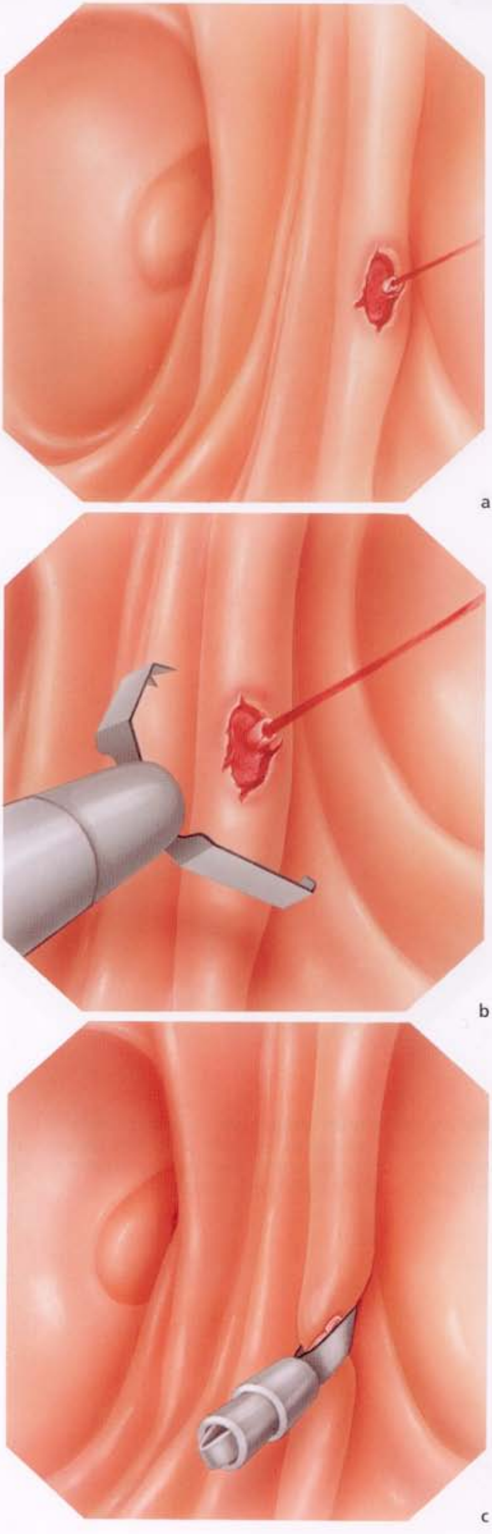


Fig. **77a–d** Hemostasis in a small bulbar ulcer with an overlying clot.
a The ulcer base is covered by a blood clot. Although bleeding has stopped, massive blood loss suggests a previous arterial bleed and a high likelihood of rebleeding.
b To prevent immediate rebleeding after removal of the clot, diluted epinephrine (1:20 000) is first injected submucosally around the clot.
c After removing the clot with a Dormia basket, the artery is visible in the ulcer base.
d The artery is ligated with a hemoclip as a definitive means of preventing rebleeding.

Fig. **78** Clip hemostasis of a bleeding ulcer in the proximal stomach. The ulcer, located along the lesser curvature, is easier to access in the retroflexed position. Pushing the clip apparatus out of the working channel with the endoscope in the retroflexed position is difficult; it is easier to advance the applicator out of the endoscope in the straightened position, open the prongs fully, and then retroflex the endoscope.



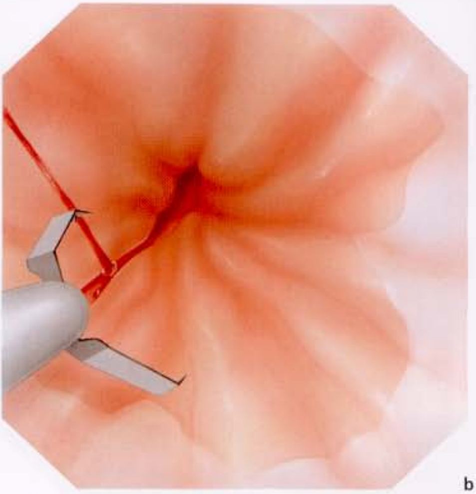
a

b

c

Fig. **79a–c** Hemostasis of an acute jejunal peptic ulcer in a patient with a Billroth II operated stomach.
a The small ulcer straddles the jejunal spur opposite the anastomosis.
b The clip is advanced and opened to its maximal span.
c The small vessel is clipped together with the jejunal fold.

a



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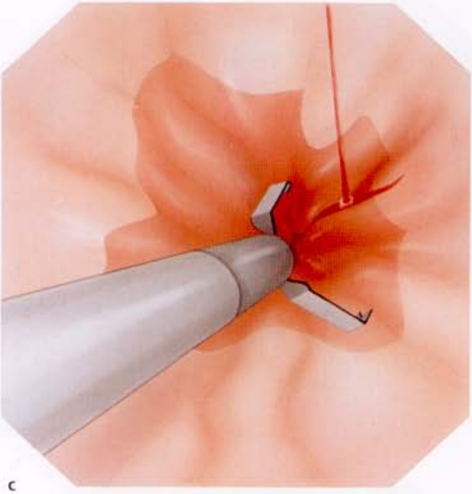
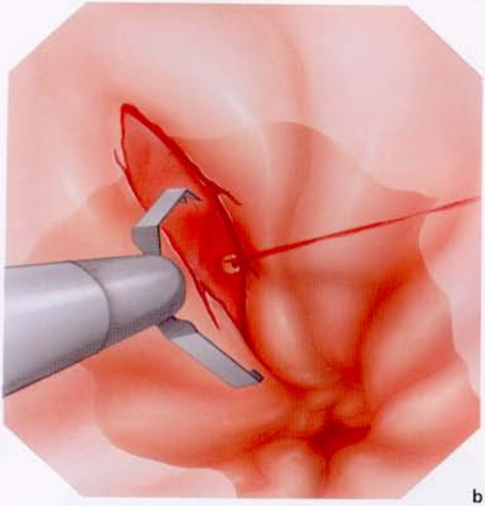


c

Fig. **80a–c** Linear Mallory-Weiss tear.
a The tear is at the 9-o'clock position in the endoscopic field, outside the axis of the working channel.
b Rotating the shaft of the endoscope counterclockwise moves the tear to the 8-o'clock position, in the axis of the working channel. The hemoclip is used to close the tear, simultaneously clipping the interposed vessel.
c Alternatively, the endoscope can be rotated clockwise to the 2-o'clock position and slightly withdrawn, thus bringing the tear into the axis of the working channel.

Mallory-Weiss tears usually cause an oozing bleed that can be adequately treated by injection of diluted epinephrine alone. In rare instances, arterial bleeding may be present. Clip hemostasis is then the preferred treatment.

a



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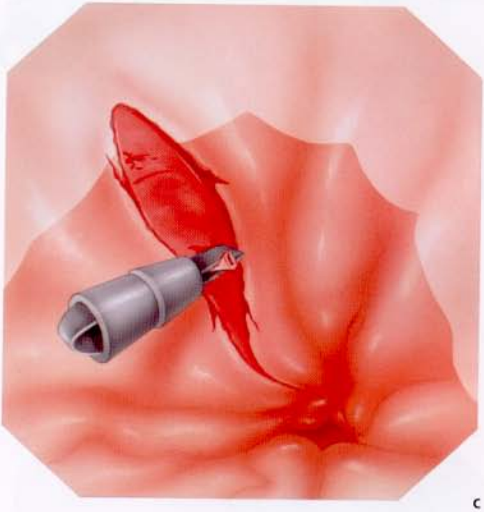


c

Fig. **81a–c** Wide gaping Mallory-Weiss tear with an artery in the center.
a The tear is at the 1- to 2-o'clock position.
b The endoscope shaft is rotated to bring the lesion into the 8-o'clock position to better access the vessel. The vessel is approached tangentially to clip its entire circumference.
c As the clip is closed, the prongs are pressed into the wall to grasp the vessel further down at its base.

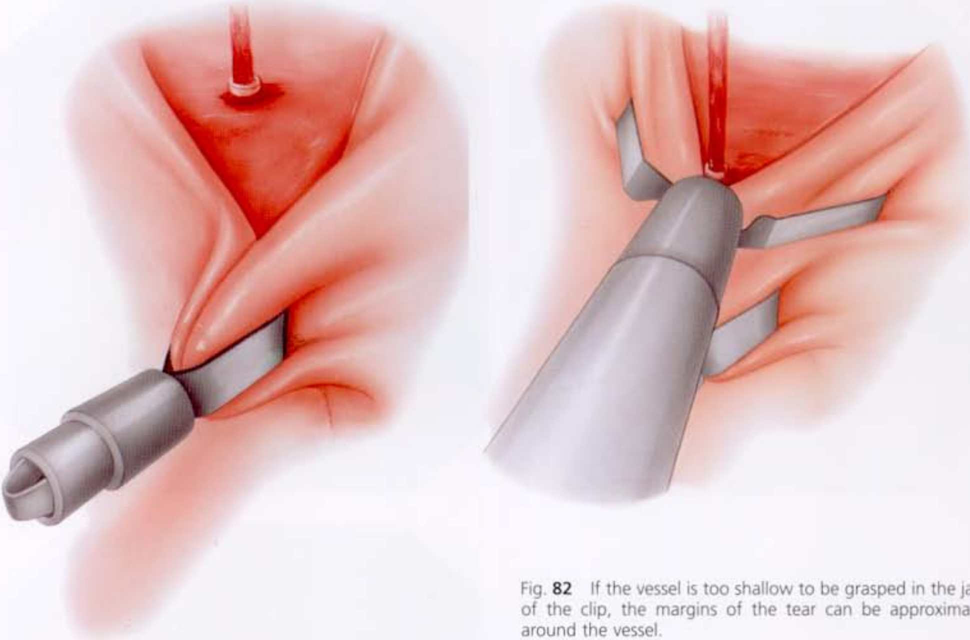


Fig. **82** If the vessel is too shallow to be grasped in the jaws of the clip, the margins of the tear can be approximated around the vessel.

Fig. **84a,b** Mallory-Weiss tear with subcardial bleeding.
a The vessel is best visualized with the endoscope in the retroflexed position. Since retroflexion impedes advancement of the clip applicator through the bent portion of the biopsy channel, it needs to be advanced and opened before the endoscope is retroflexed.
b Application of the clip to the tear margins to ligate the vessel.

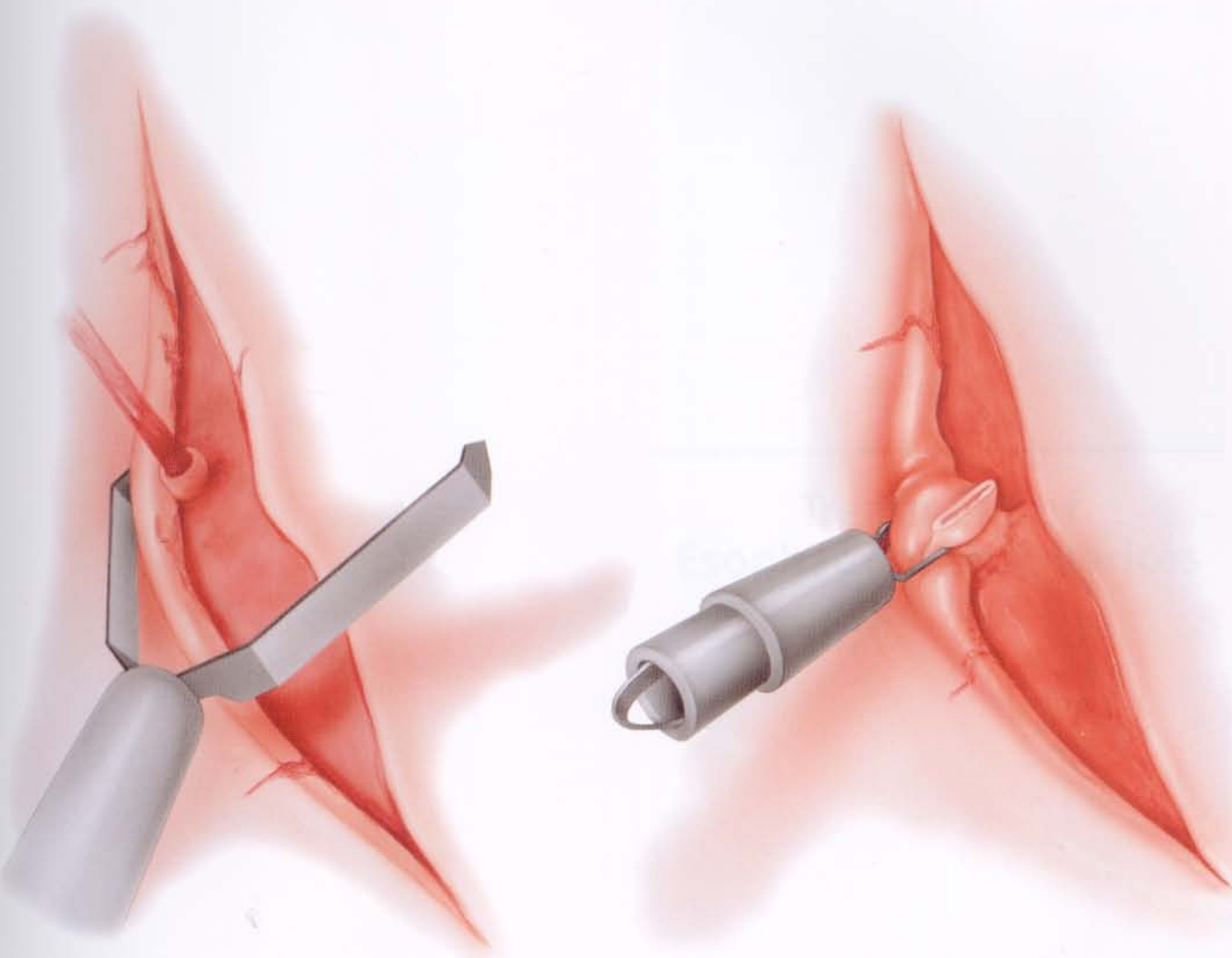
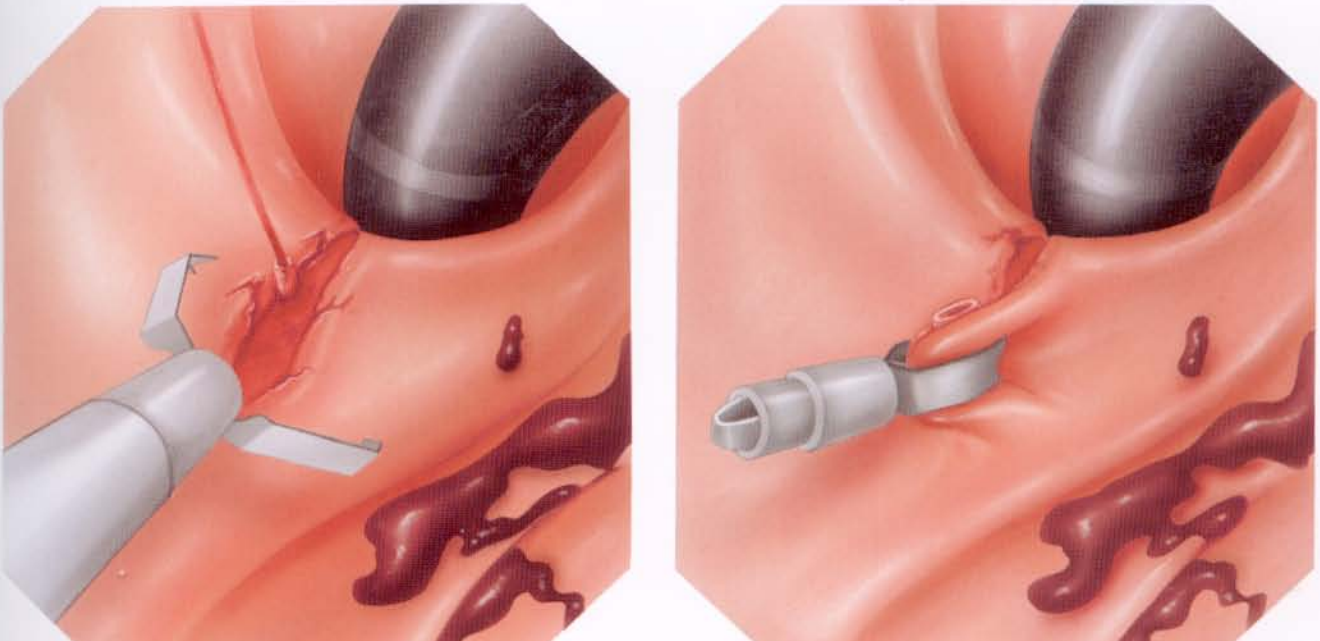


Fig. **83** Large Mallory-Weiss tear with an artery at its edge. The vessel is ligated along with the mucosal margins.



a b

Fig. **84**

7

Treatment of Esophagogastric Varices

General

The underlying cause of esophagogastric varices is liver cirrhosis in about 90% of patients. Hence, the general condition of the patient with variceal bleeding is usually poor. In addition to liver disease, the patient is also likely to have multiorgan damage because of chronic alcohol abuse. Poor health and the torrential nature of variceal bleeding are the main reasons for the uniformly dismal prognosis of acute variceal bleeding. Apart from being less invasive than surgical and radiologic shunting procedures, endoscopic hemostasis has the advantage that it can immediately follow a diagnostic endoscopy, which is indicated in the acute bleeder to determine the source of bleeding.

Indications

Urgent endoscopy is indicated for any patient with GI hemorrhage. Immediate endoscopic hemostasis is indicated if there is acute variceal bleeding evident at the endoscopy. After the acute bleeding has been arrested, endoscopic variceal eradication is performed on an elective basis to prevent rebleeding. Prophylactic treatment of varices that have never bled is justified only in exceptional situations where the risk of bleeding is ascertained to be very high. Endoscopic appearance of the varices is the prime determinant of the risk of bleeding (large, tense varices with red spots), but the status of the liver function should also be considered, because patients with Child-Pugh class C liver cirrhosis are unlikely to survive even the first episode of acute bleeding.

Fig. **85** The distal esophagus shows a dense network of mucosal venous capillaries that communicate with the deeper periesophageal veins through the perforating veins.

Prerequisites

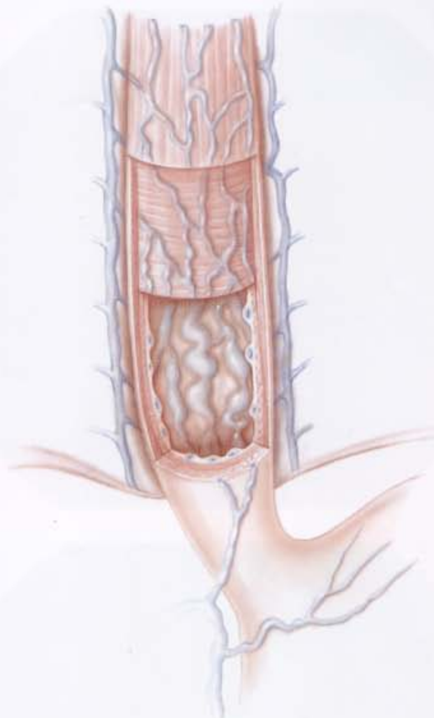
The technique and goals of endoscopic treatment are based upon a clear understanding of the variceal anatomy. The mucosa of the distal esophagus contains a dense network of venous capillaries. In portal hypertension, these capillaries dilate and may evolve into large thin-walled varices (Figs. 85, 86). Esophageal varices are therefore most predominant in the distal esophagus. Eradication of varices will prevent variceal rebleeding over the short term, but new varices may recur from the existing capillary network. Therefore, as well as eradicating the visible varices, endoscopic treatment should aim at inducing a circumferential sclerosis and fibrosis of the inner wall of the esophagus to prevent variceal reformation. Other sites where varices may form are the cardia and the stomach fundus. Splenic or portal vein thrombosis can cause isolated fundal varices due to a dominant collateral circulation via the short gastric and splenic vein (segmental portal hypertension).

Grading of the variceal size based on the endoscopic appearance is important for judging the result of treatment and the program of follow-up. The risk of bleeding is not only related to the size of the varix, but more importantly to the appearance of the variceal wall. Red-colored signs indicate varices that are at high risk for bleeding.

Esophageal and gastric varices can be divided into three grades of severity according to the criteria shown in Table 1.

Acute variceal bleeding requires the same preparations for emergency endoscopy as in nonvariceal bleeding.

a



b

Fig. **86a** Portal hypertension causes submucosal/mucosal capillaries to dilate. These vessels are extremely thin-walled and are therefore predisposed to bleeding.
b Portal hypertension resulting in the formation of gastric and esophageal venous collaterals draining into the azygos and hemiazygos veins ("spontaneous portosystemic shunts").

Table **1** Classification of the esophageal and gastric varices

Grade	Esophagus	Fundus
I	Diameter <5 mm, straight, limited to the distal esophagus (Fig. **87a**)	Diameter <5 mm, appearance similar to mucosal folds (Fig. **88a**)
II	Diameter 5–10 mm, tortuous, denser, extending above the midesophagus (Fig. **87b**)	Diameter 5–10 mm, including solitary polypoid varices (Fig. **88b**)
III	Diameter >10 mm, filling the esophageal lumen with little or no normal mucosa between columns, a thin wall, and red color signs.	Diameter >10 mm, conglomeration of multiple, large, often thin-walled polypoid varices (Fig. **88c**)

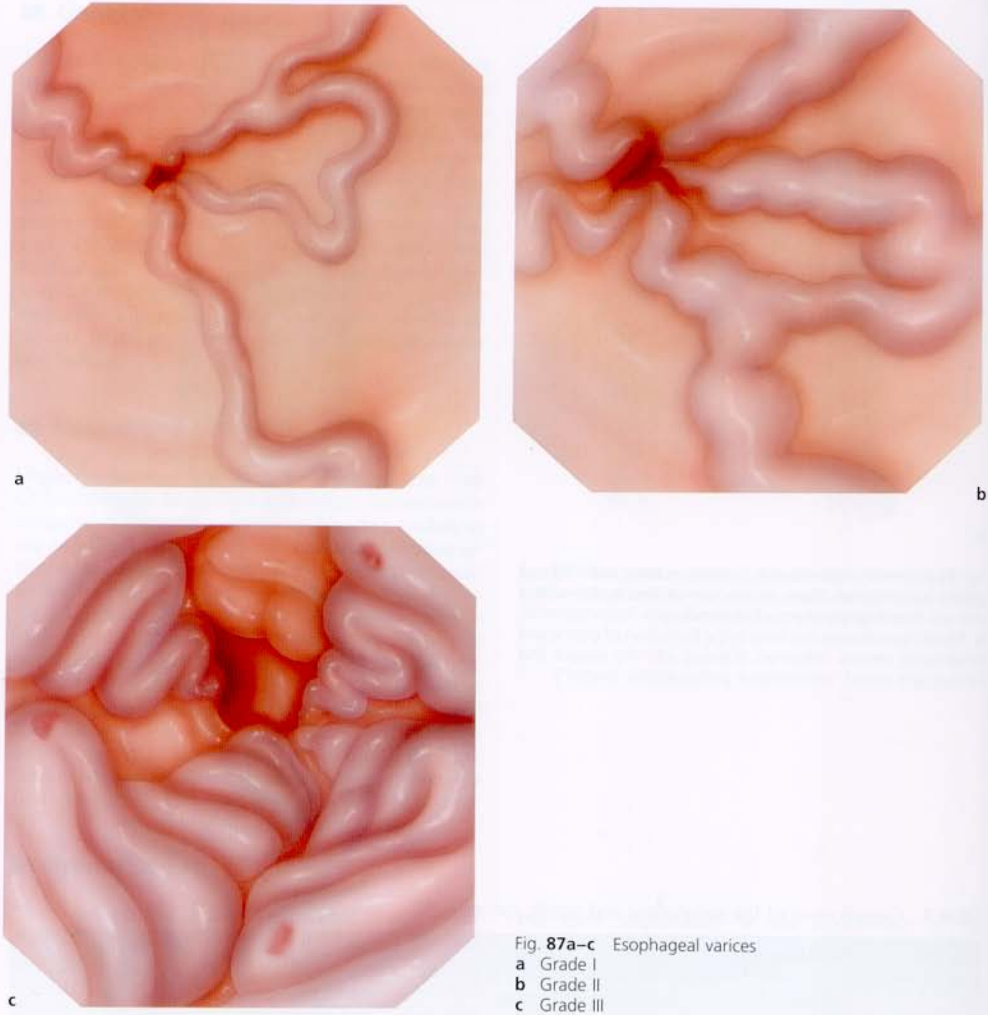
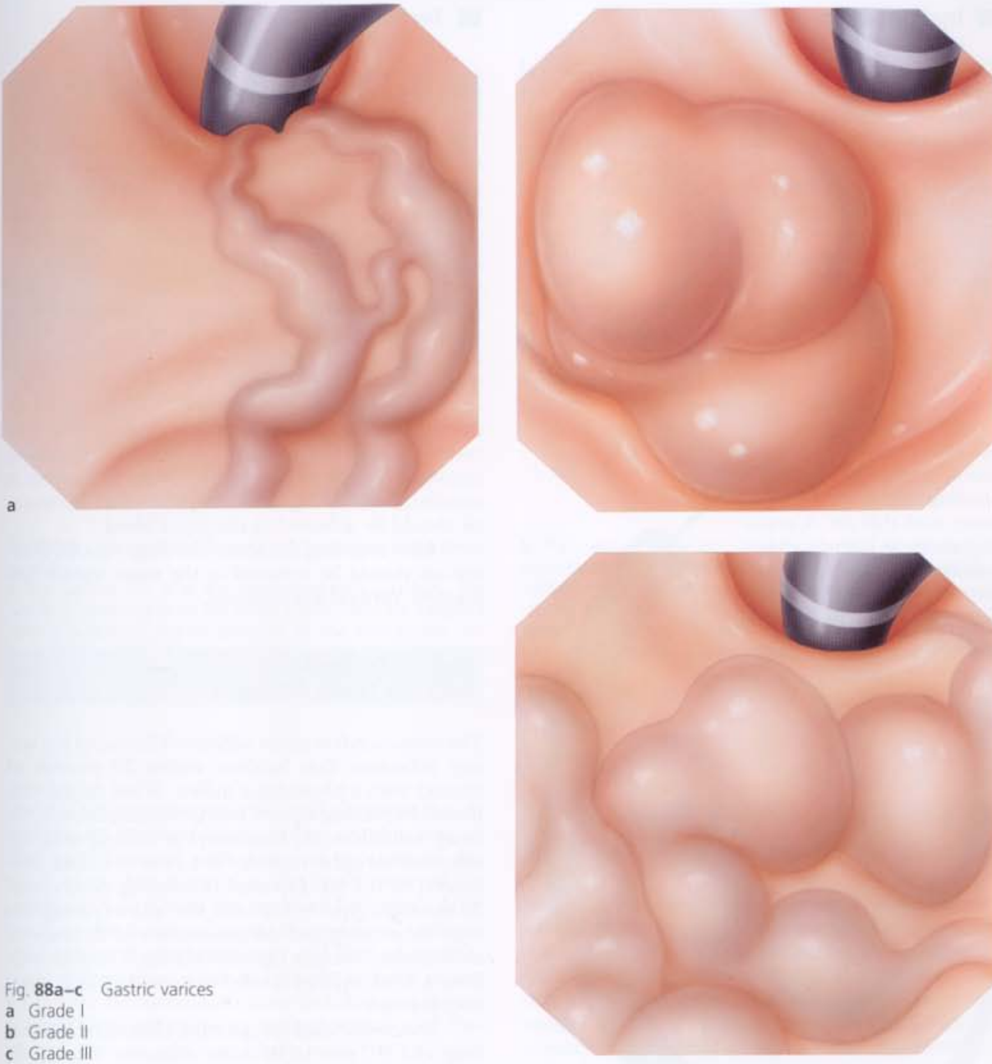


Fig. **87a–c** Esophageal varices
a Grade I
b Grade II
c Grade III



a b c

Fig. **88a–c** Gastric varices
a Grade I
b Grade II
c Grade III

Instruments

The same instruments are required for acute variceal bleeding as for nonvariceal bleeding: a large-channel endoscope, an additional suction unit for oral-pharyngeal secretions, and a water irrigation pump.

The regular sclerotherapy injection needle should have the smallest possible diameter to minimize the risk of backbleeding from the injection site. An outer diameter of 0.5 mm is sufficient for liquid sclerosants. The length of the needle should not exceed 5 mm, and the bevel should be short. Injection of cyanoacrylate tissue adhesive, however, requires a slightly larger (0.8 mm) and longer (8–10 mm) needle.

Variceal ligation requires a set of accessories (Fig. 89). A modified set utilizes a pneumatic system to eject the rubber band from a transparent plastic cylinder. Loading of the band is easier with this set. A major improvement is the multiligation device (e.g., Sixshooter). A powerful suction unit is necessary for variceal ligation.

Fig. **89** Accessories for variceal ligation (after Stiegman-Goff).
1 Overtube, 45-French bougie, Eder-Puestow wire
2 Outer cylinder
3 Ligation bands
4 Cone-shaped band loading device
5 Inner cylinder with a loaded band

Technique

Hemostasis of Acute Variceal Bleeding

The treatment of choice for profuse acute bleeding from esophageal or gastric varices is the intravariceal injection of cyanoacrylate tissue adhesive (Histoacryl). Cyanoacrylate injection is the only endoscopic treatment ideally suitable for large fundal varices. Conventional sclerotherapy is effective for the treatment of mild variceal bleeding, but, when used for severe bleeding, sclerotherapy is associated with substantial complications (wall necrosis, strictures) and a high mortality. Furthermore, rebleeding rates after sclerotherapy are high. Variceal ligation is difficult to deploy in the setting of active bleeding. Medical treatment including balloon tamponade does not assure hemostasis and is usually a temporizing measure. Because rebleeding in cirrhotic patients is associated with a high mortality, definitive hemostasis should be achieved at the index bleed.

After arresting the acute bleeding, variceal eradication should be initiated in the same session (see Elective Variceal Eradication).

Variceal Obliteration with the Tissue Adhesive

The cyanoacrylate tissue adhesive Histoacryl is a watery substance that hardens within 20 seconds of contact with a physiologic milieu. When mixed with blood, hardening occurs nearly instantaneously. To delay solidification, Histoacryl is diluted with the oily contrast agent Lipiodol in a ratio of 0.5 mL Histoacryl to 0.8 mL Lipiodol (hardening occurs after 20 seconds). Adding Lipiodol also allows roentgenologic monitoring and documentation of the variceal obliteration. Because Lipiodol is a fairly viscous solution, a 2-mL syringe is used to provide a high injection pressure.

The needle used for injecting Histoacryl is 8 mm long and 0.7 mm in its outer diameter. The needle should be checked before use, ensuring that it can be fully retracted and protruded from the outer sheath. For the injection of fundal varices, the needle should extend an additional 2–3 mm from the outer sheath because retroflexion of the endoscope tends to shorten the inner catheter. To prevent Histoacryl from adhering to the catheter itself, a few milliliters of Lipiodol are injected into the catheter, which is then rinsed with distilled water. The tip of the endoscope is also lubricated with silicone oil.

Distant embolization of the Histoacryl-Lipiodol mixture during injection is a rare complication. To minimize this risk, the mixture is injected in small aliquots of a maximum of 0.5 mL for esophageal varices and 1 mL for gastric varices. If more Histoacryl is required to obliterate the varix (as is usually the case for fundal varices), injections are repeated. As most of the Histoacryl mixture is retained in the dead

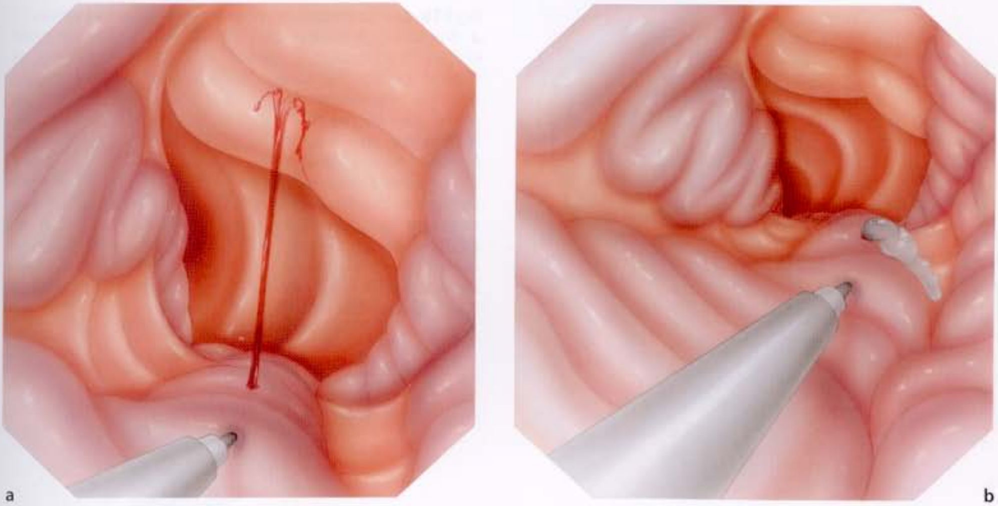


Fig. **90a,b** Hemostasis of an acute variceal bleed in the lower esophagus.
a The rupture site is at the esophagogastric junction. The needle is advanced from the outer sheath, and the targeted varix is punctured slightly proximal to the rupture site. Intravariceal position of the needle tip can be checked with a trial injection of distilled water, which should not cause mucosal swelling.
b The Histoacryl-Lipiodol mixture (0.5 mL) is injected intravariceally. As the varix is filled, bleeding stops and Histoacryl spills from the rupture site. Large esophageal varices generally require 1–2 mL of the mixture for complete obliteration, injected in aliquots of 0.5 mL. The tip of the endoscope is kept at a safe distance from the injection site to prevent contact with Histoacryl.

space of the injection catheter itself after injection, it is necessary to immediately follow the injection of Histoacryl-Lipiodol with a second injection of distilled water that is equal to the dead space of the catheter (about 0.8 mL for standard catheters). After injecting the tissue adhesive, the needle is immediately retracted into the catheter and flushed continuously with distilled water to keep the catheter patent for further injections. Care must be taken that the endoscope does not come in contact with liquid Histoacryl after its injection (there is no risk of endoscope damage after Histoacryl has solidified). The catheter is advanced for a few centimeters away from the endoscope tip to keep it at a safe distance from the optic lens, and air is continuously insufflated to keep the endoscope tip clear of tissue adhesive that may have spilled into the lumen. Suction is avoided for approximately 20 seconds after injection. All personnel should wear eye protection while working with the tissue adhesive.

The injection of Histoacryl differs from conventional sclerotherapy in that the injection must be strictly intravariceal. Furthermore, Histoacryl must be injected in a well-timed fashion to prevent the adhesive from solidifying in the catheter after injection. The endoscopy assistant should be well versed in the injection technique. Finely tuned coordination and communication between the endoscopist and assistant are essential for the success of the procedure.

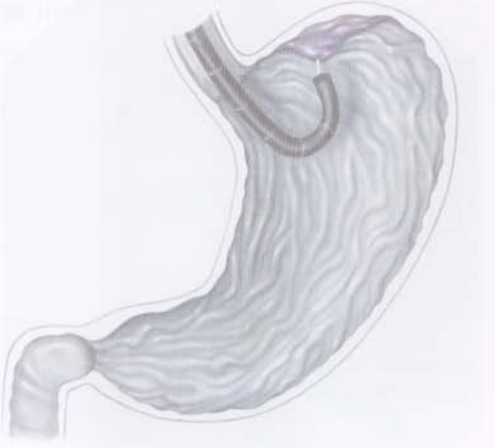
Variceal Ligation of Bleeding Esophageal Varices

Band ligation can be used to treat actively bleeding varices. In the setting of an active bleed, however, the restricted field of vision caused by the cylinder attachment makes the technique of ligation more difficult to perform than tissue adhesive injection. It is usually necessary to first survey the upper GI tract to identify the source of bleeding. After the overtube is inserted, the endoscope is prepared for variceal ligation (see Elective Treatment of Varices). Ideally, the rubber band should be delivered on the varix at the point of bleeding (Fig. 92). If, however, the point of bleeding cannot be identified, a multiple banding device can be used to place several bands over visible varices at the lower esophagus. This maneuver may induce hemostasis by causing spasm of the esophageal wall to spasm, which curtails blood flow to the varices (Fig. 93).

Sclerotherapy of Bleeding Esophageal Varices

Sclerotherapy can arrest acute variceal bleeding in a high percentage of cases. Compared to cyanoacrylate injection, however, the risk of complications and re-

Fig **91a–c** Hemostasis of acutely bleeding fundal varices.
a The bleeding fundal varix is approached with the endoscope in the retroflexed position. The injection catheter is advanced towards the varix to determine the optimal injection site. The needle extends approximately 1 cm from the outer sheath (this should be checked before the procedure).
b After the varix is punctured, 1 mL of the tissue adhesive is injected into the lumen.
c The treated varix is palpated with the tip of the injection catheter to check for hard consistency. A soft varix will require additional injections of the tissue adhesive. Large fundal varices will require 3–4 mL of the tissue adhesive to achieve complete varix obliteration. Visible feeding vessels should also be checked for obliteration as these can be the source of rebleeding from the treated varix.



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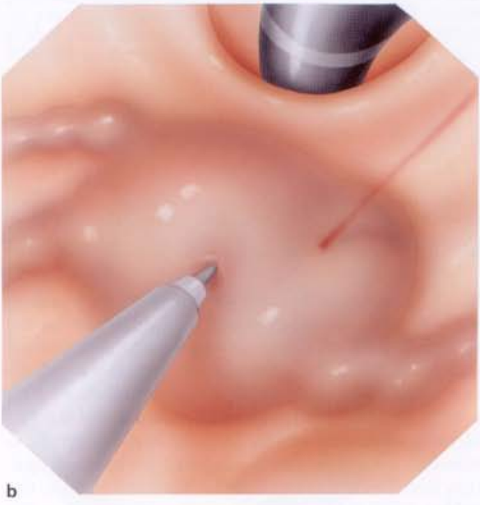

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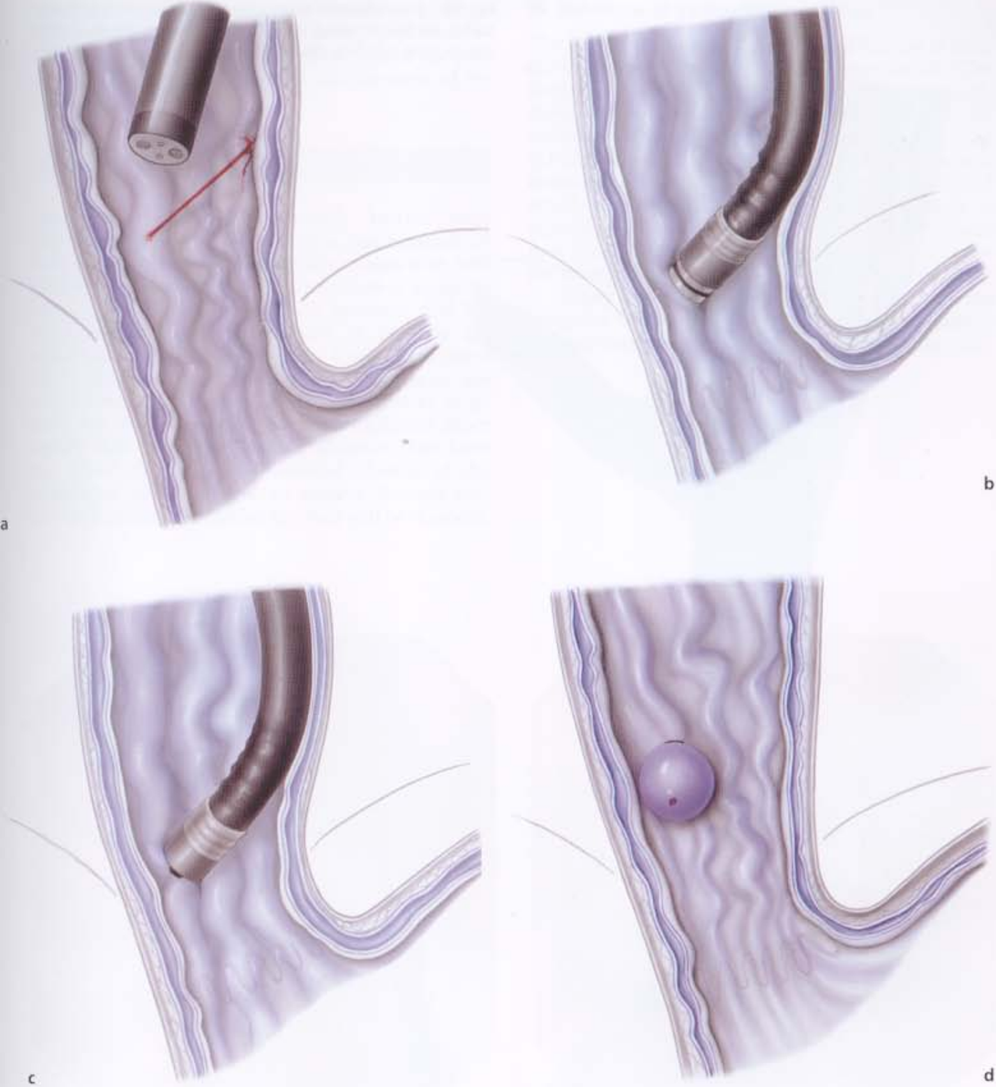


Fig. **92a–d** Hemostasis of active esophageal bleeding by rubber-band ligation.
a Upper GI endoscopy is performed to locate the site of bleeding.
b The endoscope is loaded with the banding device and reinserted into the esophagus. The bleeding varix is suctioned into the cylinder.
c The rubber band is ejected on the varix.
d The bleeding has stopped. The rupture site is seen on the ligated varix.

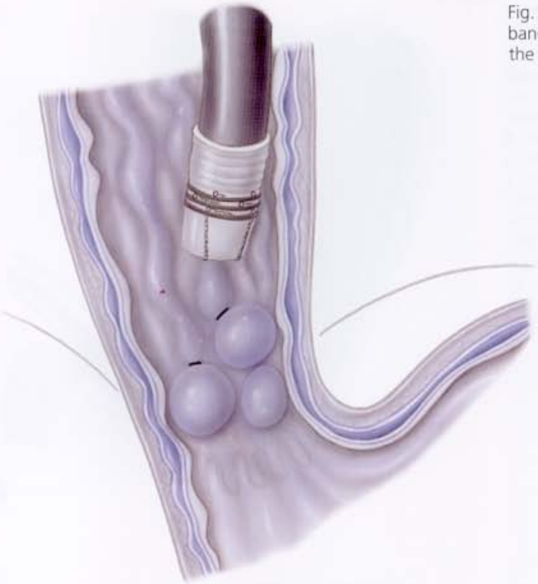


Fig. **93** If the point of bleeding cannot be identified, several bands are placed along varices in the distal esophagus using the multiple banding device.

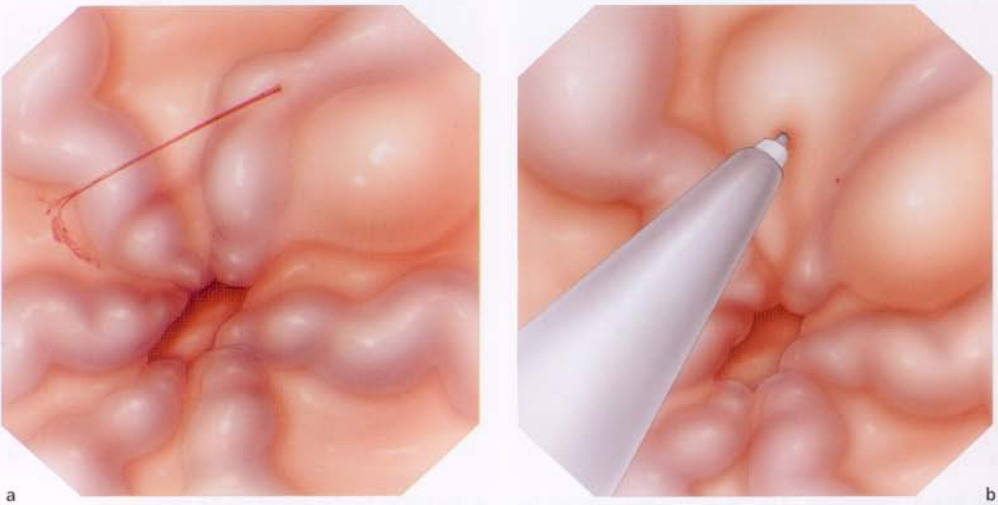


Fig. **94a**,**b** Hemostasis of a bleeding esophageal varix with sclerotherapy.
a The site of bleeding is identified. Sclerosant is injected immediately adjacent and slightly distal to the bleeding point into the submucosa until a significantly prominent bleb appears.
b The injection is repeated on the other side of the varix. Compression of the varix arrests the bleeding.

bleeding is higher. Severe bleeding, in particular, is more difficult to control using conventional sclerotherapy. The mechanism of hemostasis is primarily a tamponade effect, which usually requires large volumes of sclerosant (Fig. 94).

Elective Treatment of Varices

Varices that have bled once are predisposed to rebleeding. Variceal eradication should therefore be achieved as quickly as possible. Endoscopic treatment competes with portal decompressive surgery or the insertion of a transjugular intrahepatic shunt (TIPS). Endoscopic therapy is generally preferred because it is the least invasive. A drawback of the portosystemic shunt is the possible development of encephalopathy.

Esophageal Varices

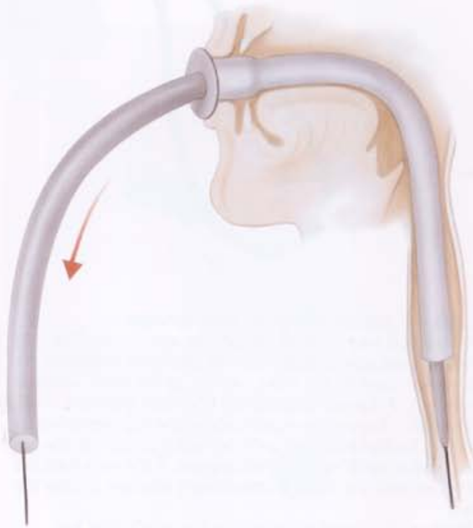
Esophageal varices are electively treated with sclerotherapy, band ligation, or a combination of both. Band ligation has distinct advantages over conventional sclerotherapy. The procedure is easier to learn and far less dependent on operator skill for good results. Complication rates of banding are much lower than of sclerotherapy. Deep or extensive ulcers that can cause mediastinitis or perforate are rarely seen with banding, and posttreatment strictures are uncommon. Varices are eradicated more rapidly with banding. Banding, however, does have the drawback that circumferential fibrosis of the esophageal wall is difficult to achieve. Because varices tend to recur, sclerotherapy may still be required.

Technique of Variceal Band Ligation

The basic technique of variceal band ligation is similar to that of band ligation of hemorrhoids. The Stiegman-Goff banding set consists of an inner cylinder that fits into an outer cylinder. The outer cylinder is attached to the tip of the endoscope; the inner cylinder is loaded with the rubber band. A trip wire is inserted through the endoscope working channel and attached to the inner cylinder. After the varix is aspirated into the cylinder unit, the band is released over the varix by pulling the trip wire, which draws the inner cylinder into the outer cylinder (Fig. 95).

Only one band can be placed at a time with the Stiegman-Goff apparatus. Multiple band application requires removal of the scope for reloading by pull-

Fig. **95** Cylinder assembly. The outer cylinder is attached to the tip of the endoscope. The trip wire is connected to the inner cylinder, which is loaded with the rubber band. The trip wire runs throughout the length of the endoscope working channel.



a b

Fig. **96a,b** Insertion of the overtube.
a A 45-French bougie serves as an obturator to prevent injury to the esophagus during insertion of the overtube. An Eder-Puestow wire is endoscopically positioned in the stomach and serves as a guide for the bougie. The overtube and bougie are inserted together as one unit over the wire.
b The bougie and wire are removed after the overtube has been fully inserted into the esophagus.

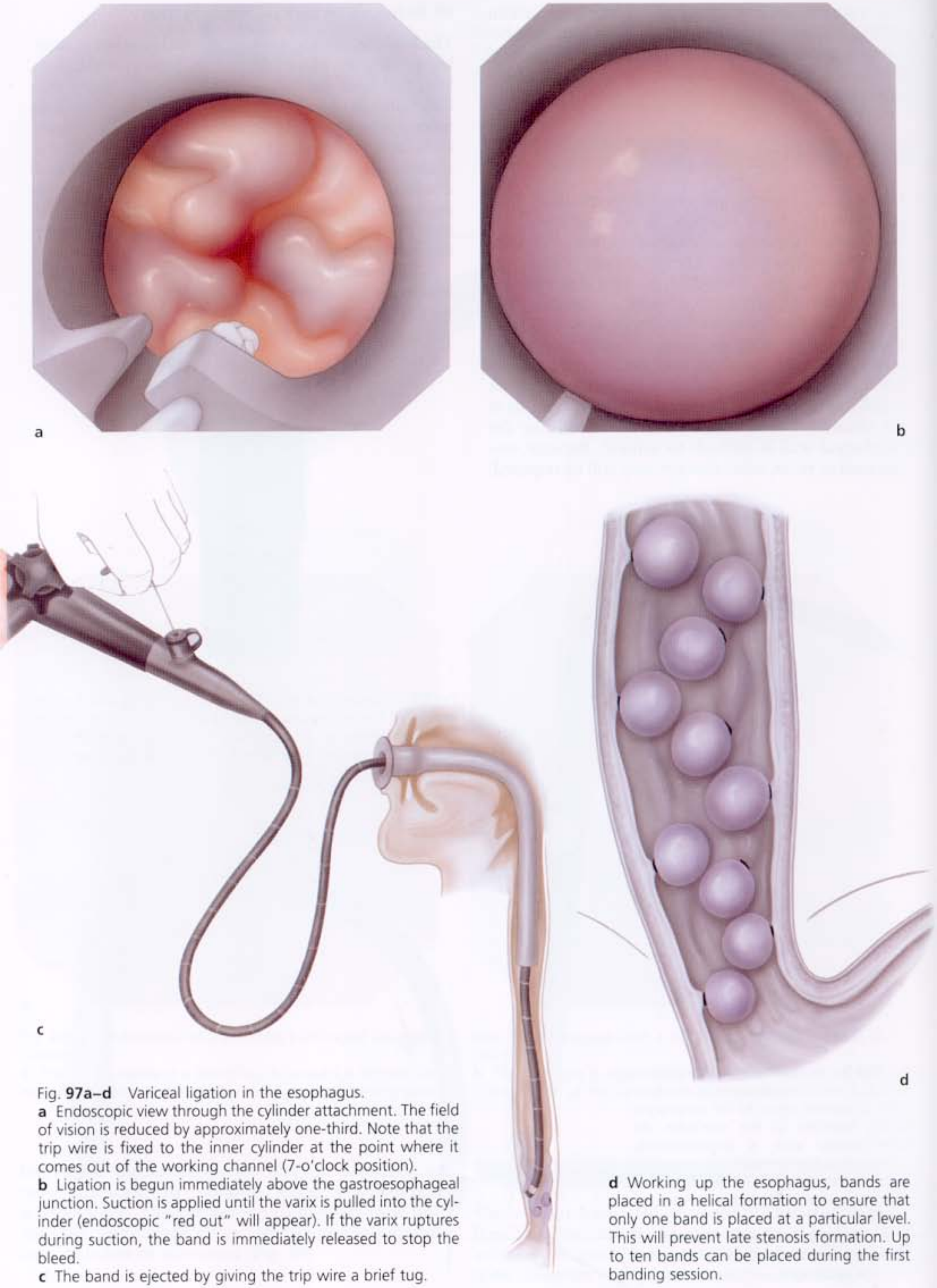


Fig. **97a–d** Variceal ligation in the esophagus.

a Endoscopic view through the cylinder attachment. The field of vision is reduced by approximately one-third. Note that the trip wire is fixed to the inner cylinder at the point where it comes out of the working channel (7-o'clock position).

b Ligation is begun immediately above the gastroesophageal junction. Suction is applied until the varix is pulled into the cylinder (endoscopic "red out" will appear). If the varix ruptures during suction, the band is immediately released to stop the bleed.

c The band is ejected by giving the trip wire a brief tug.

d Working up the esophagus, bands are placed in a helical formation to ensure that only one band is placed at a particular level. This will prevent late stenosis formation. Up to ten bands can be placed during the first banding session.

ing the endoscope out every time. To facilitate repeated intubations, an overtube is placed at the beginning of the procedure (Fig. 96).

The multiple banding device permits the application of several bands without having to remove the endoscope before every application. The device consists of a single transparent plastic cylinder loaded with the bands. A string that extends from the cylinder is backloaded through the working channel and connected to a cranking handle at the channel inlet port (Fig. 99). The bands are individually released by pulling the string into the handle. Using the Six-shooter device, the string splits at the end into three threads that attach to the cylinder at equidistant points along its circumference. Knots along the threads separate the bands so that they can be individually released (Fig. 100). Up to six bands can be sequentially placed with this device (Fig. 101). Placement of an overtube is not necessary, which makes the procedure quicker and safer (potential complications from overtube insertion are avoided).

Technique of Sclerotherapy

The goals of sclerotherapy are the eradication of visible varices and the fibrosis of the inner wall of the esophagus to prevent new varices from forming. The sclerosant is injected submucosally around the varix column (perivariceal injection). Intravariceal injection should be avoided as the sclerosant is likely to

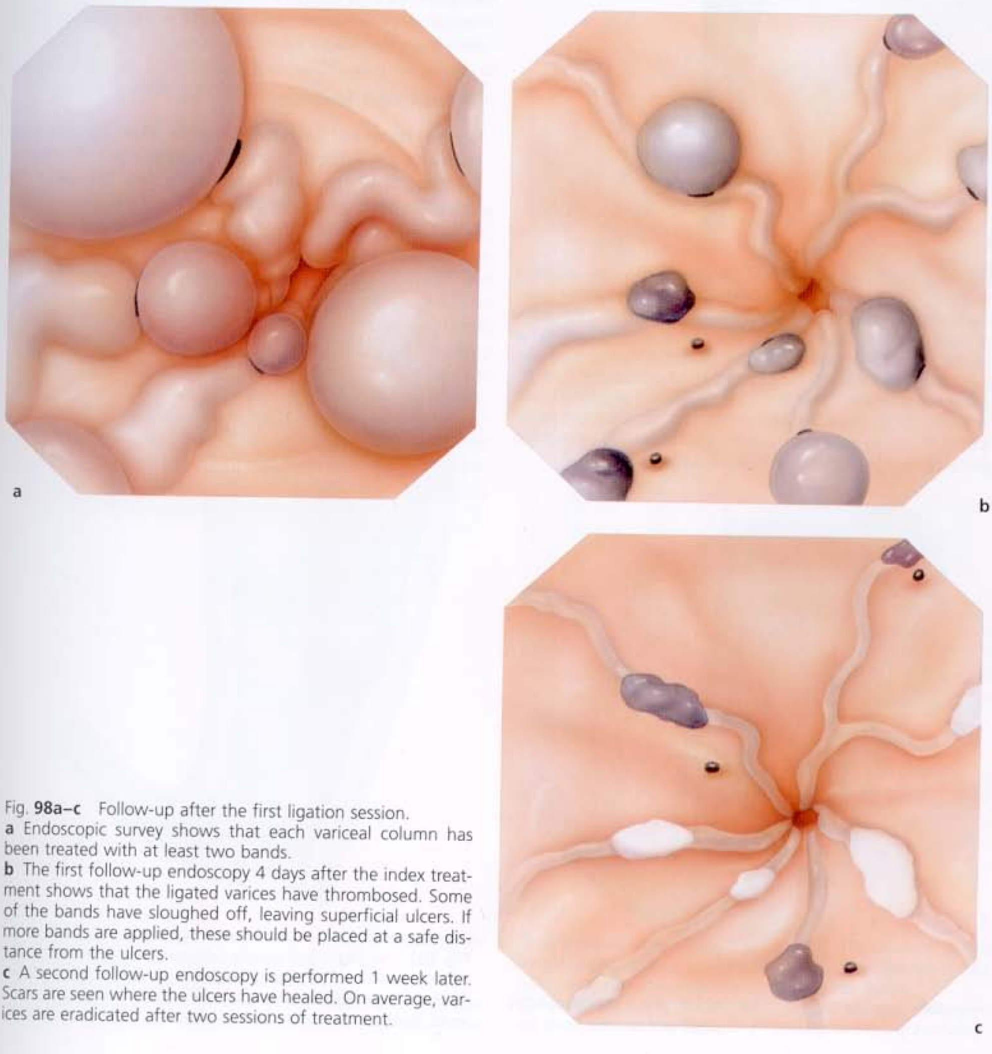


Fig. **98a–c** Follow-up after the first ligation session.
a Endoscopic survey shows that each variceal column has been treated with at least two bands.
b The first follow-up endoscopy 4 days after the index treatment shows that the ligated varices have thrombosed. Some of the bands have sloughed off, leaving superficial ulcers. If more bands are applied, these should be placed at a safe distance from the ulcers.
c A second follow-up endoscopy is performed 1 week later. Scars are seen where the ulcers have healed. On average, varices are eradicated after two sessions of treatment.

Fig. **99** The lid of the rubber cap attached to the working channel inlet port is opened, and the cranking handle is inserted into the port. We recommend a 3.7-mm channel therapeutic gastroscope equipped with an accessory port for a water pump. The diagnostic gastroscope does not have the necessary shaft stability for multiple band placement; furthermore, traction on the endoscope tip, when angulated, can damage the scope. If the view becomes obstructed, the water pump is used to irrigate the lumen. Suction should be avoided because the cylinder produces a vacuum chamber.

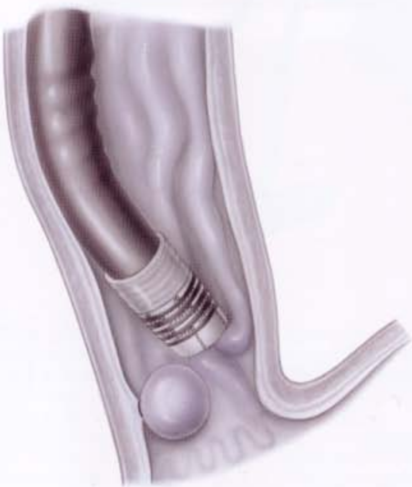


Fig. **100** Ligation is commenced at the esophagogastric junction, progressing cranially in a helical fashion.

enter the circulation and cause systemic side effects (Fig. **102**). The most common technical error is the injection of the sclerosant into the deeper layers of the esophageal wall. This will produce deep ulcers and sequelae such as periesophageal inflammation (mediastinitis, pleural effusion), bleeding, perforation, or stricture formation. Superficial injection of the sclerosant produces an obvious mucosal bleb and tissue blanching (Fig. **103**). Sclerotherapy can usually be restricted to the region of the distal esophagus immediately above the esophagogastric junction. The more proximal varices usually thrombose and disappear spontaneously (Fig. **104**).

A wide selection of sclerosants are available for sclerotherapy. The sclerosant of choice is a watery solution that does not induce pain after injection (e.g., 1% polidocanol). The sclerosant is injected in small aliquots of 2–3 mL. A total of 20–30 mL is generally required to sclerose the entire circumference of the esophageal wall.

Treatment Schedule

Several sessions of sclerotherapy or band ligation are required to achieve variceal eradication. Since rebleeding tends to occur within the first few days to weeks after the index bleed, sessions should be scheduled at short intervals. The second session can

Fig. **101** Six bands will usually suffice for the initial treatment of visible varices. The second session is performed 4 days later, followed by sessions at weekly intervals until all varices are eradicated.

be scheduled 4 days after the first session. Thereafter, sessions are scheduled at weekly intervals. The patient should be kept on a pureed diet during treatment to avoid dysphagia. Varices that cannot be adequately eradicated with band ligation alone are treated with sclerotherapy. Large varices that cannot be eradicated or that rebleed should be treated with cyanoacrylate injection. Cyanoacrylate injection should also be considered for patients with large varices who are unlikely to survive any episode of rebleeding (Child-Pugh class C liver cirrhosis, comorbid diseases).

Fundal Varices

The eradication of large fundal varices with sclerotherapy or banding is difficult and can result in massive bleeding from the necrosis at the injection or banding site. Cyanoacrylate injection is more effective because it physically occludes the lumen and thereby stops the blood flow in the varices (Fig. **105**).

Complications

Severe early complications of sclerotherapy include deep ulcers, bleeding, mediastinitis, and perforation. These are primarily sequelae of a faulty sclerotherapy technique: the injections are too deep (into the muscle layer), or too much sclerosant is injected. The type of needle used may contribute to complications; a thick, long needle will predispose to excessive, deep injections. Apart from the inherent nature of the selected sclerosant, the amount injected and the concentration used have a definite bearing on the adversity of the results. Failed attempts to arrest rebleeding with sclerotherapy will compound the risk of complications. The most common late complications are strictures and impaired esophageal motility.

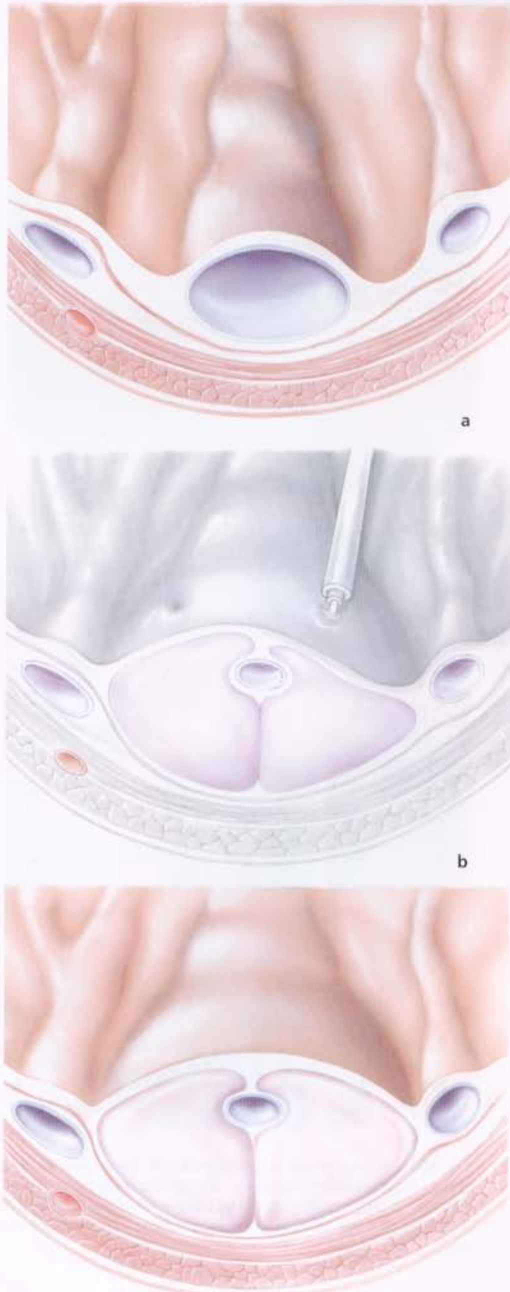


Fig. **102a–c** Schematic representation of the perivariceal injection technique of esophageal varices.
a Cross section of esophageal varices.
b The injection needle approaches the esophageal wall tangentially. Several milliliters of sclerosant are injected submucosally immediately adjacent to the varix. The injection should immediately produce a submucosal bleb. The absence of bleb formation indicates that the injection is too deep.
c The varix is barely visible after injection has been completed on both sides of the varix.

a

b

Fig. **103a–b** Perivariceal sclerotherapy of esophageal varices.
a The sclerosant is injected submucosally immediately adjacent to the variceal columns in the distal esophagus.
b After treatment, the esophageal mucosa appears edematous and the varices are hardly visible.

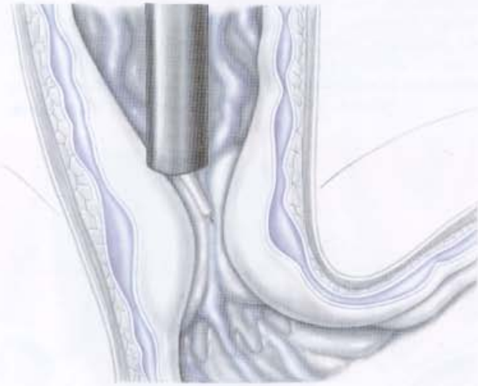


Fig. **104** Sclerotherapy is commenced in the region of the distal esophagus immediately above the esophagogastric junction. Complete fibrosis of the inner wall of the esophagus in this region will usually result in complete variceal eradication.

Variceal banding has a lower complication rate than sclerotherapy. The patient may experience retrosternal pain and dysphagia during the first few days of treatment. Insertion and manipulation of the overtube has been reported to cause esophageal tears and even perforations. The use of the multiple banding device avoids these complications by eliminating the need for an overtube.

Cyanoacrylate injection has the potential to embolize into neighboring vessels or the systemic circulation. This complication is rare and is usually asymptomatic. There have been isolated reports of cerebrovascular accidents due to dissemination of the tissue adhesive into the cerebral circulation, which may be because of extremely rare arteriovenous shunting in the thorax. Restricting the amount of cyanoacrylate injected per aliquot will minimize the risk of embolization.

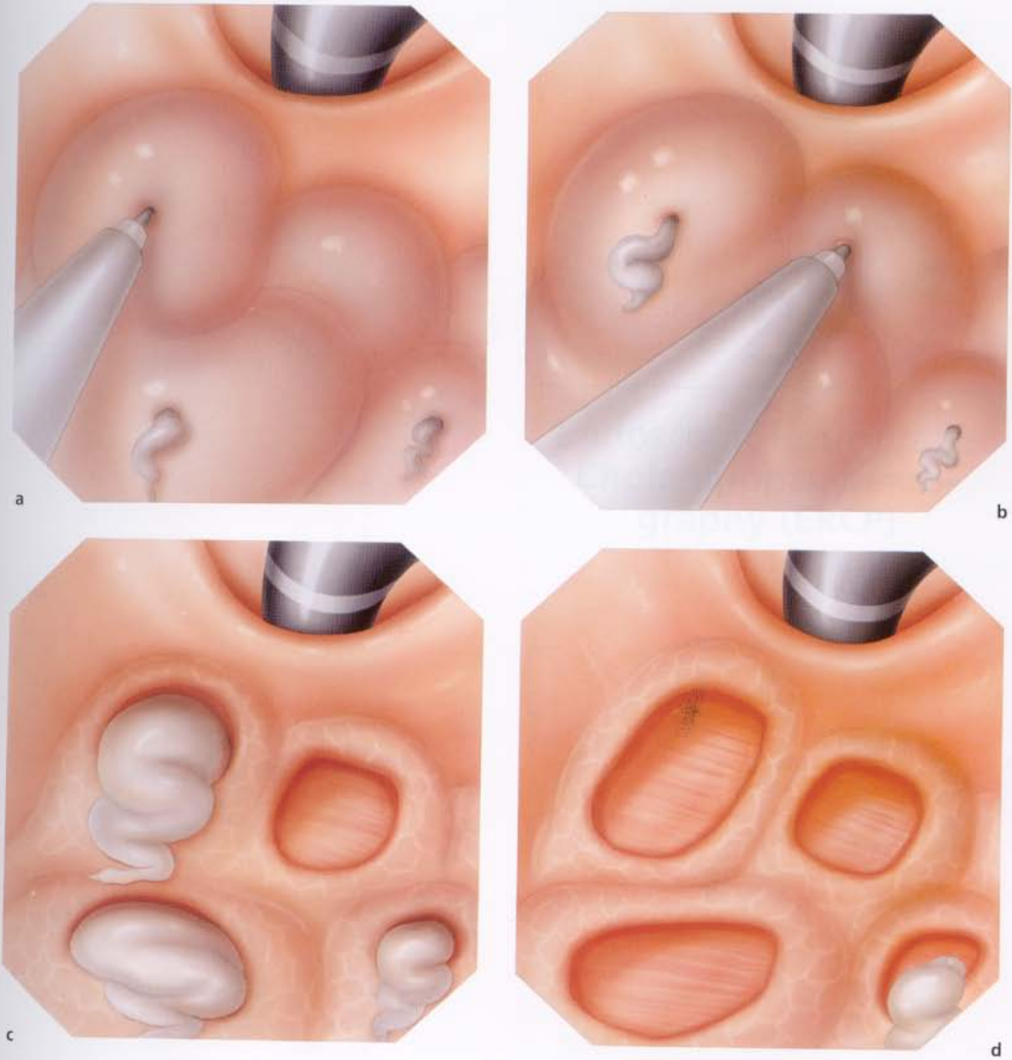


Fig. **105a–d** Obliteration of large fundal varices in the retroflexed position.
a The Histoacryl-Lipiodol mixture is injected in aliquots of 1 mL.
b Large varices are injected at different sites to ensure complete obliteration. After injection, obliterated varices feel hard when they are palpated with the injection catheter.
c Over a period of weeks, the mucosa sloughs off, and a kind of glue cast is extruded from the varix into the stomach lumen.
d After the tissue adhesive is expelled, the injection site re-epithelializes with scar formation.

8

Endoscopic Retrograde Cholangiopancreatography (ERCP)

General

Endoscopic retrograde cholangiopancreatography (ERCP) is the radiologic imaging of the hepatobiliary tree and pancreatic duct after cannulating the papilla of Vater. Although it seems straightforward, ERCP can be technically challenging because of anatomic variants, postoperatively altered anatomy, and pathologic changes.

Indications

ERCP has evolved into a primarily therapeutic procedure. The main indication is an obstructive pathology involving the biliary or pancreatic duct, or the major/minor papilla itself. A less common indication is postoperative ductal injury (leaks, fistulas).

The indication for a purely diagnostic ERCP should be carefully weighed against the risk of inducing post-ERCP pancreatitis.

Prerequisites

A team approach is necessary to carry out a successful ERCP. In addition to the endoscopist, at least two nurses are needed to assist during the ERCP procedure—one to handle instrumentation, and the other to monitor the patient's condition. A radiologist is required to manage the X-ray equipment and should not only be well versed in all technical aspects of fluoroscopy and film processing, but also familiar with pancreaticobiliary anatomy.

The fundamental prerequisites for performing a successful ERCP are a fully equipped X-ray room with high-resolution fluoroscopy, modern endoscopic equipment, and a variety of accessories. Facilities for rapid film development are desirable to verify or analyse fluoroscopic findings in greater detail during ERCP as these may have a decisive bearing on the further steps of the procedure.

Prior to ERCP, it is prudent to obtain a baseline plain X-ray film to look for artefact (e.g., radiopaque items on clothing, surgical clips), calcification (pancreas, lymph nodes, or ribs), and residual contrast from prior radiologic examinations. All of these may be superimposed upon the fluoroscopic field of interest and can lead to misinterpretation of the ERCP films.

Routine pulse oximetry is recommended, particularly in view of the difficulty of monitoring the patient in the darkened ERCP room. Pulse oximetry is mandatory in high-risk patients. An emergency trolley stocked with equipment and drugs for resuscitation should be at hand. This deserves all the more emphasis when the long duration of therapeutic ERCP procedures and the need for deeper sedation are taken into account.

Instruments

A duodenoscope with a 4.2-mm channel is generally recommended to enable therapeutic intervention following diagnostic ERCP.

Successful cannulation requires an assortment of cannulating catheters (Fig. **106**). These differ primarily in the shape of the tip. The tip may be metal or non-metal. Metal-tipped catheters have the advantage of visibility on fluoroscopy and increased durability. The tapered metal-tipped catheters may traumatize the papilla more than non-metal-tipped catheters. Our preference is to use the rounded ball-tipped or bullet metal-tipped catheter, through which a guidewire can be passed (Fig. **106**).

Accessories for the entire spectrum of interventional procedures should be at hand. These are covered elsewhere (see Chapter 9, Sphincterotomy and Chapter 11, Biliary Stent Drainage).

Technique

Positioning of the Patient

The patient is placed in the left lateral position. Some endoscopists prefer to start with the patient in the prone position as it allows better delineation of biliary and pancreatic ductal anatomy. It is easier, however, to rotate the patient either to the right or the left from the left lateral position to evaluate the ductal anatomy in different planes. The lateral position has the advantage of being more comfortable for the patient. Fluoroscopy in the supine position is required for a precise definition of the ductal anatomy.

Insertion of the Duodenoscope

A side-viewing endoscope is introduced into the esophagus and advanced into the second portion of the duodenum. It is preferable to advance the duodenoscope under direct vision in order to identify important landmarks such as the cardia, the direction of the gastric folds, the incisura, and the pylorus. Adequate insufflation is necessary to identify these landmarks, but excessive air insufflation may accentuate a J-shaped stomach, making it difficult to pass the pylorus. Particular care should be taken when going through the cardia, pylorus, and duodenal bulb as direct vision is lost when negotiating these areas. After passing the endoscope into the second portion of the duodenum, the duodenoscope is straightened (Fig. 107a-g). Apart from being more stable, the straightened position of the endoscope is the best for viewing and accessing the papilla.

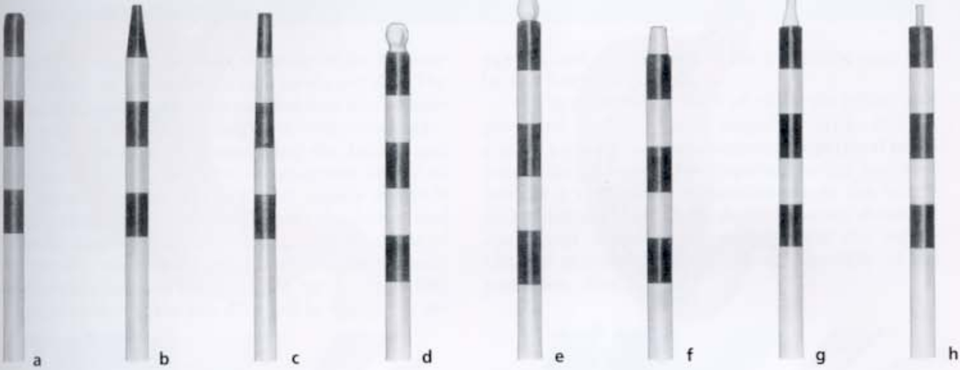


Fig. **106a–h** Assortment of ERCP catheters used for cannulation.
a Standard non-metal-tipped catheter
b Short tapered non-metal-tipped catheter
c Long tapered non-metal-tipped catheter
d Ball metal-tipped catheter
e Bullet metal-tipped catheter
f Conical metal-tipped catheter
g Tapered metal-tipped catheter
h Minor papilla blunt needle-tipped catheter

Fig. **107a–g** Maneuvers for reaching the papilla and straightening the endoscope.
a Upon entering the stomach, the lesser curvature is first visualized with the side-viewing instrument. Slight downward deflection of the endoscope tip will usually offer a tubular view of the stomach lumen. The endoscope is advanced along the longitudinal folds of the stomach into the antrum.
b Once in the antrum, the pylorus is identified by a further downward deflection of the tip. The pylorus is positioned in the middle of the viewing field.
c To pass the pylorus, the endoscope tip is straightened as the endoscope is slowly advanced. The stomach should not be insufflated with air. The pyloric ring will appear to sink into the setting-sun position.

Fig. **107d–g** ►

Straightening is achieved by turning the endoscope controls maximally to the right and upward, and then slowly withdrawing the endoscope as it is simultaneously torqued in the clockwise direction until the major papilla comes into view. The typical landmarks are the hood, the papilla proper, and the frenulum (Fig. 108).

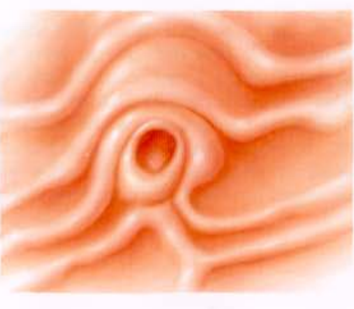
d

e

f

g

Fig. **107d** In the J-shaped stomach the endoscope tip may fail to negotiate the pylorus and slip into a retroflexed position. Further advancement of the endoscope may lead to retrograde intubation of the cardia.
e The duodenal bulb is identified by the distinctive villous appearance of the mucosa. The junction between the first and second part is identified, and the endoscope is advanced into the second portion of the duodenum. Some slide-by may be necessary, but generally a tubular view of the duodenum can always be maintained.
f The superior duodenal angle is used as a fulcrum to straighten the endoscope. The endoscope controls are turned maximally to the right and upward, and then the endoscope is slowly withdrawn while being simultaneously rotated in a clockwise direction. The right-left wheel is then locked, and the up-down wheel is stabilized with the left thumb.
g On withdrawal, the endoscope may first paradoxically advance beyond the papilla deeper into the second portion of the duodenum. On further withdrawal, however, the endoscope tip retracts, and the major papilla comes into view. The frenulum may be more readily identified than the papilla and indicates the location of the papilla.



◀ Fig. **108** Endoscopic view of the major papilla (of Vater). The orifice of the papilla is frequently covered by a transverse mucosal fold (hood). The frenulum, a longitudinal fold joining the papilla at its base, is the most important landmark.

Cannulation of the Papilla

A slight upward angulation of the tip of the catheter is desirable to get proper access to the papilla. The catheter tip may need to be molded into this angulation prior to insertion through the instrument channel. The direction for cannulating the biliary and pancreatic ducts depends on the anatomic course of the respective ducts. The bile duct usually descends steeply along the posterior wall of the duodenum and joins the ampullary orifice in the upper left portion of the papilla, whereas the pancreatic duct opens fairly horizontally into the inferior right region (Fig. **109**). Thus, cannulating the bile duct will be vertical to the papilla, and cannulation of the pancreatic duct will be in a horizontal plane.

In approximately 60% of cases, the biliary and pancreatic ducts join at the ampullary orifice to form a short common terminal segment. Superficial insertion of the catheter in the ampullary orifice may thus achieve a simultaneous opacification of the biliary and pancreatic ducts. Both ducts, however, should be cannulated selectively depending upon the indication, to prevent ductal overflow, especially of the pancreatic duct.

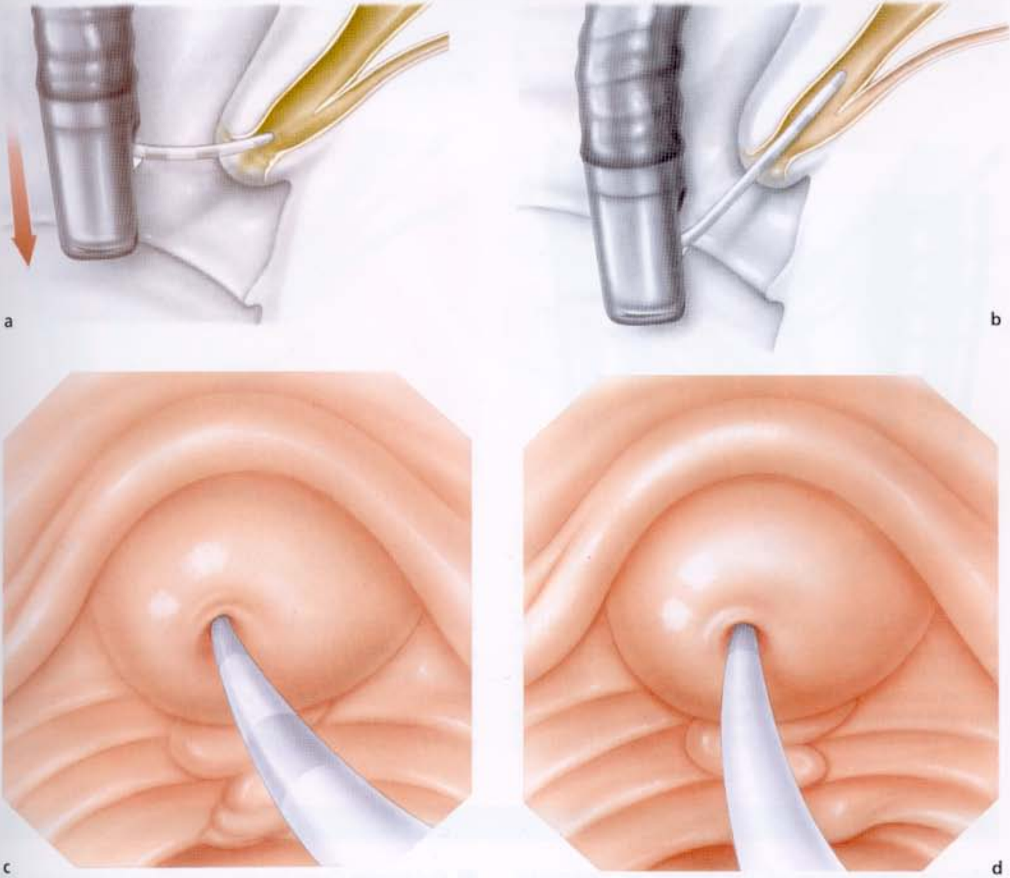


Fig. **109a–d** Bile duct cannulation.

a,**b** The endoscope is positioned close to the ampulla, and the tip of the cannula is wedged at the superior margin of the ampullary orifice in the 11- to 12-o'clock position. Withdrawing the endoscope while applying clockwise rotation may facilitate access to the superior margin. The elevator is initially closed when the cannula is inserted; once the cannula is wedged in the papillary orifice, the elevator is gradually opened to give the cannula a more cranial orientation toward the direction of the bile duct. Flexing the tip of the endoscope toward the papilla, using the up-down wheel, will accentuate this cranial approach. With the catheter firmly engaged in the papilla, the endoscope is slightly pushed with the elevator fully open. The cannula will usually slip into the bile duct with this maneuver.

c,**d** Deep cannulation of the bile duct. Note the caudocranial, tangential approach to the papilla. Contrast medium is injected to confirm bile duct cannulation.

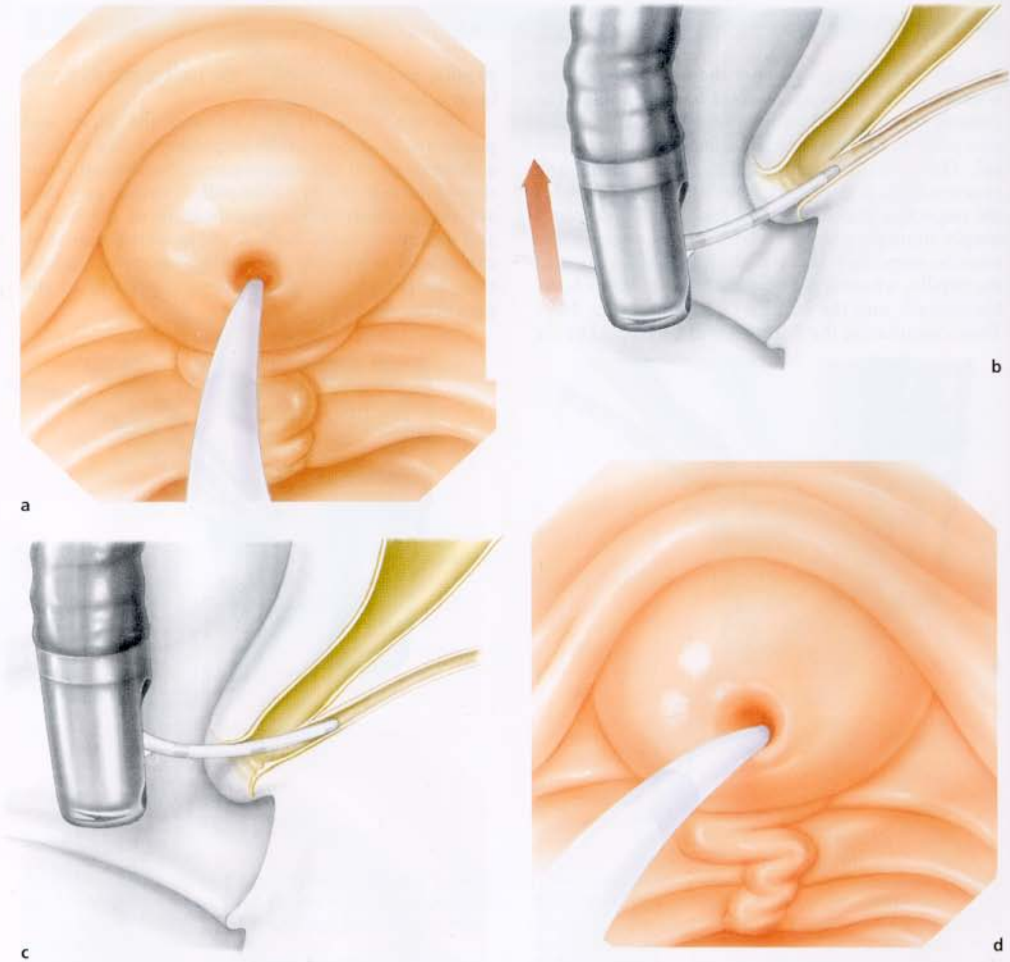


Fig. **110a–d** Pancreatic duct cannulation.
a The cannula is wedged at the middle portion of the papillary orifice, orienting the cannula from left to right.
b,c The endoscope is withdrawn slightly to obtain a more horizontal direction of cannulation.
d The direction of cannulation is adjusted from left to right by using the right-left dial and rotating the endoscope clockwise.

Difficult Cannulation

Selective cannulation of the biliary or pancreatic ducts usually succeeds with standard cannulae. Cannulation may occasionally be difficult, however, and require other instruments and techniques. It is important that the endoscopist not persist too long in attempting cannulation, as this will cause excessive trauma to the papilla. This not only causes edema, making further cannulation attempts more difficult, but also increases the risk of pancreatitis. Cannulation using a guidewire should be the next maneuver of choice as this is less traumatic to the papilla.

Guidewire Cannulation

(Figs. **111, 112**)

A flexible guidewire can be used in conjunction with a wire-guided catheter to achieve selective cannulation. A hydrophilic guidewire, which has a special polymer coating that becomes slippery when wet, should be used for this maneuver. The wire is immersed in water by injecting saline through an outer sheath that houses the wire. Once wet, the hydrophilic guidewire has a low coefficient of friction

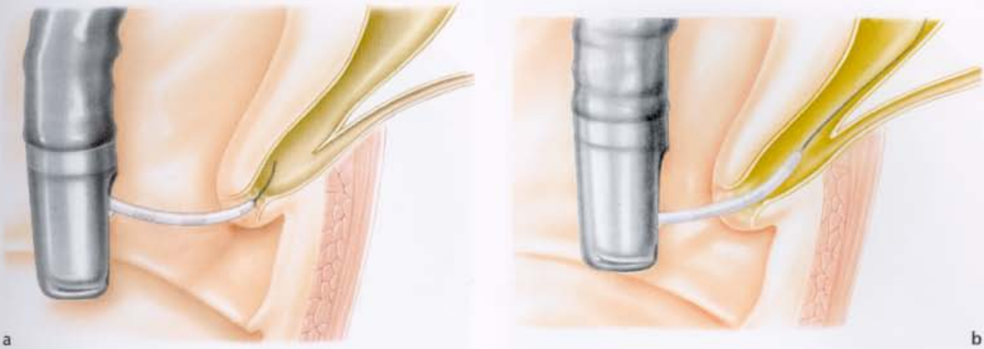


Fig. **111a,b** Guidewire cannulation of the bile duct.
a The hydrophilic guidewire extends several millimeters from the tip of the catheter. The catheter is oriented in the direction of the bile duct. Using to- and fro- movements combined with rotation of the wire, the papillary orifice is cautiously probed until the wire slips into the bile duct.
b Once deep cannulation with the guidewire is achieved, the catheter can be advanced over the wire.

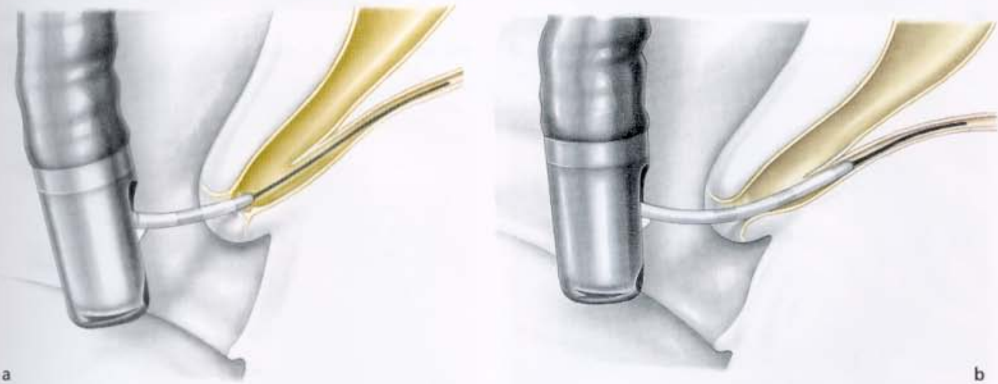


Fig. **112a,b** Guidewire cannulation of the pancreatic duct. Using the same technique, the pancreatic duct can be cannulated with a guidewire by orienting the catheter horizontally in the direction of the pancreatic duct.

and will effectively seek out the ductal path. We use a 0.032-in wire, 260 cm long with a J-shaped tip.

A number of instruments can be used as a delivery catheter for guidewire cannulation: a standard ERCP cannula, the Universal catheter, or a double-lumen wire-guided sphincterotome. The tip of this cannula or sphincterotome should be tapered and appropriately curved to orientate the wire towards the bile duct. A wire-guided sphincterotome has two advantages: angulation of the tip can be adjusted with bending, and a sphincterotomy can immediately follow cannulation.

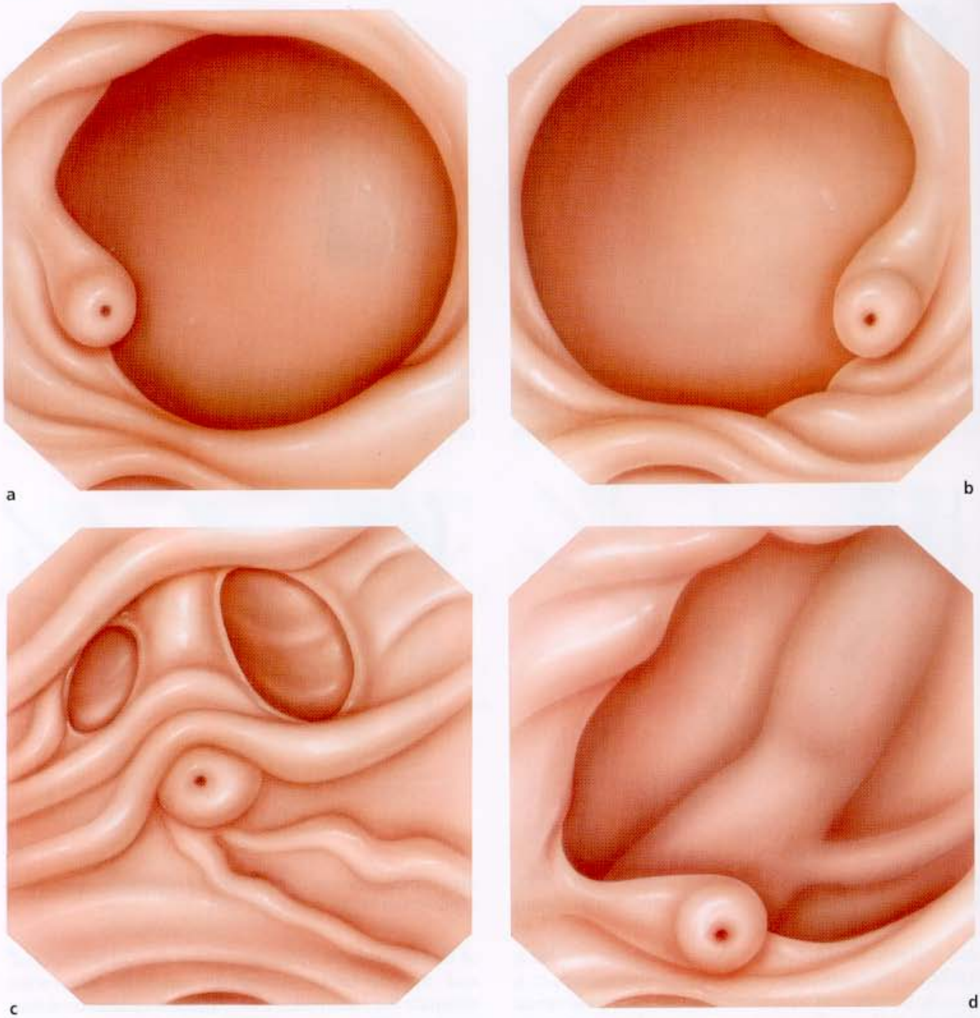
Special Considerations

Juxtapapillary Diverticula

Juxtapapillary duodenal diverticula are frequently found in elderly patients (Fig. **113**). Cannulation is more difficult because the anatomy of the papilla is distorted and the course of the bile duct is displaced by the diverticulum.

If the papilla is located within the diverticulum, several maneuvers may help bring the papilla into a more favorable position. Aspirating air from the diverticular cavity may draw the papilla toward the endoscope tip. Applying abdominal pressure to the right upper quadrant or changing the patient's position (e.g., to the prone position) may also be helpful. If these maneuvers fail, a small depot of saline can be injected into the contralateral (diverticular) side of the papilla to tilt the papillary orifice towards the endoscopist (Fig. **114**).

A large diverticulum will distort the course of the distal common bile duct, hindering deep insertion of the cannula. The direction of cannulation after en-



a b c d

Fig. **113a–d** The location of the papilla relative to a juxtapapillary diverticulum will vary depending on diverticular size, location, and number.

a,b Usually the papilla is located along the outer rim of a large diverticulum, either on the left **(a)**, or the right side **(b)**.
c,d Less commonly, the papilla is located between two small diverticula **(c)**, or within a large diverticulum **(d)**.

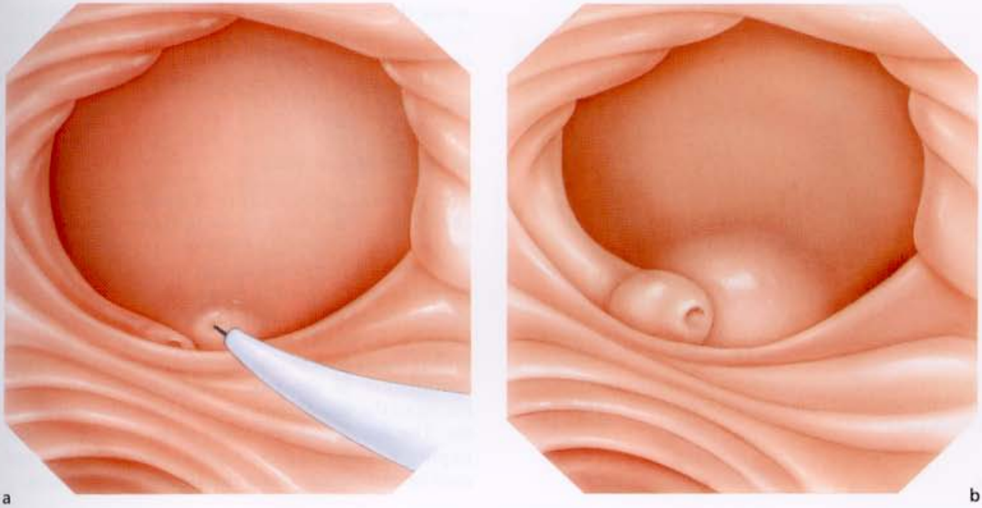


Fig. 114 **a** A small depot of saline is injected into the diverticular side of the papilla.

b The submucosal swelling tilts the papilla out of the diverticulum, improving its accessibility for cannulation.

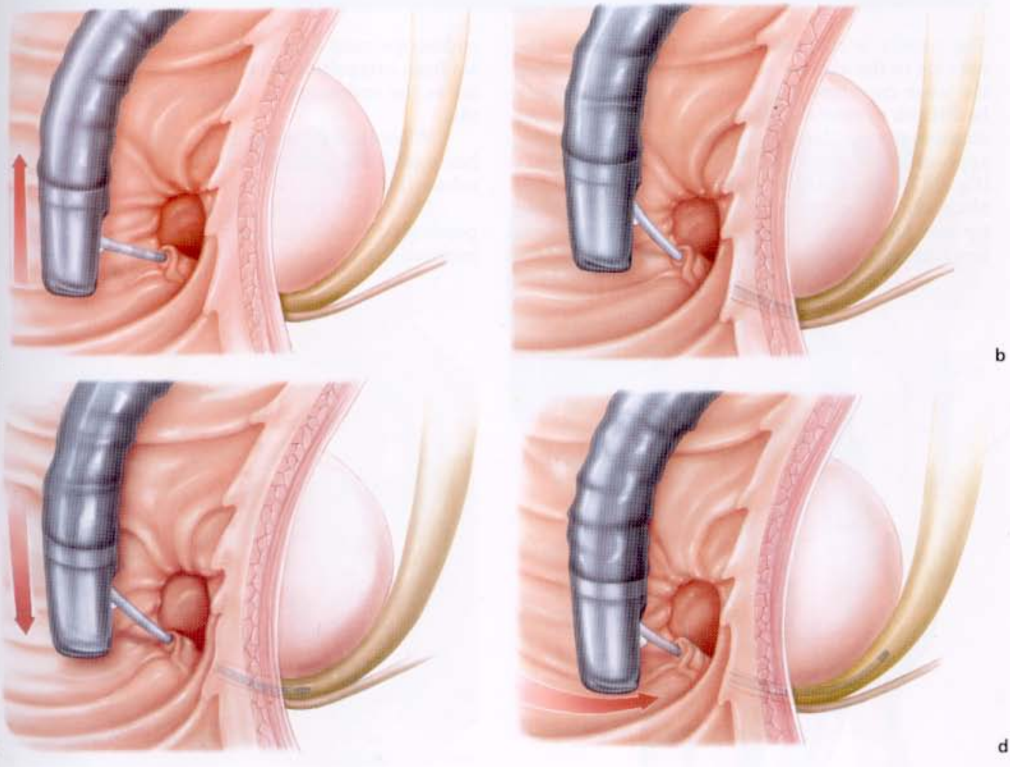


Fig. **115a–d** Cannulation of the bile duct in a patient with a large peripapillary diverticulum.

a,b The papilla is located at the outer rim of a diverticulum. After inserting the tip of the catheter at the 11-o'clock position, the catheter is directed caudally by withdrawing the endoscope slightly.

c,d To achieve deep cannulation, the arched course of the bile duct is followed by first advancing the endoscope, then drawing the endoscope closer to the papilla by using the up-down dial.

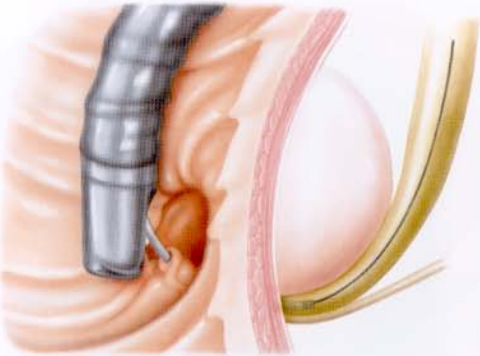


Fig. **116** Use of a hydrophilic guidewire to facilitate deep cannulation of the bile duct in a patient with a large peripapillary diverticulum.

tering the biliary orifice must be altered according to the anatomy of the diverticulum (Fig. **115**). If free cannulation fails, a hydrophilic guidewire can help to establish the path for insertion of a cannula (Fig. **116**)

Billroth II Operation

The patient with a Billroth II operation poses two challenges. The first is reaching the papilla. The second is cannulation in the face of a reversed anatomy.

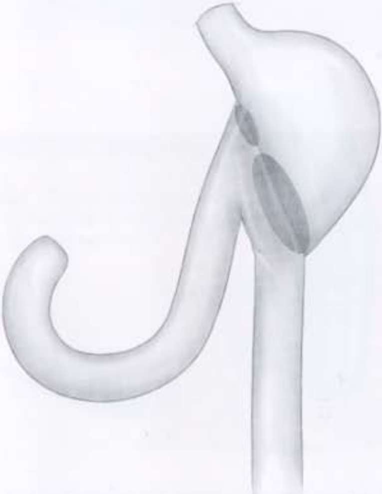
Either a forward-viewing or a side-viewing instrument can be used to access the papilla. Each instrument has advantages and disadvantages. When using a forward-viewing endoscope, the afferent limb is easier to identify, intubate, and negotiate, but cannulation of the papilla may be more difficult owing to the tangential view and the lack of an elevator. The duodenoscope offers an en face view of the papilla, but reaching the papilla is more difficult and may be impossible when the afferent loop is long.

Reaching the Papilla

The papilla is reached via the afferent loop. The opening of the afferent loop is usually located along the lesser curvature of the resected stomach. It may be difficult to enter the afferent loop if the axis of the anastomosis is oblique to the stomach. The opening, appearing as a narrow slit distal to the cardia (Fig. **117**), is entered by advancing the endoscope along the lesser curvature, and then angulating the tip into the opening. Typically, the endoscope tip is first turned to the right, then flexed downward. The endoscope must be advanced slowly to prevent the tip from catapulting back into the stomach. Sucking air as the endoscope is advanced will help prevent this.

When the axis of the anastomotic attachment is horizontal, the afferent loop is usually easy to intubate (Fig. **118**).

The length of the afferent loop may vary depending on whether an antecolic or retrocolic gastrojejunostomy is performed (Fig. **119**). With a retro-



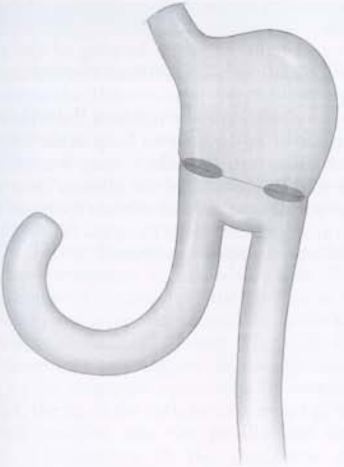
a

b

Fig. **117a,b** Billroth II resected stomach with an oblique attachment of the anastomosis.

a The afferent jejunal loop is joined obliquely to the lesser curvature of the resected stomach.

b The opening appears on the lesser curvature as a narrow slit distal to the cardia.

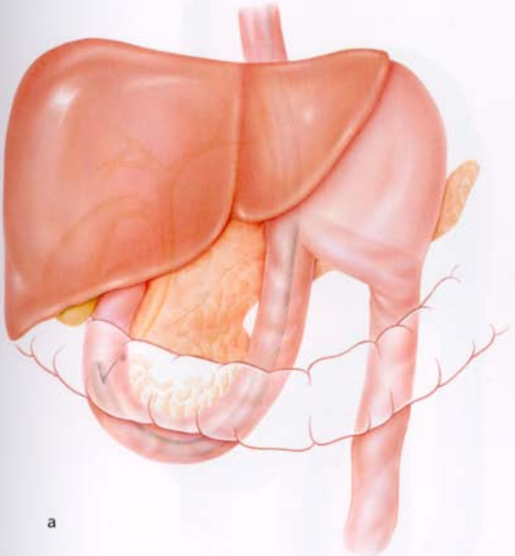


a

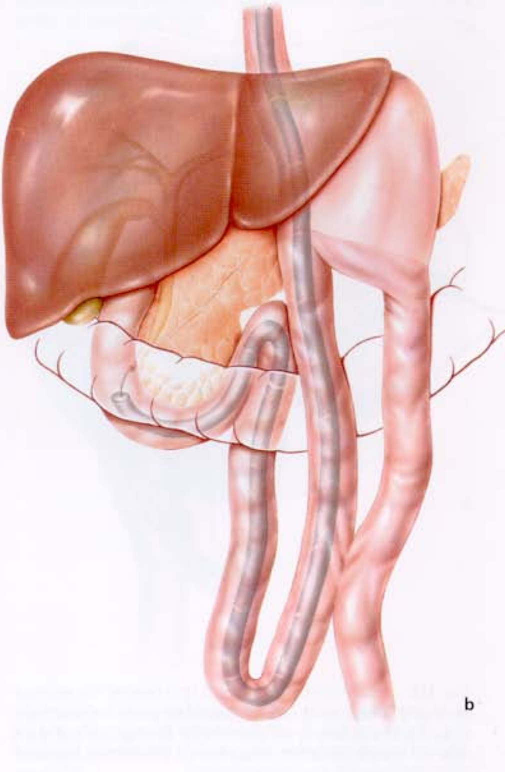
b

Fig. **118a,b** Billroth II resected stomach with a horizontal attachment of the anastomosis.

a The afferent loop is attached horizontally to the lesser curvature of the resected stomach.
b The afferent loop is readily identified on the right side and is easy to intubate.



a



b

Fig. **119a,b**
a Billroth II operation with a retrocolic gastrojejunostomy. The afferent loop is usually short. The papilla can be reached with a forward-viewing gastroscope or a duodenoscope.
b Antecolic gastrojejunostomy with a long afferent limb combined with a jejunojejunostomy. A pediatric colonoscope is usually required to reach the papilla.

colic gastrojejunostomy, the afferent loop is short, whereby with an antecolic gastrojejunostomy, the afferent loop is long and usually combined with a jejunojenunostomy. The jejunojenunal anastomosis is done to divert the bile into the efferent loop. Sorting out the anatomy may be difficult. Usually the endoscopist encounters two luminal openings: the extension of the afferent loop (usually on the right), and the aboral limb of the efferent loop (usually on the left). Occasionally a third lumen is seen, which represents the limb of the efferent loop leading to the stomach. If three luminal openings are seen, the middle opening is usually the extension of the afferent loop.

Occasionally excessive looping of the afferent loop will occur, making it difficult to advance the endoscope beyond the jejunojejunal anastomosis. In this case, one can initially intubate the efferent loop and cross over to the afferent loop at the jejunojejunostomy. This will provide a more horizontal approach to the extension of the afferent loop beyond the jejunojejunostomy. The efferent loop can also be used as an alternative route to access the papilla if the afferent loop cannot be intubated.

Fig. **120** Intubation of the afferent limb beyond the jejunojejunal anastomosis may fail because of an acute angle or looping. The endoscope is withdrawn into the stomach, and the efferent loop is intubated. Intubation of the afferent loop is reattempted via the jejunojejunostomy.

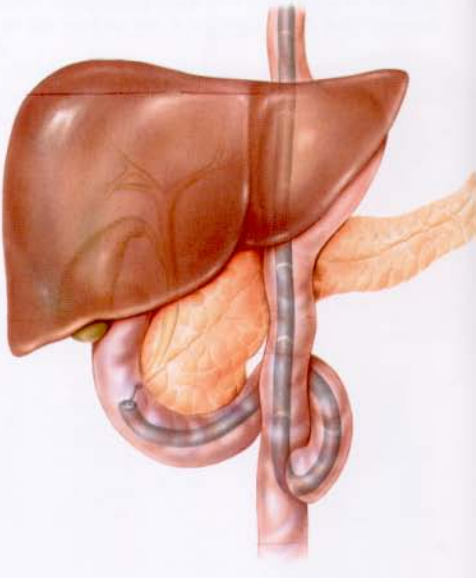


Fig. **121** Roux-en Y anastomosis. The anatomy resembles that of an antecolic gastrojejunostomy combined with a jejunojejunostomy.

Cannulation Technique

Because the endoscope approaches the papilla from below instead of from above, the papillary anatomy in the Billroth II patient will be reversed. The cannulation technique must therefore be modified accordingly. This will vary depending on whether a duodenoscope or forward-viewing endoscope is used. It is advisable to use a new catheter without any curvature at the tip.

The forward-viewing endoscope or duodenoscope has advantages and disadvantages. With the forward-viewing endoscope, the papilla is viewed tangentially and is therefore more difficult to access—particularly without an elevator (Fig. 122). If accessible, however, cannulation is usually successful owing to the tangential approach. To cannulate the bile duct, the tip of the catheter is inserted at the 5- to 6-o'clock position into the papilla and then advanced. Cannulation of the pancreatic duct is achieved by inserting the catheter at the 11-o'clock position and aiming the catheter upwards with a right-to-left orientation. The bile duct is usually easier to cannulate than the pancreatic duct as the catheter is automatically directed in the axis of the bile duct.

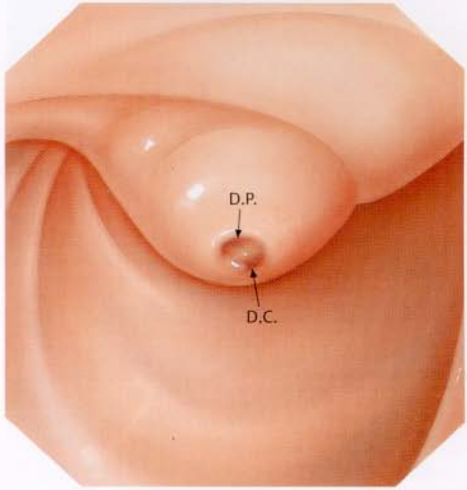
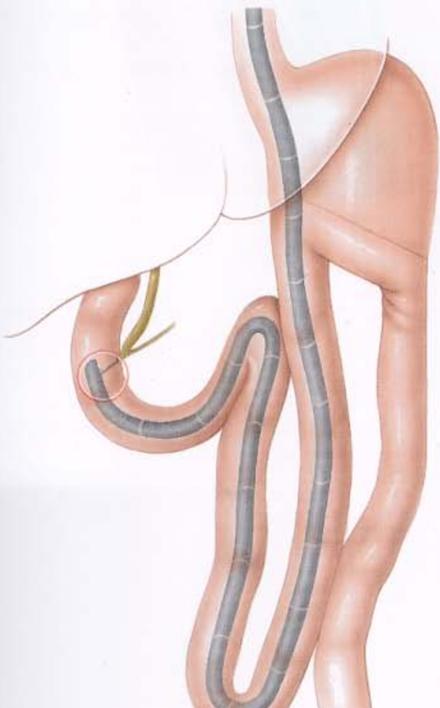


Fig. **122** View of the papilla in the Billroth II patient using the forward-viewing endoscope. D.C. = orifice of bile duct; D.P. = orifice of pancreatic duct.



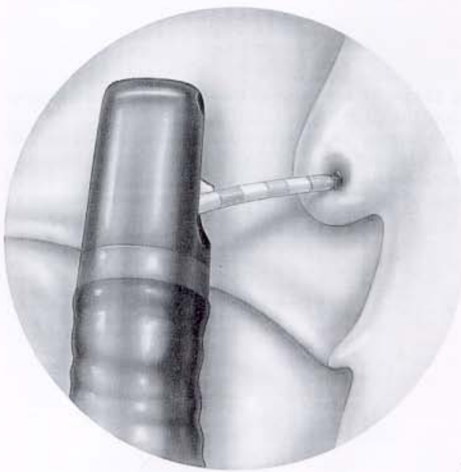


Fig. **123a,b** Using the duodenoscope, the papilla is seen en face, but the cannula approaches the papilla at a perpendicular angle and therefore predisposes to cannulation of the pancreatic duct.

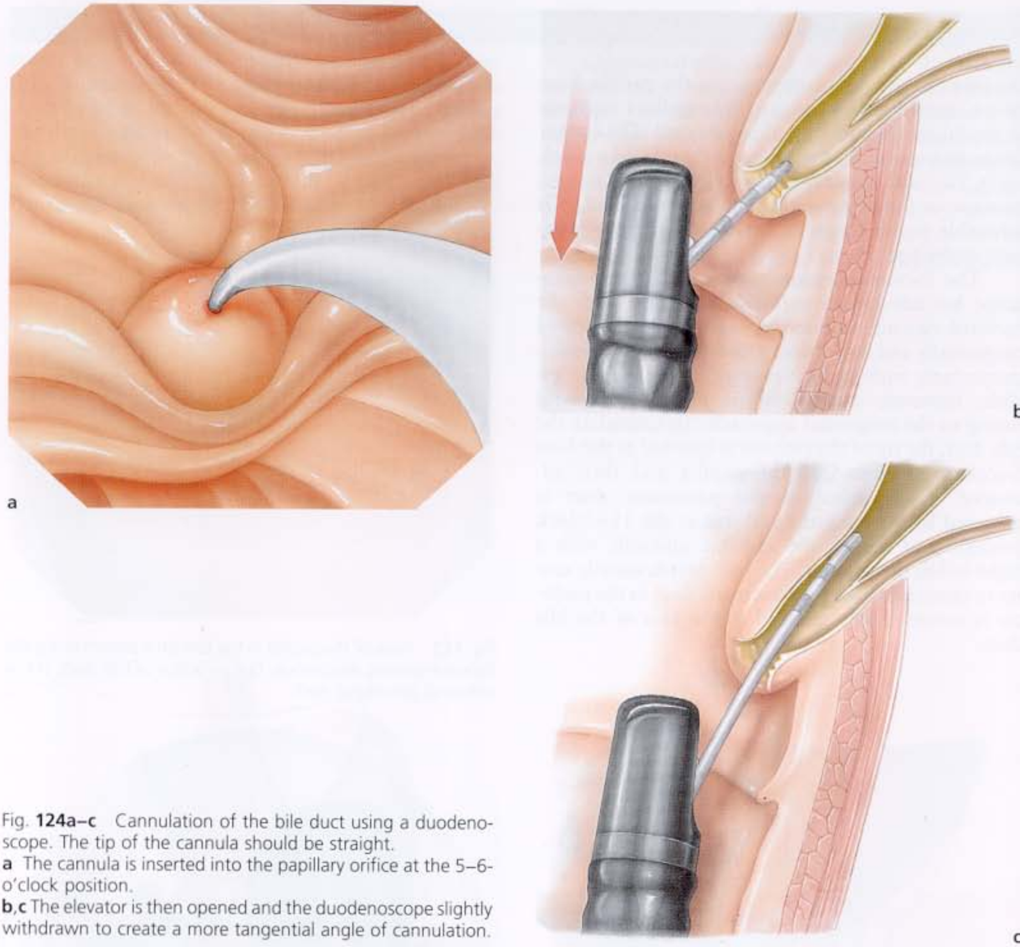


Fig. **124a–c** Cannulation of the bile duct using a duodenoscope. The tip of the cannula should be straight.
a The cannula is inserted into the papillary orifice at the 5–6-o'clock position.
b,c The elevator is then opened and the duodenoscope slightly withdrawn to create a more tangential angle of cannulation.

■ Complications

Acute pancreatitis is the most common complication of ERCP. Clinical symptoms and signs are usually evident within 24 hours of the procedure. The major cause is trauma to the pancreatic duct following repeated attempts at cannulation or excessive filling of the pancreatic duct with contrast medium (acinarization). Occasionally simple edema of the papilla is enough to induce pancreatitis.

9

Sphincterotomy

General

Endoscopic sphincterotomy aims at opening the terminal part of the common bile duct or pancreatic duct by incising the papilla and the distal portion of the sphincter of Oddi. It is usually done as a preliminary step before performing therapeutic biliary and pancreatic procedures. In most cases, an incomplete incision of the sphincter muscles is sufficient, and thus the sphincter mechanism of the biliary and pancreatic ducts can be partially preserved.

Indications

The main indication for a sphincterotomy is for the removal of biliary or pancreatic duct stones. Balloon dilatation may be adequate for the removal of small stones (5 mm), but this approach is not necessarily safer than a small sphincterotomy. A less common indication for sphincterotomy is for the treatment of benign papillary stenosis. Rarely, incision of the minor papilla may be indicated in a patient with pancreas divisum.

Sphincterotomy is often performed prior to the insertion of catheters and/or biliary or pancreatic stents. The sphincterotomy facilitates stent insertion (and reinsertion in the event that stent exchange is necessary), particularly if a second stent or the additional placement of a nasoductal catheter is required.

Sphincterotomy is usually therapeutic in nature, but it may also serve a diagnostic purpose. An example is the insertion of a miniscope into the biliary or pancreatic ducts for direct visualization of the duct from within.

Prerequisites

The endoscopist should be accomplished in the basic cannulation technique before embarking on a sphincterotomy. As selective cannulation is a prerequisite for sphincterotomy, it is desirable that the endoscopist should also be skilled in the use of the precut technique to achieve selective cannulation. Precutting should be judiciously implemented to avoid repeated failed attempts at cannulation that can increase the risk of ERCP-induced pancreatitis.

A variety of sphincterotomes are required for a flexible approach tailored to the needs of the endoscopist. The technical settings as well as the condition of the equipment should be checked prior to each procedure. Sphincterotomy should be performed with a pure cutting current, usually at a setting of 3 to 4 (approximately 30–40 Watts). Some endoscopists add coagulation current to prevent postsphincterotomy bleeding, but our experience has been that the use of a pure cutting current enables a cleaner cut without increased risk of bleeding. Coagulation current is likely to cause tissue edema, which increases the risk of postprocedure pancreatitis.

Instruments

An assortment of sphincterotomes are available with different lengths of cutting wire and papillotome tip (Fig. 125). We prefer to use a sphincterotome with a short tip of 1 mm and a short cutting wire of 10–15 mm.

Fig. **125** Assortment of sphincterotomes.
- **a** Standard Erlangen model
- **b** Precut model
- **c** Long-nosed sphincterotome
- **d** Double-lumen over-the-guidewire sphincterotome
- **e** needle-knife sphincterotome
- **f** Billroth II sphincterotome
- **g** Double-lumen over-the-guidewire Billroth II sphincterotome

Fig. **126a–c** Manual molding of a new sphincterotome.
a The tip of a new sphincterotome is straight.
b The tip is bent cephalad.
c For cannulation of the bile duct the tip is twisted to the left to orient the cutting wire toward the 11- to 12-o'clock position.

Because the tip of any new sphincterotome is usually straight, it is helpful to manually mold or shape the tip according to the orientation of the duct to be cannulated. To cannulate the bile duct, the tip is curved cephalad with a slight deviation to the left so that the cutting wire is in the 11- to 12-o'clock position (Fig. 126). The exception is in the patient with a Billroth II operation where it is better to leave the sphincterotome straight to accommodate the reversed anatomy.

Technique

Bile Duct Sphincterotomy

Following deep bile duct cannulation, the position of the sphincterotome is confirmed by injecting contrast medium. The sphincterotome is then slowly retracted until approximately half of the wire length is exposed outside the papilla (Fig. 127). The cut is made by using the elevator to gently lift the sphincterotome against the papillary roof while applying short bursts of current. To maintain the 11-o'clock cutting direction, the endoscope may need to be slightly torqued in the anticlockwise direction.

Some endoscopists bend the sphincterotome to establish contact between the cutting wire and the papillary roof. Excessive bending should, however, be avoided to prevent a sudden zipper cut. The key to minimizing complications is to perform the sphincterotomy in a cautious and graduated manner. The length of the incision should be tailored to the indication of the sphincterotomy. A small incision (up to 1 cm) is usually adequate for insertion of stents, whereas stone extraction may require a larger incision.

The transverse duodenal fold at the upper margin of the papilla is generally considered to be the limit for the upper extent of the sphincterotomy. However, this may not always correlate with the upper margin of the intraduodenal portion of the bile duct. It is necessary to consider the papillary size and bile duct diameter when judging the maximal limits of the sphincterotomy. Particular caution is necessary when the papilla is small and the bile duct caliber is narrow, or when a juxtapapillary diverticulum is present (Fig. 128).

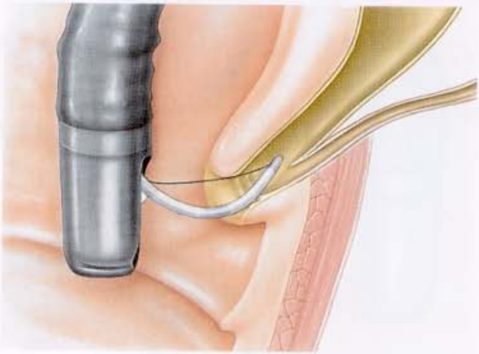
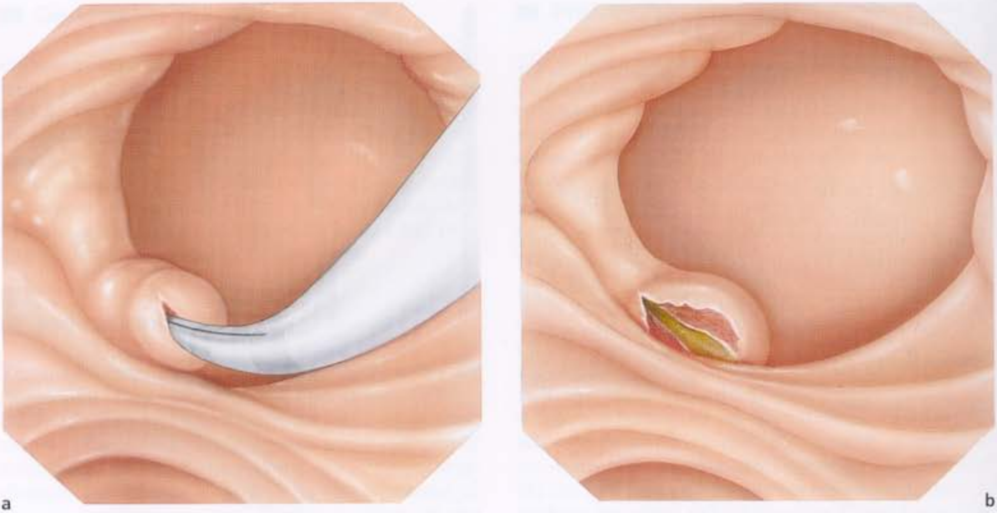


Fig. **127** Sphincterotomy is performed when approximately half the wire length is exposed outside the papilla.

Cannulation of the Bile Duct with the Sphincterotome

If sphincterotomy is indicated, the bile duct can be cannulated from the very start with a sphincterotome (Fig. 129). Selective cannulation of the bile duct is sometimes easier as the sphincterotome can be bent toward the axis of the bile duct. If free cannulation with the sphincterotome fails, a double-lumen sphincterotome that accommodates a guidewire (cannulotome) can be used to attempt cannulation with a hydrophilic guidewire.

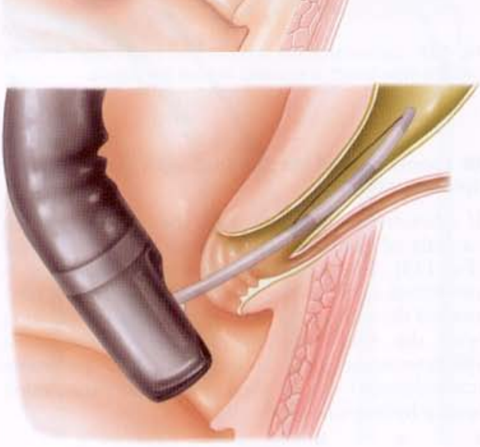


a b

Fig. **128a,b** Sphincterotomy in the presence of a juxtapapillary diverticulum.
a The sphincterotome is directed along the intraduodenal course of the bile duct away from the diverticulum.
b The length of the mucosal incision tends to appear smaller than the actual extent of the sphincterotomy. The sphincterotomy should therefore be extended in a very gradual manner, cutting only 2–3 mm at a time.

a

b



c

Fig. **129a–c** Cannulation of the bile duct with the sphincterotome.
a The tip of the sphincterotome is inserted at the 11-o'clock position in the papilla. The elevator is kept closed.
b The sphincterotome is bent to accentuate the cranial orientation of the tip. The endoscope is then advanced slightly while opening the elevator to approach the papilla more tangentially from below.
c The tip of the sphincterotome slips into the bile duct. The sphincterotome is advanced into the bile duct by bringing the endoscope tip closer to the papilla using the up-down wheel.

Over-the-Guidewire Sphincterotomy

If the biliary or pancreatic duct is cannulated with a standard ERCP cannula, a Teflon-coated guidewire (400 cm long, 0.035 in) can be inserted through the cannula to establish a path across the papillary orifice. The catheter can then be replaced with a sphincterotome that accommodates a guidewire. The guidewire is removed from the sphincterotome just prior to performing the sphincterotomy. Use of a sphincterotome with a long nose will prevent the sphincterotome from slipping out of the bile duct after the guidewire is removed (Fig. **130**). Alternatively, if an insulated guidewire or a double-lumen sphincterotome is used, the guidewire can be left in position during the sphincterotomy (Fig. **131**).

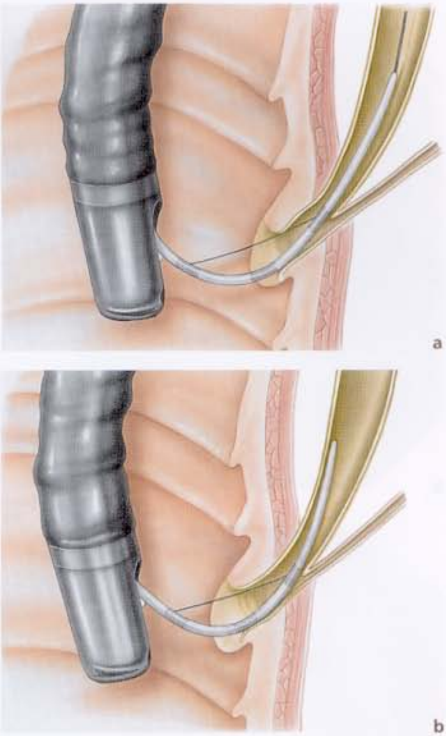


Fig. **130a,b**
a A long-nosed sphinctertome is fed over a guidewire that was previously inserted through a cannulating catheter.
b After the guidewire is removed, the sphincterotome remains anchored in the duct.

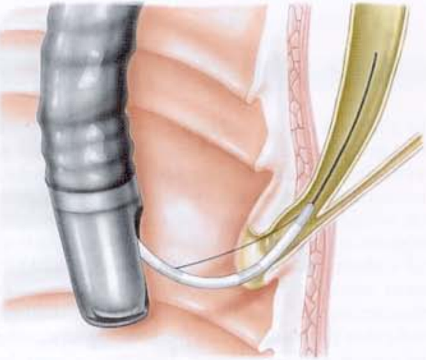


Fig. **131** Double-lumen sphincterotome that enables sphincterotomy with the guidewire in place.

a

b

c

Fig. **132a–g** Technique of precutting for selective cannulation of the bile duct.

a The tip of the sphinctertome is first positioned at the papillary porus, taking care not to cannulate the pancreatic duct orifice. Deep insertion of the sphincterotome will risk injury to the pancreatic duct and pancreatitis.

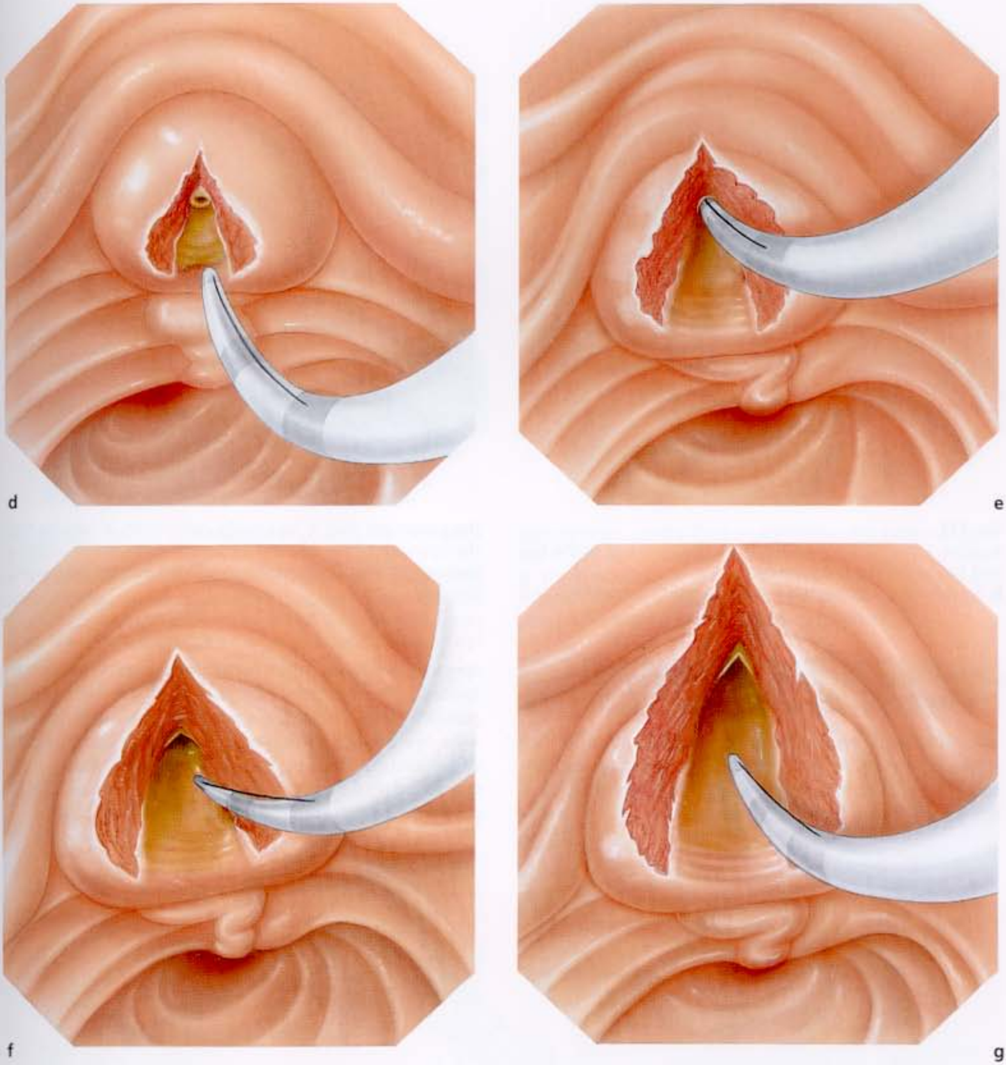
b The sphincterotome is maneuvered to incise the papillary roof in the 11-o'clock position using a pure cutting current. Care is taken to avoid excessive coagulation of tissue as this causes edema that obscures anatomic landmarks. Edema also increases the risk of pancreatitis. Short bursts of current are applied while the sphincterotome is moved.

c After the roof is incised, it typically retracts, thus exposing the underlying submucosal tissue layer. This layer is incised until the salmon-pink opening of the bile duct is recognized. Bile may be seen to flow from the orifice on gentle suction.

Fig. **132d–g** ▶

Precut Technique

The goal of a precut technique is to open the roof of the papilla in order to expose the biliary or pancreatic ductal orifice for selective ductal cannulation. This maneuver is necessary when selective cannulation would otherwise fail. A special precut sphincterotome is used, which has only a 1-mm leading tip and a short (10–15 mm) cutting wire (Fig. 132). A precut can also be performed with a needle-knife sphincterotome, which consists of a diathermic needle that protrudes 5 mm from the tip of a catheter. The precut sphincterotome, however, allows for a more precise incision because the direction, length, and depth of the incision are easier to control.



d The bile duct sphincter is usually recognized as a whiteish longitudinal bulge extending cranially from the orifice.
e Targeted cannulation of the bile duct with the same sphincterotome.
f A sphincterotomy follows selective cannulation.
g Completed bile duct sphincterotomy.

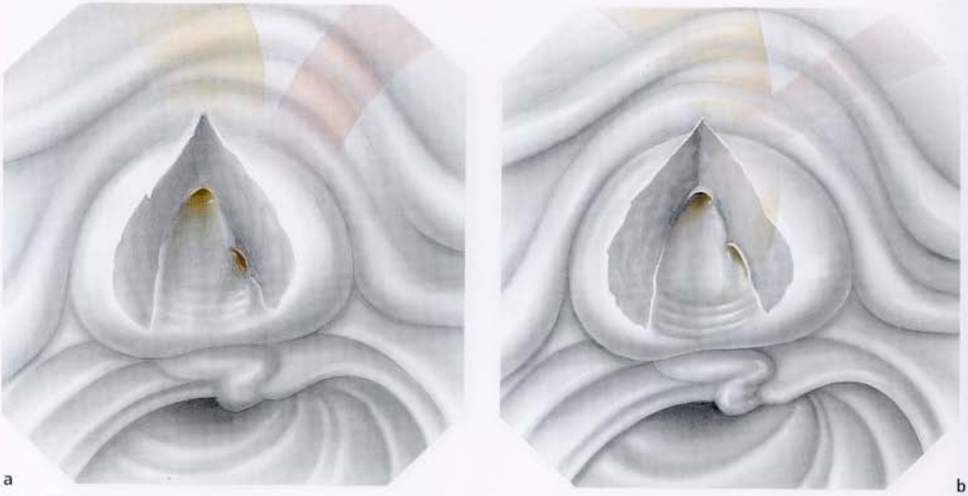


Fig. **133**
a After a complete sphincterotomy, the openings of the bile and pancreatic ducts are exposed.
b If cannulation of the bile duct fails despite precutting, or if the pancreatic duct is repeatedly cannulated, it may be that the openings of the bile and pancreatic ducts are located in a reversed position. The precut should then be oriented towards the right.

Sphincterotomy in the Billroth II Resected Stomach

The standard sphincterotome is not suitable for sphincterotomy in the Billroth II patient as the cutting wire will be directed toward the posterior wall of the duodenum. It is therefore necessary to use a special push-type sphincterotome designed to accommodate the reversed anatomy of the Billroth II patient. This sphincterotome has a convex cutting wire oriented in the reverse position of the standard sphincterotome (Fig. **134**). When the wire is retracted, the catheter is straight. A precut can also be performed with this sphincterotome (Fig. **136**).

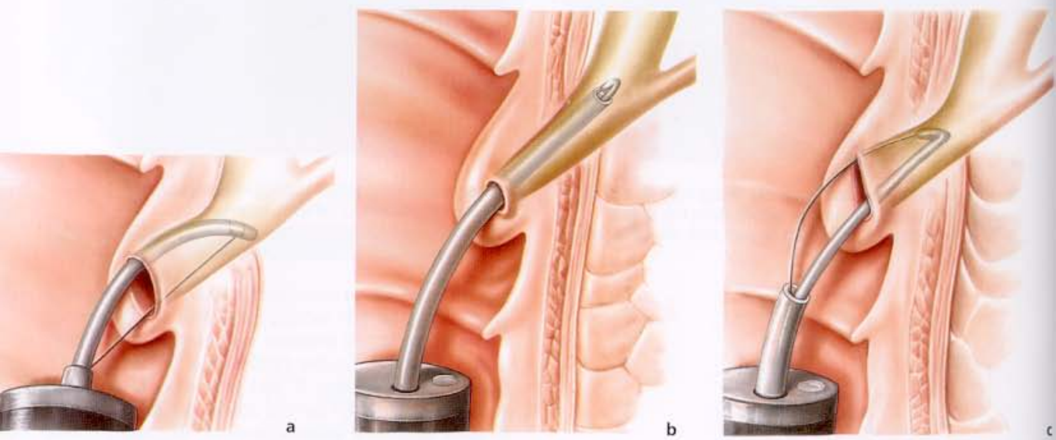


Fig. **134a–c** Billroth II sphincterotomy using a forward-viewing endoscope.
a Using a standard Erlangen sphincterotome, a sphincterotomy in the Billroth II patient is directed toward the posterior wall of the duodenum rather than toward the bile duct.
b,c The Billroth II sphincterotome is constructed so that the convex side of the instrument is used for cutting. The wire will align toward the duodenal lumen along the more compliant anterior wall in the 5-o'clock position. The bile duct is cannulated with the wire retracted within the sphincterotome sheath. Contrast can be injected through the catheter to confirm bile duct cannulation. To perform the sphincterotomy, the cutting wire is pushed out of the catheter sheath. Approximately half of the cutting wire is exposed outside of the papilla prior to performing sphincterotomy.

b

Fig. **135a**,**b** Billroth II sphincterotomy using the duodenoscope.

a A straight-tipped sphincterotome is easier to insert into the bile duct. After a deep selective bile duct cannulation, the cutting wire is pushed out from the sheath and the sphincterotome retracted until at least half of the cutting wire is seen outside of the papilla. Care is taken to prevent excessive bending of the wire as this may result in a sudden zipper incision.

b The bent wire will align itself along the intraduodenal segment in the 5-o'clock position. The incision is performed in progressive steps using short bursts of current.

a

b

Fig. **136a**,**b** Precutting with the Billroth II sphincterotome (using a duodenoscope).

a The cutting wire is pushed out approximately 10 mm from the sphincterotome sheath. The papillary roof is progressively incised along the 5-o'clock position until the bile duct epithelium is identified.

b The bile duct can be immediately cannulated with the same instrument, followed by a sphincterotomy.

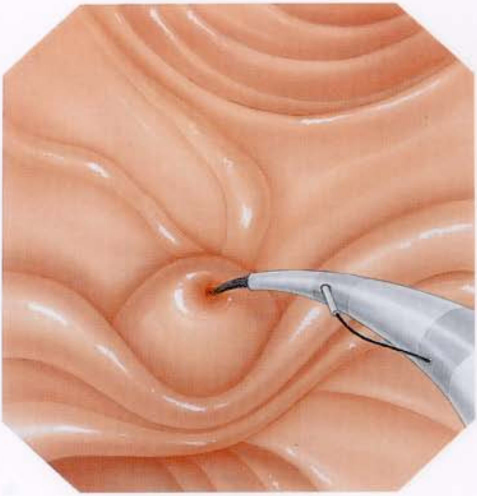


Fig. **137** A double-lumen Billroth II sphincterotome that accommodates a guidewire can be used when free cannulation with the sphincterotome fails. A polymer-coated guidewire is inserted into the desired duct, following which the sphincterotome is fed over the guidewire.

Fig. **138** An alternative approach to performing sphincterotomy is to use the needle-knife sphincterotome after inserting a 7-French stent in the duct. The stent serves as a guiderail for making the incision in the 5-o'clock position.

Pancreatic Sphincterotomy

Sphincterotomy of the Major Papilla

Pancreatic sphincterotomy is performed in a similar manner to biliary sphincterotomy. Because the intramural segment of the pancreatic duct is shorter than that of the bile duct, the risk of perforation with pancreatic sphincterotomy is inherently higher. To minimize this risk, the incision should not exceed 10 mm. No more than 5 mm of the cutting wire should be inserted into the pancreatic duct when performing the sphincterotomy. The wire is oriented in the 1- to 2-o'clock position (Fig. **139**).

As a rule, pancreatic duct cannulation can be performed from the onset with the sphincterotome. If selective pancreatic duct cannulation fails, however, a preliminary biliary sphincterotomy may help to identify the pancreatic duct orifice. This is typically located slightly caudal and to the right of the bile duct orifice (Fig. **140**). In less than 5% of cases, however, the positions of the pancreatic and biliary ducts orifices will be reversed (Fig. **141**).

a

Fig. **139a–c** Pancreatic sphincterotomy performed after the pancreatic duct is cannulated. The cutting wire of the sphincterotome is oriented in the 1- to 2-o'clock position to accommodate the anatomical course of the pancreatic duct. The incision is made in millimeter increments up to a length of about 10 mm.

Sphincterotomy of the Minor Papilla

Pancreas divisum occurs in approximately 5% of the general population. The main pancreatic duct drains through Santorini's duct into the minor papilla.

Cannulation of the minor papilla can be challenging owing to its small size. Special cannulae such as the blunt needle-tipped cannula should be used for diagnostic pancreatography (Fig. **106h**). Precise

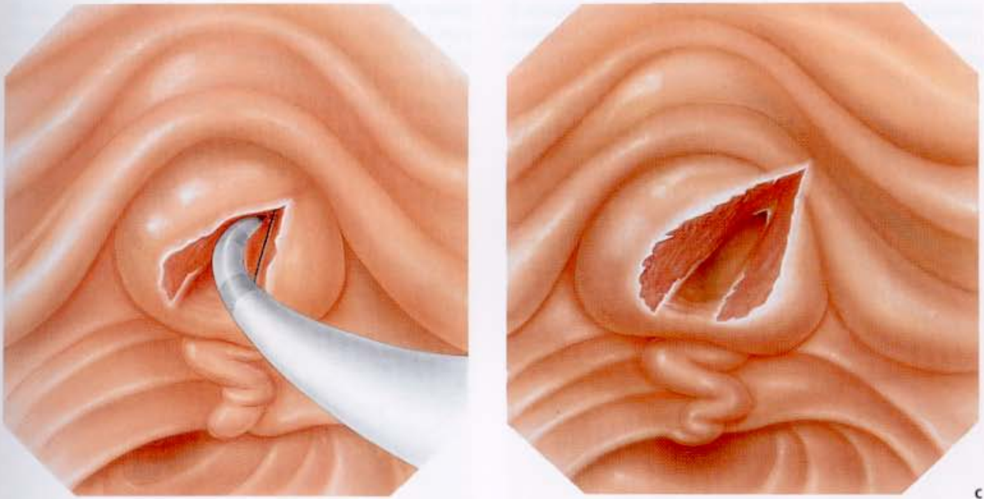


Fig. **139b** and **c**

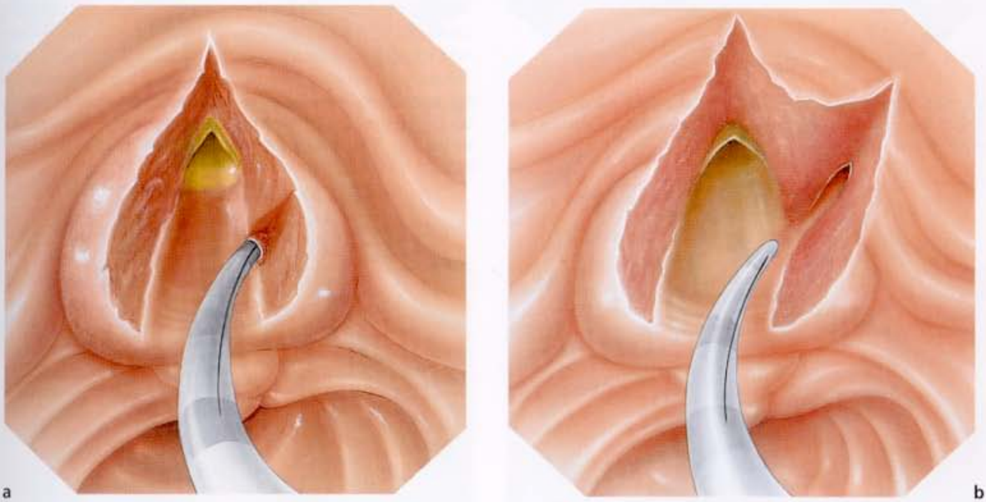


Fig. **140a,b** Pancreatic sphincterotomy following preliminary biliary sphincterotomy.
a After the biliary sphincter has been opened, the pancreatic-duct orifice is readily identified caudal and slightly to the right of the bile duct orifice. The pancreatic duct is selectively cannulated with the sphincterotome.
b Note the divergent courses of the bile and pancreatic ducts after the pancreatic sphincterotomy.

identification of the ductal orifice is mandatory to achieve a high success rate. Intravenous administration of secretin prior to cannulation will stimulate pancreatic-juice flow from the minor papilla and can help in identifying the orifice.

Sphincterotomy of the minor papilla is a delicate procedure that is best performed after preliminary placement of a guidewire. Using a catheter with a tapered tip to position the guidewire at the orifice of the minor papilla, Santorini's duct is first cannulated with a fine hydrophilic guidewire (0.028 or 0.032 in with an angulated tip). The wire is advanced under fluoroscopic control into the main pancreatic duct using a combination of to-and-fro and twirling movement of the wire. The catheter is then inserted into the pancreatic duct, and the hydrophilic guidewire is exchanged for a conventional 0.032-in Teflon-coated wire.

Sphincterotomy of the minor papilla can be performed using a one-step or two-step approach. Using the one-step approach, a double-lumen sphinctero-tome with a short cutting wire (10 mm lomg) is advanced over a previously inserted guidewire and a 2- to 3-mm incision made (Fig. **142**). Using the two-step approach, a 5- or 7-French stent (5 cm long) is first inserted over the guidewire. The sphincterotomy is performed at a second session with the needle knife, using the stent as a guiderail for the incision. The lat-

Fig. **141** Endoscopic view of the major and minor papilla. The minor papilla is located 2–4 cm cephalad to and to the right of the major papilla.

Fig. **142** Sphincterotomy of the minor papilla using a double-lumen sphincterotome. The sphincterotome is inserted over a previously inserted guidewire. The length of the incision should not exceed 2–3 mm.

a

b

Fig. **143a,b**

a A 7-French stent has been inserted over the guidewire into Santorini's duct.

b Sphincterotomy of the minor papilla is performed over the stent using the needle knife.

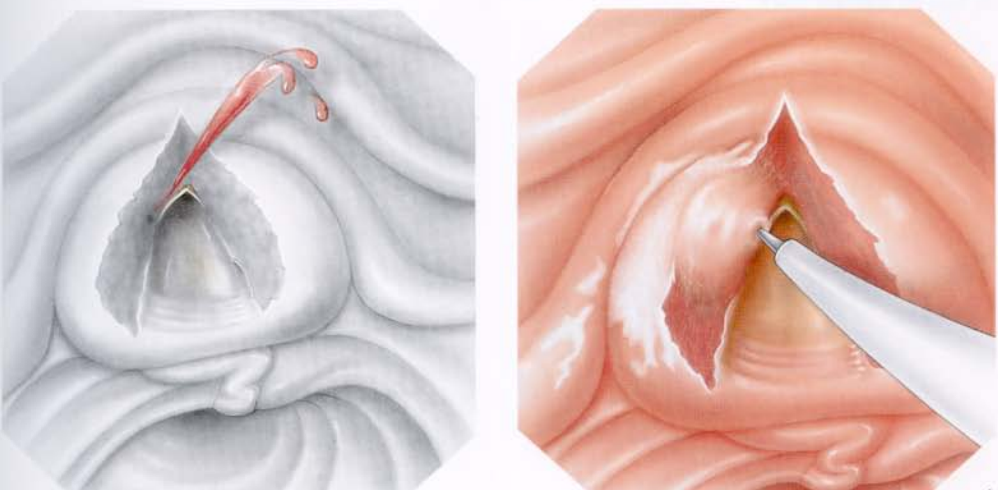
ter approach has the advantage that the indication for sphincterotomy can be determined by the therapeutic response to stent drainage alone. After the sphincterotomy, the stent can be left in place for several days with a view of minimizing the risk of postprocedure pancreatitis.

■ Complications

The most common complication of sphincterotomy is acute pancreatitis. The risk can be minimized by a cautious cannulation technique. Repeated attempts at failed cannulation should be avoided (see Chapter 8, ERCP). Judicious and timely use of precutting can help to achieve selective cannulation

Perforation is the most serious complication, usually caused by a zipper cut that is uncontrolled and too long. Anatomic factors may predispose to perforation: a small papilla, juxtapapillary diverticula, intradiverticular papilla, narrow duct, and the Billroth II operation. Perforation is usually retroperitoneal. An early clinical sign may be crepitus in the right inguinal region due to the downward spread of retroperitoneal air along the psoas muscle. Retroperitoneal air can usually be readily identified on fluoroscopy, enabling early recognition of this complication. A stent or a nasobiliary catheter should be placed if this can be done quickly with relative ease. Retained air and fluid should be aspirated from the duodenum and stomach before removing the endoscope. Most perforations respond to conservative management with systemic antibiotics, nasogastric suction, and parenteral nutrition. Surgery is indicated only if the patient develops signs of peritonitis.

Postsphincterotomy bleeding is usually self-limiting and does not require intervention. Severe bleeding may result from an incision that is too long or wrongly oriented. If bleeding is severe or persistent, hemostasis can be achieved by injecting diluted epinephrine (1:20 000 concentration) submucosally along the incisional margins (Fig. **144**). Hemostasis is usually definitive. If bleeding is arterial, vessel ligation with a hemoclip can achieve a more permanent hemostasis (Fig. **145**) (see also Chapter 6, Hemostasis).



a b

Fig. **144** Spurting arterial bleed following sphincterotomy.
a The point of bleeding is identified at the left upper margin of the incision.
b Hemostasis is achieved after injection of epinephrine, diluted 1:20 000, submucosally along the margin of the spincterotomy cut. Hemostasis is due to a tamponade effect of the submucosal depot, combined with the vasoconstrictive effect of epinephrine. Caution must be exercised that the region of the pancreatic orifice is not injected.

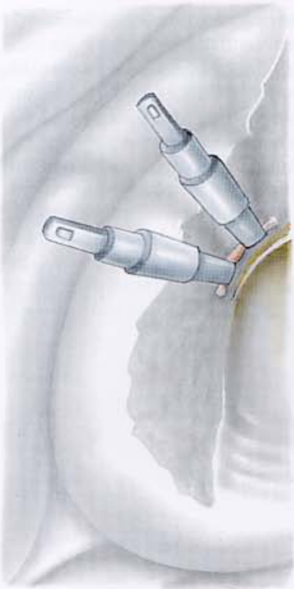


Fig. **145** Hemostasis of a postsphincterotomy bleed by placement of two hemoclips. The bleeding vessel is mechanically clipped. It is important to note that, because of the raised elevator, the angulation of the applicator device can impede advancement and opening of the clip through the sheath. Hence, the clip has to be advanced and opened with the elevator fully open; this is usually a blind maneuver because the applicator leaves the field of endoscopic vision. Thereafter the elevator can be raised to position the clip. After the clip is closed, the elevator needs to be lowered again to dislodge the clip from the applicator device.

10

Biliary Stone Extraction

General

The endoscopic approach has largely replaced surgical exploration of the common bile duct. It is the treatment of choice for retained or recurrent stones after cholecystectomy, and it is an acceptable treatment in patients with a gallbladder in situ. The risks associated with endoscopic treatment carried out by an experienced team are lower than those associated with surgical exploration of the common bile duct.

Indications

An impacted stone at the papilla or in the common bile duct causing acute biliary obstruction is an indication for emergency endoscopic therapy. In the elective setting, the indications for endoscopic versus surgical treatment depend on a number of factors: the skill and experience of the endoscopist, the age and general condition of the patient, and whether associated cholecystolithiasis is present.

Prerequisites

Endoscopic stone extraction is usually preceded by a sphincterotomy. The endoscopist may be confronted with unexpected problems such as stone impaction or a broken basket; appropriate equipment and experience with lithotripsy and ductal decompression techniques are necessary to resolve these problems.

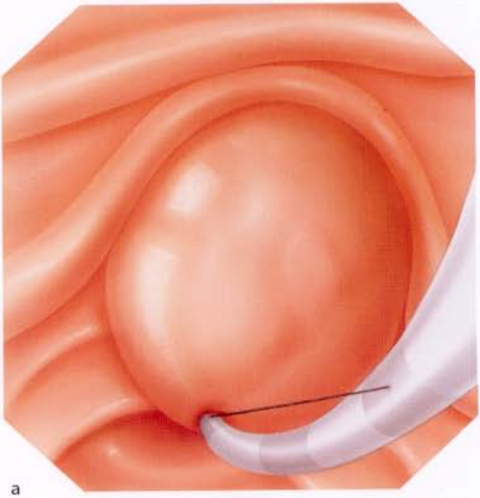
Instruments

Basic instruments for stone extraction include a balloon-tip catheter and Dormia basket. A mechanical lithotriptor is an essential piece of equipment; it will be required on an emergent basis if both the stone and basket become impacted in the bile duct. Sophisticated equipment for intraductal lithotripsy is desirable, but unfortunately it is expensive. A stent or nasobiliary catheter is required in the event of unsuccesful or incomplete stone extraction to prevent cholangitis.

Technique

Impacted Stone at the Papilla of Vater

Stone impaction at the papilla commonly presents as a medical emergency. Impaction leads to acute pancreatitis and/or obstructive jaundice, often associated with cholangitis. Sphincterotomy alone is therapeutic as the stone spontaneously dislodges from the incised papilla. Either the precut sphincterotome (Fig. **146**) or the needle knife (Fig. **147**) can be used. The incision is begun at the orifice and directed over the stone.



a

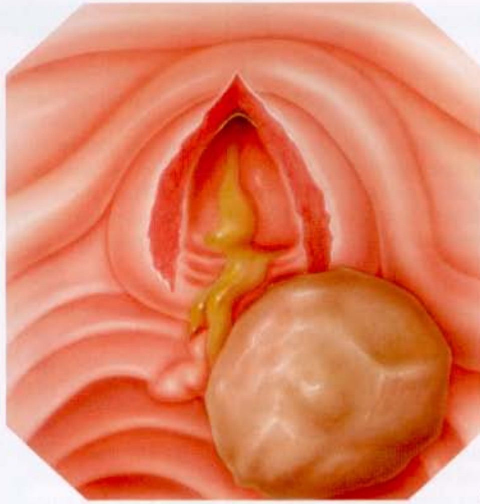
b

Fig. **146a–d** Use of the precut sphincterotome to free an impacted stone at the papilla.
a The tip of the sphincterotome is positioned at the caudally displaced papillary orifice.

b The incision is extended cranially in the 12-o'clock position. At this point pus may be seen exuding from the congested bile duct.

c

Fig. **146 c** Nearly complete precut incision of the papillary roof. The stone spontaneously dislodges from the papilla.



d

d The stone has passed into the duodenal lumen. The lumen of the dilated distal bile duct is visible.

Fig. **147** Alternatively, the needle knife can be used in a similar manner to the precut sphincterotome to free an impacted stone at the papilla.

Standard Extraction Techniques

Following endoscopic sphincterotomy, 80% to 90% of common bile duct stones can be removed with either the Dormia basket (Fig. **148**) or the balloon-tip catheter (Fig. **149**). Stone extraction should first be attempted with the Dormia basket because it is sturdier and provides better traction. The balloon-tip catheter is more fragile and should be reserved for the removal of small stones (0.5 cm) or sludge that cannot be captured in the basket.

If multiple medium or large stones are present, it is important to remove stones individually, beginning with the lowermost stone (Fig. **150**). Failure to capture the most distal stone may result in its impaction at the distal common bile duct. If a more proximal stone is inadvertently captured, it can be dislodged from the basket by pushing it upward into the hepatic duct confluence where the basket will tend to fold over and disengage the stone (repeated opening and closing of the basket will help release the stone). Once the stone is released, the basket is advanced into a hepatic duct and closed.

The direction of traction should be maintained in the axis of the bile duct as the stone is extracted.

Fig. **148** Extraction of a stone from the common bile duct using the Dormia basket. The stone is entrapped within the arms of the basket, after which the basket is gently closed around the stone and withdrawn. The basket should not be closed too tightly because this could fragment a soft stone, necessitating time-consuming repeated sweeping of the bile duct until clear. It is therefore preferable to fish out stones by trawling the open basket through the duct.

a

b

Fig. **149** Extraction of small stones and gravel from the common bile duct using the balloon-tip catheter. The balloon is inflated above the stones under fluoroscopic guidance. As the balloon is withdrawn, it may need to be slightly deflated to allow passage through the papilla.

Fig. **150a–c**
a Multiple stones in the common bile duct.
b Using fluoroscopy, the Dormia basket is slowly opened around the lowermost stone. The stone is captured by cautiously maneuvering the wires around the stone using abbreviated opening and closing movements.
c The remaining stones are sequentially captured and extracted.


a


b

This can be checked fluoroscopically. The endoscope tends to slip above the papilla during stone extraction and may therefore need to be repositioned at the papilla.

If a captured stone becomes impacted at the papilla during extraction, the force of traction can be increased by cautiously withdrawing the endoscope back into the stomach under fluoroscopy. The wheels of the endoscope are unlocked, and the basket catheter is anchored at the channel port with the left hand.

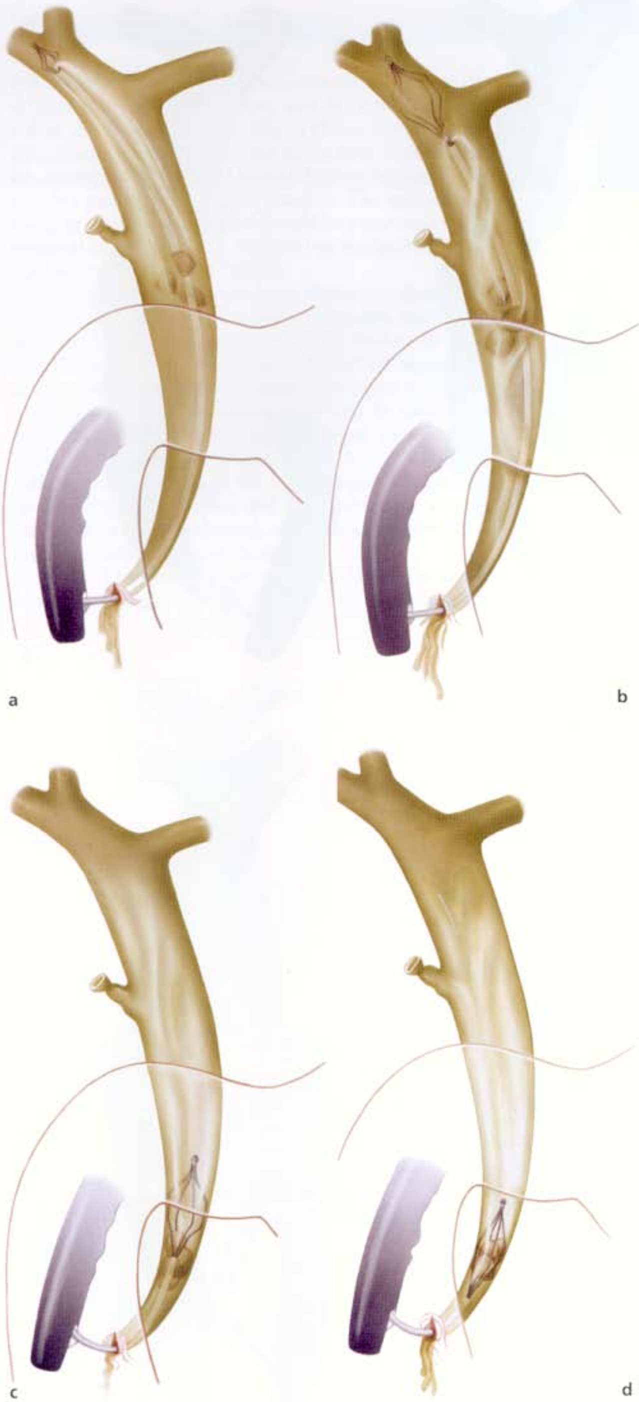
Difficult Stones

Failure of standard stone-extraction techniques is usually due to large stones (2 cm), multiple impacted stones, or stones proximal to a stricture. A variety of modalities are currently available to fragment these difficult stones prior to extraction. These include mechanical lithotripsy, intraductal shock wave lithotripsy, extracorporeal shock wave lithotripsy, and dissolution therapy.

Mechanical Lithotripsy

Using mechanical lithotripsy, the stone is trapped in a Dormia basket and forcefully crushed against the leading edge of a metal sleeve. This method is the simplest and most cost-effective lithotripsy technique. Two basic variations of mechanical lithotripsy exist: nonendoscopic and through-the-endoscope.


c

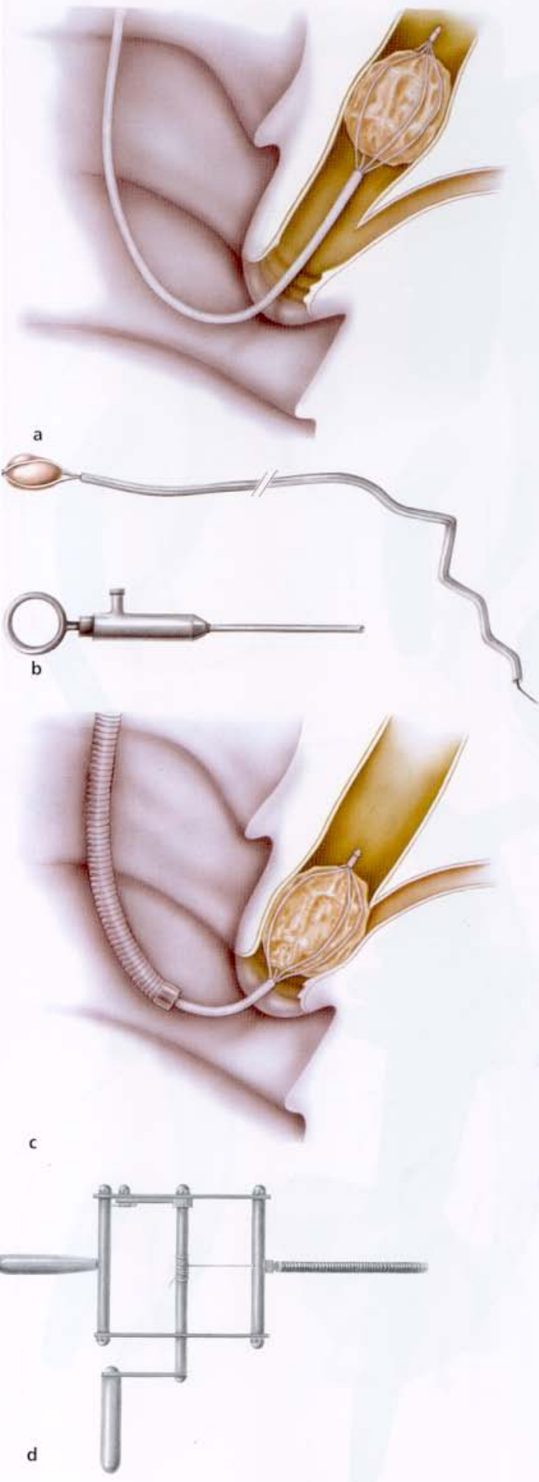


a b c d

Fig. **151a–d** Injection of contrast medium below small stones may propel the stones into the hepatic ducts, which will make stone extraction more difficult.
a Contrast is injected above the stones with the basket slightly open, which propels the stones into the distal common bile duct.
b The basket is completely opened.
c As the basket is withdrawn under fluoroscopic guidance, suction is applied.
d The small stones are captured in the basket.

Fig. **152** After injecting the duct, very small stones and sludge are removed by holding the Dormia basket open at the papilla and applying suction.

Fig. **153** Maneuver to extract a stone impacted at the papilla. The dials of the endoscope are unlocked and the endoscope is withdrawn into the stomach while the basket is held in place at the channel port. This maneuver must not be performed with excessive force because this can result in a tear of the duodenal wall.



Nonendoscopic Method

This method is used when both the stone and Dormia basket become impacted at the distal choledochus. The basket handle is cut off, and the endoscope is removed over the basket catheter and cable. A flexible metal coil sheath (6 mm) is then advanced over the Teflon sheath under fluoroscopic control up to the basket containing the stone. The basket cable is connected to a cranking device, and the stone is crushed by drawing the basket forcefully into the metal sheath (Fig. **154**). The nonendoscopic lithotriptor device assists in emergency situations where stone and basket become impacted, and should be considered an indispensable component of the ERCP armamentarium.

Fig. **154a–e** Nonendoscopic mechanical lithotripsy.
a Both the basket and the stone are impacted in the distal common bile duct. After the basket handle is cut off, the endoscope is removed, leaving the Teflon-sheathed basket catheter in place.
b Prior to cutting off the basket handle, several kinks are made in the Teflon-sheathed basket catheter near its handle. This will prevent the Teflon sheath from slipping back. The Teflon sheath holds the stone secured in the basket and protects the GI mucosa against trauma from the bare wire.
c The flexible metal sheath is advanced over the basket catheter until it abuts against the stone.
d The proximal end of the basket wire and metal sheath are connected to the winding peg and cranking device, respectively.
e By turning the winding peg, the basket is forcefully withdrawn into the metal sheath, and the stone is crushed into multiple smaller fragments. The duct can then be cleared of fragments with a new Dormia basket.

Through-the-Endoscope Method

This method uses a single assembly unit consisting of a Teflon-protected crushing basket within a flexible metal sheath. The relatively thin metal sheath fits through the working channel of the duodenoscope. The advantage of this method over the nonendoscopic method is that the endoscope does not have to be removed to perform mechanical lithotripsy. The drawback, however, is that the endoscopist must capture the stone using the lithotriptor basket, which is more difficult to manipulate within the bile duct than a standard Dormia basket. In contrast to the nonendoscopic lithotriptor, this device was conceived for the situation where mechanical lithotripsy is anticipated before attempted stone extraction.

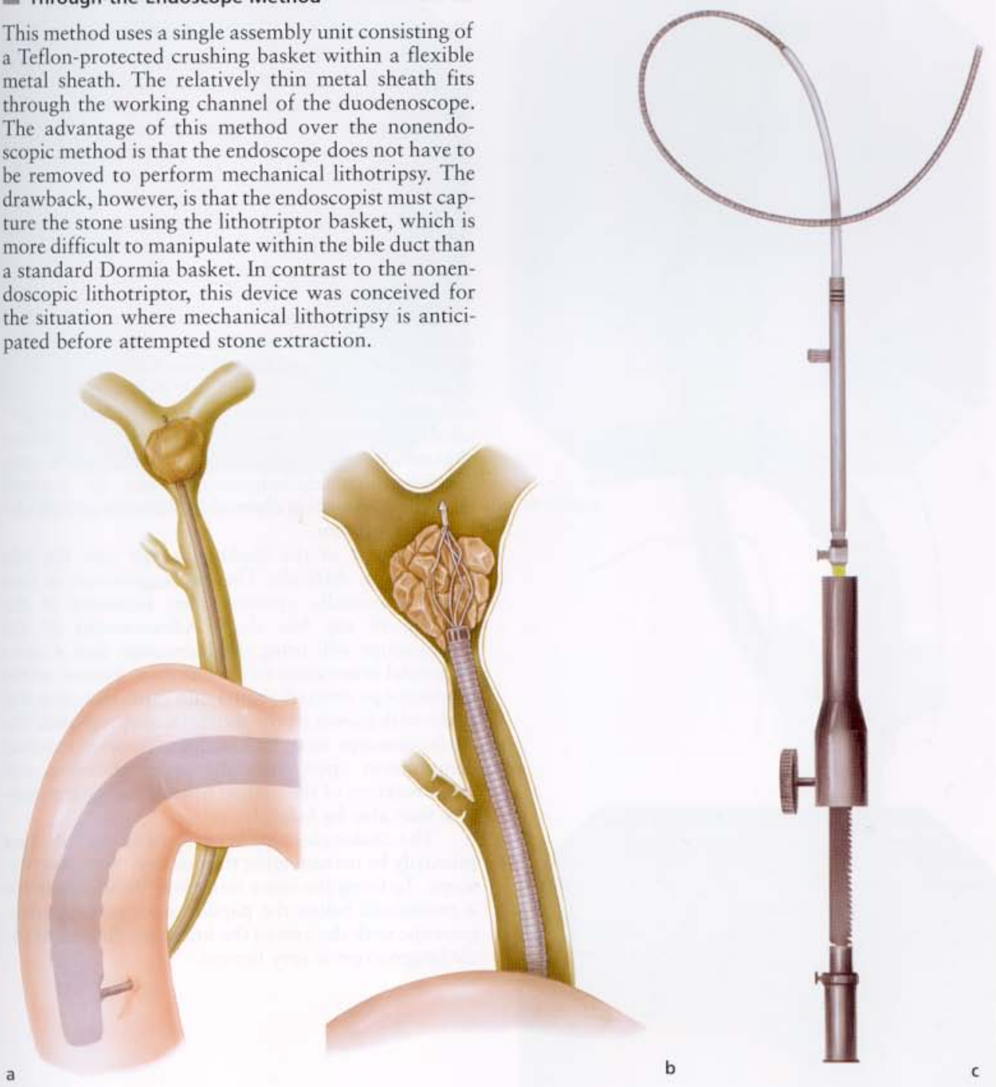


Fig. **155a,b** Transendoscopic method of mechanical lithotripsy.
a A stone located above a stricture in the common hepatic duct is entrapped in the wires of the lithotriptor basket. The metal sheath is advanced over the basket catheter up to stone.
b,c The basket is forcefully withdrawn using the lithotriptor cranking device. The stone is crushed against the metal sheath.

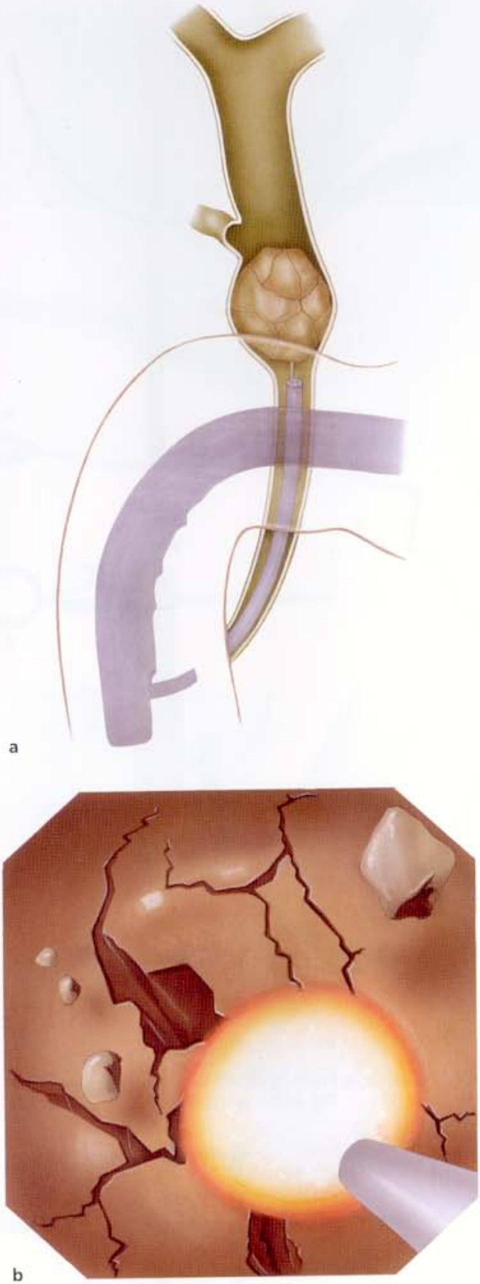


Fig. **156a,b** Cholangioscopic shock-wave lithotripsy.
a The cholangioscope is inserted into the bile duct through the motherscope. The lithotripsy probe is already inserted through the working channel of the babyscope. The tip of the lithotripsy probe is placed at the center of the stone.
b Cholangioscopic view of intraductal lithotripsy.

Intraductal Shock-Wave Lithotripsy

The prerequisite for successful mechanical lithotripsy is that the stone first be securely captured in the wires of the lithotripsy basket. This may fail if stones are too large, firmly impacted, or above a stricture.

Shock waves can be generated using either electrohydraulic or pulsed laser (dye laser, Nd:YAG laser) technology. The shock-wave energy is applied directly to the stone surface using flexible probes that are introduced through the working channel of the endoscope into the bile duct. In most cases, stones can be fragmented and removed within a single session.

Intraductal shock-wave lithotripsy without a stone-tissue recognition system can cause injury to the bile duct wall and should therefore be performed under cholangioscopic guidance. A mother-baby endoscope system is required for this. The "babyscope" (cholangioscope) is inserted through the working channel of the "motherscope" (duodenoscope). Smaller-caliber cholangioscopes can be inserted through the working channel of a therapeutic duodenoscope (4.2 mm).

Insertion of the cholangioscope into the bile duct can be difficult. The cholangioscope is first flexed maximally upward, then impacted at the opening to the bile duct. Advancement of the motherscope will bring the babyscope into a more tangential orientation to the bile duct. Flexion of the motherscope toward the papilla (and, occasionally, slight withdrawal of the motherscope) will slide the cholangioscope into the bile duct. Targeted external compression upon the right upper abdomen and slight rotation of the patient toward the supine position may also be helpful.

The cholangioscope is oriented in the bile duct primarily by maneuvering the position of the motherscope. To bring the stone into view, the motherscope is positioned below the papilla to align the cholangioscope with the axis of the bile duct. Flexion of the cholangioscope is very limited.

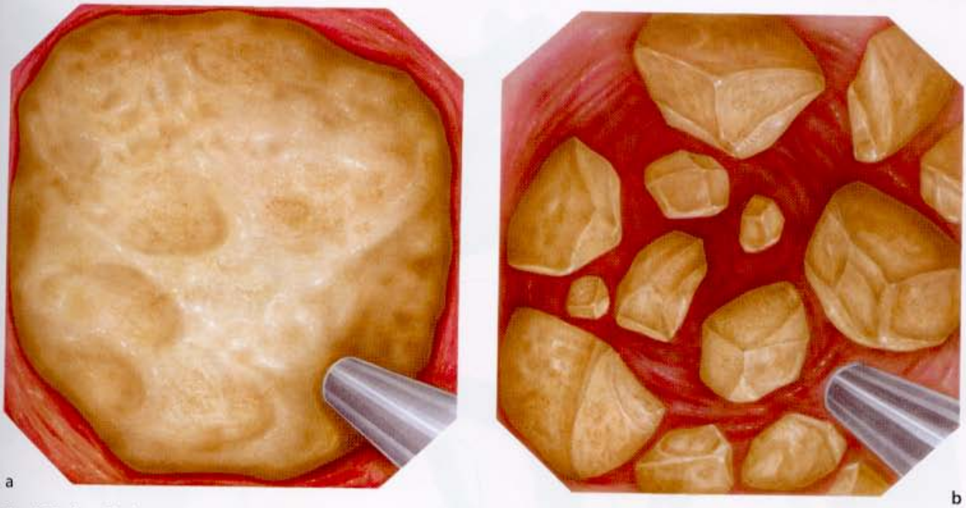


Fig. **157a,b** Cholangioscopic views of the stone before and after lithotripsy.

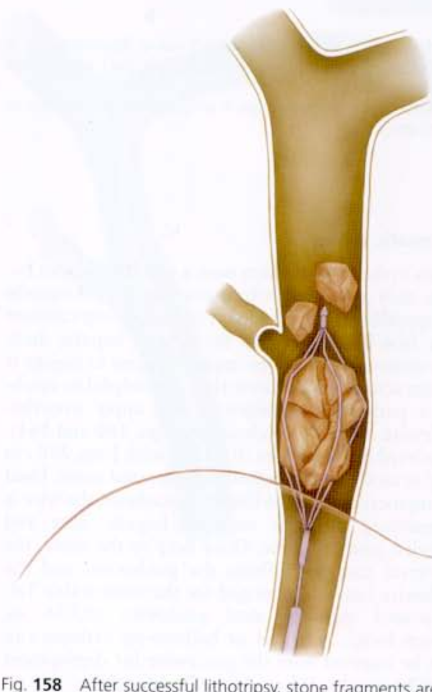


Fig. **158** After successful lithotripsy, stone fragments are extracted with the Dormia basket.

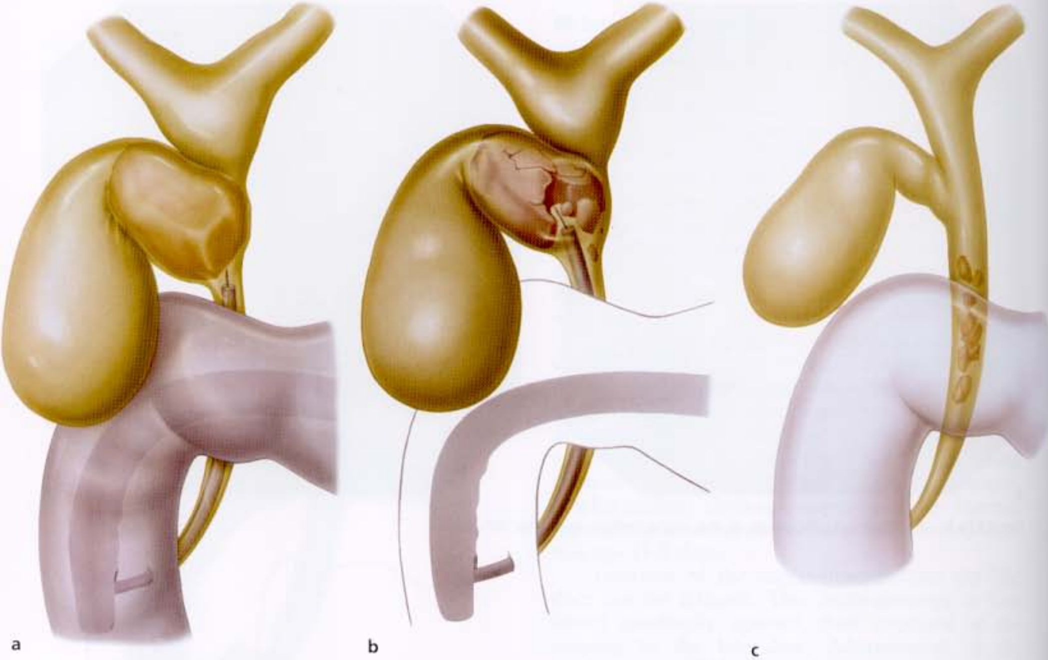


Fig. **159a–c** Cholangioscopic shock-wave lithotripsy of a giant stone in the cystic duct causing bile duct obstruction (Mirizzi syndrome).
a Positioning of the babyscope in preparation for shock-wave lithotriopsy.
b Targeted application of shock waves under cholangioscopic guidance.
c Residual fragments in the common bile duct after lithotripsy.

Hepatic Stones

Stones in the hepatic ducts pose a special problem because they are difficult to access via the retrograde transpapillary route. A basket or balloon-tip catheter must first be passed into the desired hepatic duct, then maneuvered past the impacted stone to engage it for extraction. To facilitate this, it is helpful to establish a path with a guidewire and apply over-the-guidewire extraction techniques (Figs. **160** and **161**). A hydrophilic guidewire (0.032 in with J-tip, 260 cm long) is used to pass beyond the impacted stone. Used in conjunction with the Universal catheter, the wire is maneuvered into the required hepatic duct and wriggled past the stone. Once deep to the stone, the Universal catheter follows the guidewire, and the guidewire can be exchanged for the more stable Teflon-coated stainless steel guidewire (0.035 in, 400 cm long). A basket or balloon-tip catheter can then be inserted over the guidewire for deployment (see Chapter 11, Biliary Stent Drainage).

If endoscopic extraction fails with this technique, extracorporeal shock-wave lithotripsy (ESWL) can be used to fragment hepatic stones. Small stone fragments will usually spontaneously pass in the absence of a distal obstruction.

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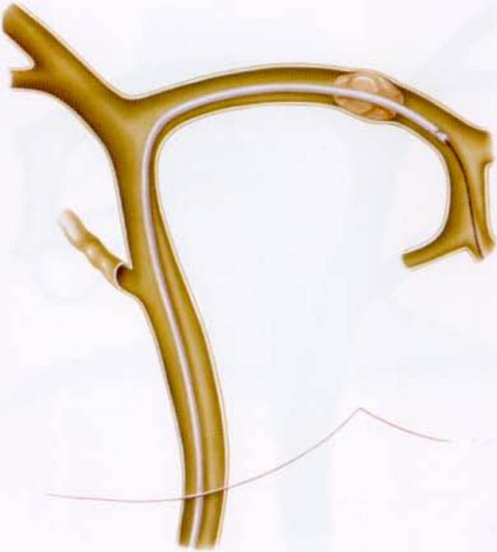

c

Fig. **160 a–c** Hepatic stone extraction using the Dormia basket or balloon-tip catheter over a previously inserted guidewire.
a Extraction with the balloon-tip catheter.
b,c A special wire-guided Dormia basket is coaxially inserted over a stainless steel guidewire. The wire is threaded through a hole at the tip of basket.

Fig. **161a–c** Hepatic stone extraction using the Segura basket.
a A guidewire has been inserted past the impacted hepatic stone.
b The sleeve component of the Segura basket is inserted over the guidewire.
c The guidewire is exchanged for the Segura basket. The basket is opened proximal to the stone.
d The stone is captured and extracted unter fluoroscopic guidance.

Complications

Complications such as bile duct perforation or tears at the papilla are exceedingly rare when cautious technique is used. They occur in the context of difficult stone extraction or intraductal lithotripsy. Using mechanical lithotripsy, the basket may break at its attachment to the cable, resulting in impaction of both the stone and the basket. The stone can be fragmented using intraductal or extracorporeal shockwave lithotripsy and the broken basket subsequently retrieved.

Failure to clear the bile duct of stones after sphincterotomy places the patient at substantial risk of developing cholangitis and sepsis. Providing drainage is therefore mandatory (see Chapter 11, Biliary Stent Drainage). In most cases this can be endoscopically achieved by inserting a nasobiliary catheter or biliary stent. In a septic patient, nasobiliary catheter placement allows for biliary duct irrigation and instillation of antibiotics (Fig. 162). A stent may be placed to provide temporary drainage pending further treatment, or can serve as definitive treatment in the high-risk patient (Fig. 163).

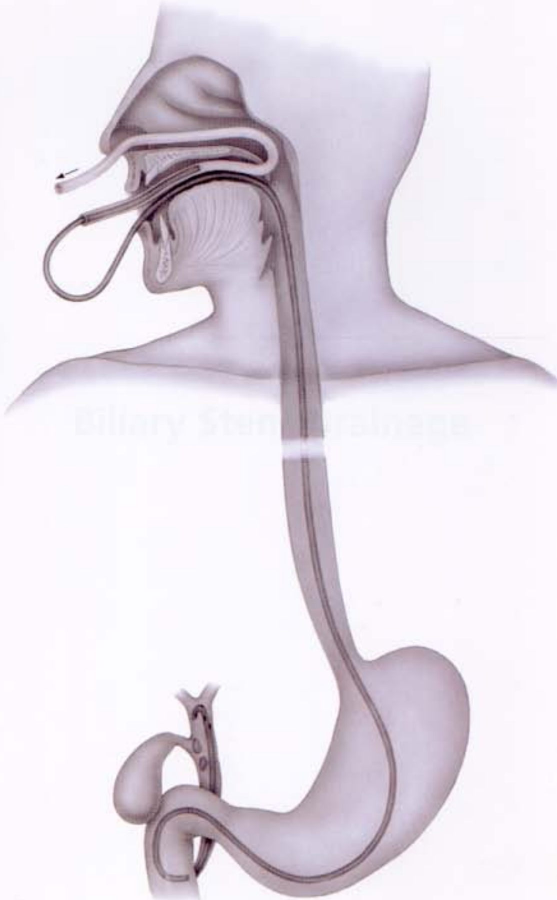

Fig. **162** Incomplete stone extraction. A 7-French nasobiliary catheter is placed in a patient with suppurative cholangitis for bile duct irrigation.

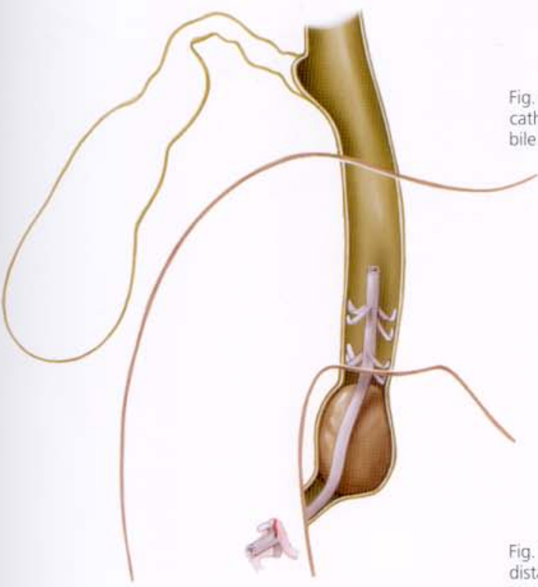

Fig. **163** Failed extraction of an impacted large stone in the distal common bile. A 7- or 10-French Tannenbaum stent is inserted past the stone.

11

Biliary Stent Drainage

General

Stent drainage has become the palliative treatment of choice for malignant biliary obstruction. Endoscopic transpapillary drainage is generally preferred to percutaneous drainage, with the exception of advanced Klatskin tumors involving the hepatic branches where percutaneous drainage provides better hepatic duct decompression.

Indications

Endoscopic drainage is indicated as a palliative measure to relieve jaundice in the patient with malignant bile duct obstruction. Biliary stenting may be an alterative to surgery for the treatment of benign biliary strictures, early iatrogenic strictures, and postoperative biliary leaks.

Fig. **164** The Universal catheter is made of radiopaque Teflon and 260 cm long. The tip tapers from 7- to 4.5-French and is slightly curved. The orientation of the curved tip can be manually modified by heating the Teflon catheter. A Y-adapter is connected to the handling end to allow injection of contrast medium with a guidewire in place.

Prerequisites

Competence in ERCP cannulation technique and sphincterotomy is a prerequisite for successful endoscopic stent drainage. Furthermore, the endoscopist must master techniques of stent retrieval and exchange to treat two common complications of biliary stenting: stent migration and clogging. These complications entail the application of various techniques of exchanging stents in the event of clogging.

The endoscopist should be familiar with different types of biliary stents. Plastic stents are standard for biliary drainage and are generally preferred to the expandable metal stents. The major advantage of expandable stents is their large diameter (up to 10 mm), which provides excellent initial drainage following insertion. The expandable stent may occlude over time, however, due to tumor ingrowth or overgrowth, and is not endoscopically removable. That the stent cannot be removed or exchanged is a strong argument against its use for benign stenoses. An expandable stent is primarily indicated when a plastic stent repeatedly occludes or migrates, or when cholangitis accompanies malignant obstruction. Cholangitis is usually seen in patients with slow-growing tumors, such as a Klatskin cholangiocarcinoma.

Instruments

Placement of a 10-French stent requires a duodenoscope with a large working channel (4.2 mm) and a variety of accessories:

- Universal catheter for guiding the wire and dilating the stricture (Fig. **164**)
- Dilating catheters of different diameters (Fig. **165**)
- Hydrostatic balloon-tip dilating catheter (Fig. **166**)
- Variety of guidewires (hydrophilic wire, 260 cm long, 0.032 in with J-tip; Teflon-coated stainless steel wire, 400 cm long, 0.035 in)
- A 6-French guiding catheter (320 cm long) with radiopaque marker rings at the tip for measuring the stricture length
- Biliary stents of different designs (Fig. **167**)
- Appropriate pusher tube for the selected stent
- Stent Retriever devices in different sizes

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Fig. **165** The dilating catheter is made of radiopaque Teflon and comes in sizes 5 to 12 French.

Fig. **166** The hydrostatic balloon-tip catheters are available in sizes 4–8 mm.

Fig. **167** Different biliary stents. From left to right: double pigtail, single pigtail, straight stent with side-holes (Amsterdam stent), straight stent without side-holes (Tannenbaum stent). Our preference is a 10-French Tannenbaum stent made of Teflon for drainage. Teflon has a lower coefficient of friction than polyethylene and is therefore easier to insert.

■ Technique

Stent Insertion

A small sphincterotomy will facilitate insertion of a large-bore stent, multiple stents for the treatment of bifurcation tumors, or a stent together with a naso-biliary catheter for the treatment of cholangitis.

The conventional Teflon-coated stainless steel guidewire is fairly rigid, which heightens the risk of perforation when attempting to pass through tight or tortuous strictures. The hydrophilic glidewire, made of titanium-nickel alloy, has a special polymer coat-

Fig. **168** Three-layer technique for the insertion of a Tannenbaum stent. The 6-French guiding catheter minimizes step-off between the guidewire and the stent. The pusher tube is used to advance the prosthesis over the guidewire into the bile duct. The pusher tube and stent should be of different colors so that the end of the stent can be readily identified (the stent may otherwise be pushed into the duct). ▶

ing that lowers the coefficient of friction, allowing easier, less traumatic passage through strictures. Another advantage is the effective transmission of torque, enabling steered movement of the tip. Because the hydrophilic glidewire is very slippery, it should be exchanged for the Teflon-coated stainless steel guidewire once the stricture is traversed.

Stent placement is performed using the Seldinger technique. For straight stents, the 3-layer technique is used: the 6-French guiding catheter is inserted over the Teflon-coated stainless steel guidewire, then the stent is inserted over the guiding catheter (Fig. 168). Pigtail stents, which are tapered toward the tip, are inserted directly over the wire.

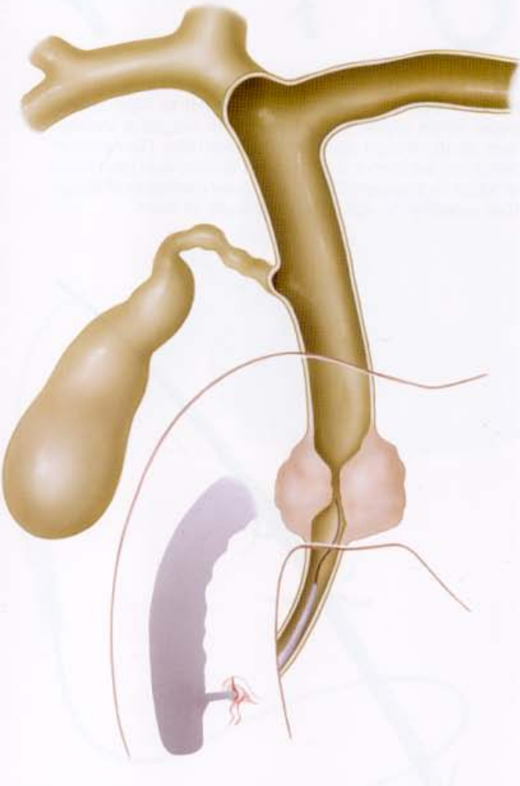


Fig. **169** After performing a small sphincterotomy, the bile duct is cannulated with the hydrophilic guidewire (260 cm long, 0.032 in, J-tipped). The Universal catheter is positioned below the stricture, and the hydrophilic wire is maneuvered through the stricture under fluoroscopic guidance using a combination of to-and-fro and twirling movements. The position of the curved catheter tip is altered depending on the desired orientation of the wire relative to the stricture.

Fig. **170** Once the hydrophilic wire has negotiated the stricture, the Universal catheter follows to dilate the stricture. Dilatation of the stricture with the 7-French Universal catheter will usually allow insertion of a 10-French stent without difficulty.

Fig. **171** Following stricture dilatation, contrast medium can be injected to obtain a complete cholangiogram above the stricture. The hydrophilic wire is then exchanged through the Universal catheter for the Teflon-coated stainless steel guidewire (400 cm long, 0.035 in).

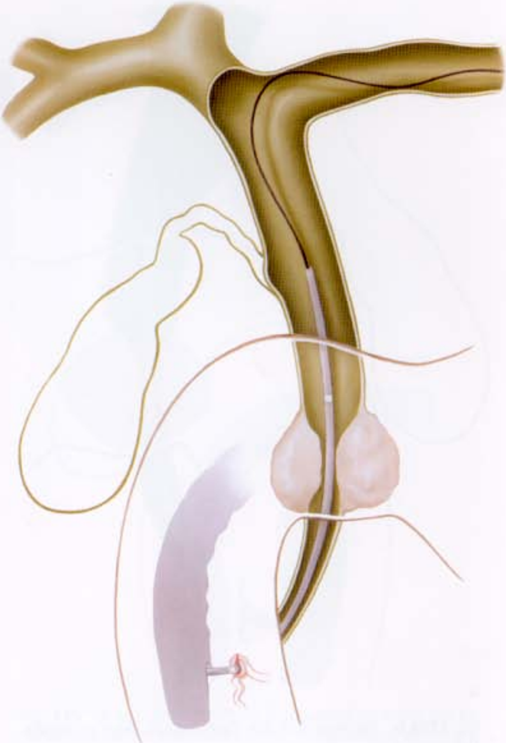


Fig. **172** The stainless steel guidewire is stabilized in a hepatic branch, and the Universal catheter is exchanged over the wire for the 6-French guiding catheter. The guiding catheter has two metal marker rings at the tip to measure the length of the stricture. Since the distance between the rings is 7 cm, the length of the stricture can be measured by adjusting the position of the rings relative to the upper border of the tumor and the papilla. The proximal tip of the stent should extend at least 2 cm above the upper border of the stricture and the distal tip 1 cm into the duodenum.

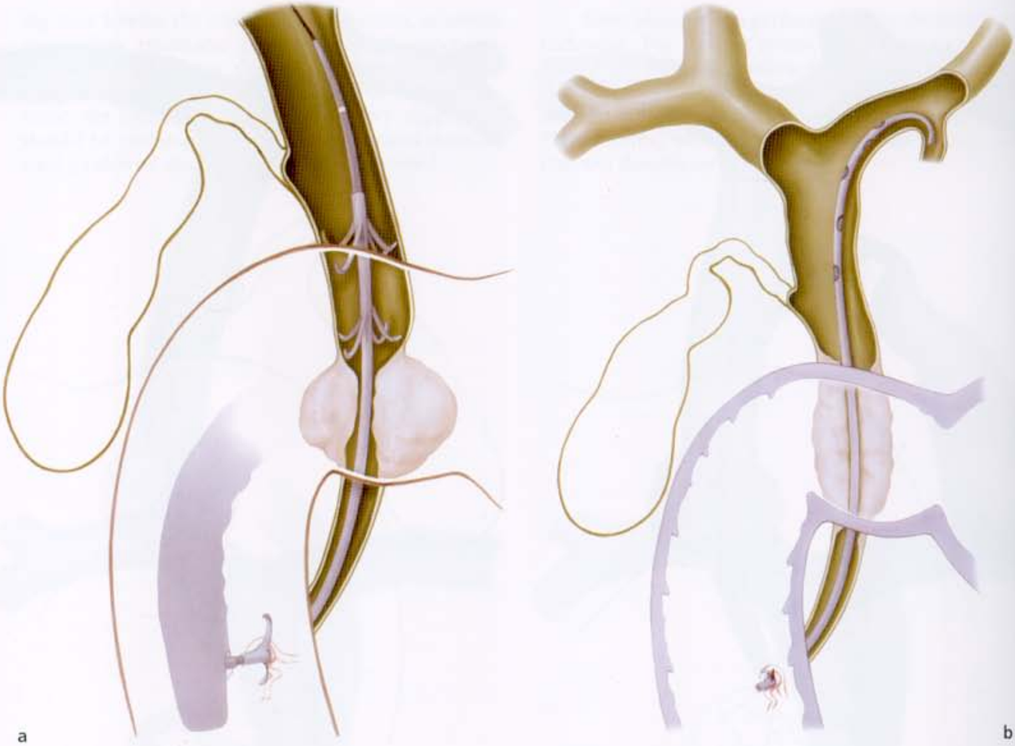


Fig. **173a,b** Placement of the Tannenbaum stent to bypass the stricture.
a The stent is advanced through the stricture by using the elevator, up-down dial (upward movement of the endoscope tip), and anticlockwise torque of the endoscope shaft in combination. The proximal flaps should be anchored directly above the upper pole of the stricture.
b A pigtail stent can be used for high-grade strictures that cannot be sufficiently dilated for the insertion of a straight stent. Since the pigtail stent is more prone to clogging than the straight stent, it should be exchanged for a straight stent after 3 to 4 weeks.

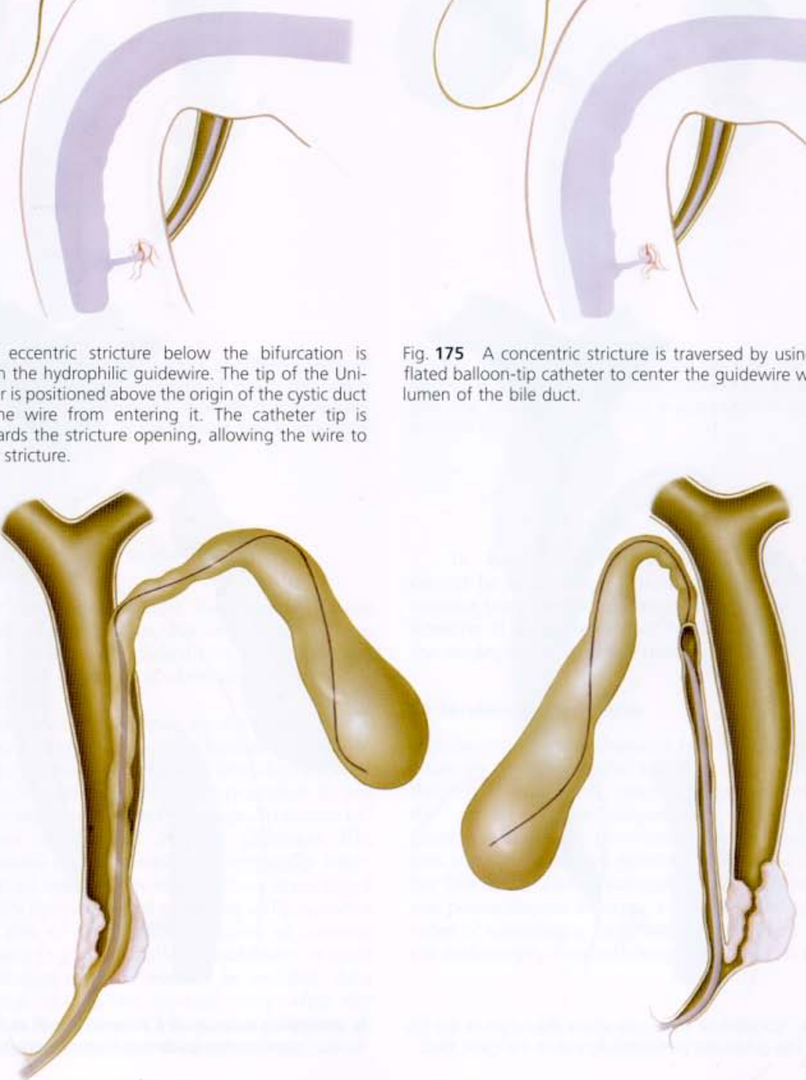
Passing Difficult Strictures

Various maneuvers using the hydrophilic guidewire may help to negotiate a complicated stricture. The stricture is traversed using repeated to-and-fro movements combined with twirling movements. The angle of access to the stricture can be changed by adjusting the position of the Universal catheter tip, which is slightly curved. An angulated guidewire tip is helpful for negotiating eccentric strictures and induces less trauma than the straight tip. For concentric strictures, an inflated balloon-tip catheter will help center the guidewire in the axis of the stricture.

Fig. **176a,b** Long cystic duct running parallel to the bile duct. ▶
a A long cystic duct that joins the common bile duct below a stricture may be mistaken for the bile duct on cannulation.
b Rotating the patient to the supine position, the bile and cystic ducts diverge, revealing cannulation of the cystic duct and gallbladder rather than the bile duct. A dilated pancreatic duct can also be mistaken for the bile duct. Patient rotation and looking for side-branch filling will help differentiate between the two ducts.

Fig. **174** An eccentric stricture below the bifurcation is traversed with the hydrophilic guidewire. The tip of the Universal catheter is positioned above the origin of the cystic duct to prevent the wire from entering it. The catheter tip is oriented towards the stricture opening, allowing the wire to negotiate the stricture.

Fig. **175** A concentric stricture is traversed by using the inflated balloon-tip catheter to center the guidewire within the lumen of the bile duct.



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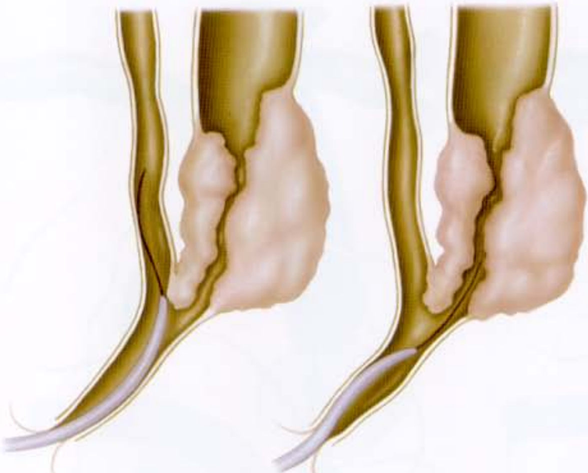
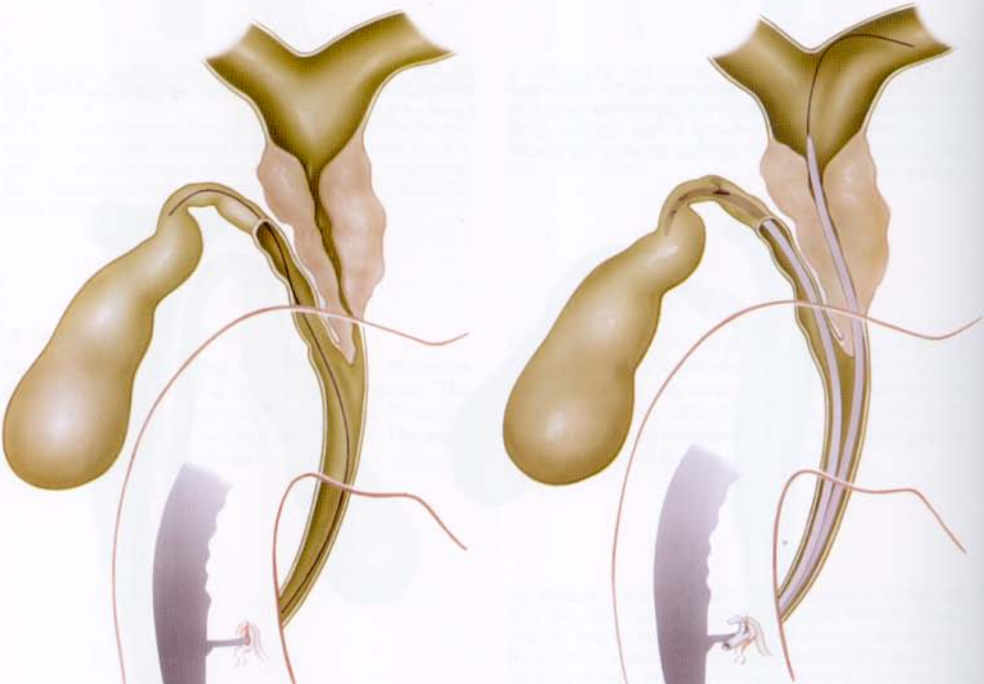


a b

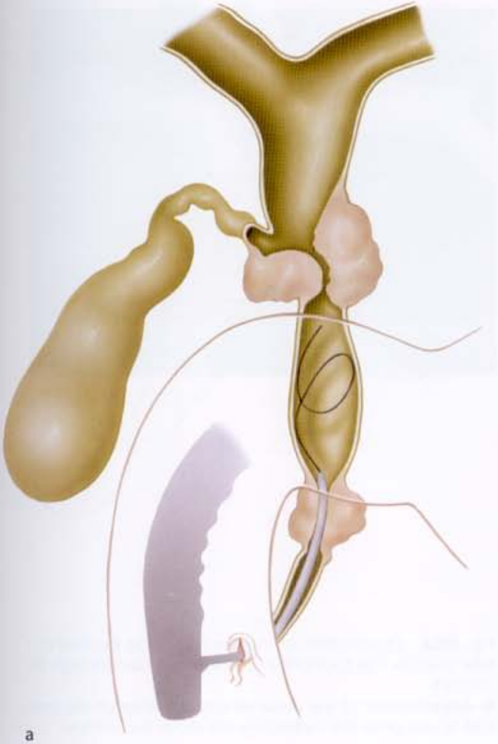
Fig. **177a** Low insertion of the cystic duct may impede cannulation of a distal common bile duct stricture. The guidewire preferentially enters the cystic duct.
b The Universal catheter is positioned below the stricture and oriented in the direction of the bile duct. Simultaneous clockwise rotation of the endoscopes may help to orient the guidewire toward the bile duct. Subtle alterations of orientation under magnified fluoroscopic monitoring are often necessary.



a b

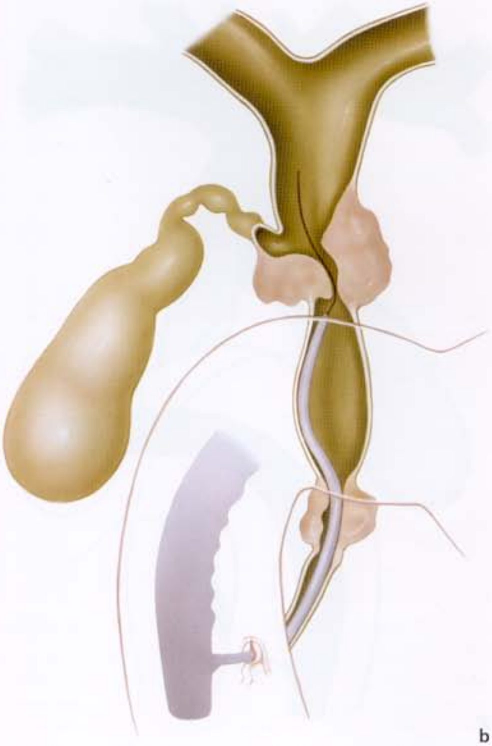
Fig. **178a** Location of a stricture above the origin of the cystic duct. The guidewire preferentially enters the cystic duct.

b Preliminary insertion of a 7-French pigtail stent into the cystic duct prevents the guidewire from entering the cystic duct.



a

Fig. **179a** The possibility of a stricture at different levels of the bile duct should always be considered, which also underlines the importance of obtaining a complete cholangiogram. Narrowing may be caused by the primary tumor and metastatic spread.



b

b After negotiating the most distal stricture, the Universal catheter is advanced to the lower border of the proximal stricture. The hydrophilic guidewire is again used to traverse the proximal stricture.

Cholangiocarcinomas at the Bifurcation (Klatskin Tumors)

Endoscopic decompression of bifurcation tumors poses a particular challenge, not only because these strictures are technically difficult to stent, but also because bilateral drainage is often necessary to prevent cholangitis.

The management depends on the extent of hepatic duct involvement. Strictures limited to the common hepatic duct (Klatskin I) or at the bifurcation of the right and/or left hepatic ducts (Klatskin II) are amenable to endoscopic stent drainage. Strictures extending into the hepatic radicles (Klatskin III), however, should not be treated endoscopically. Injection of contrast medium above a stricture that cannot be adequately decompressed endoscopically carries a substantial risk of cholangitis. Injection of contrast under pressure (e.g., with balloon occlusion) to open an occluded duct should therefore be avoided. As a rule, contrast should be injected only after the guidewire has negotiated a bifurcation stricture, allowing for subsequent stent decompression.

In Klatskin II strictures, bilateral drainage should be achieved. If this is not successful, percutaneous transhepatic drainage may be required, particularly if contrast medium has been injected into the inadequately drained system.

Rendezvous Technique

If endoscopic biliary drainage fails because of altered anatomy or unsuccessful bile duct cannulation (e.g., Billroth II operation, juxtapapillary diverticulum), the rendezvous technique can be applied. A guidewire is passed percutaneously-transhepatically into the duodenum to provide endoscopic access to the bile duct. The advantage of this approach over the percutaneous stenting is the possibility it provides of inserting a large-bore plastic stent through the endoscope, thus inflicting less injury to the liver.

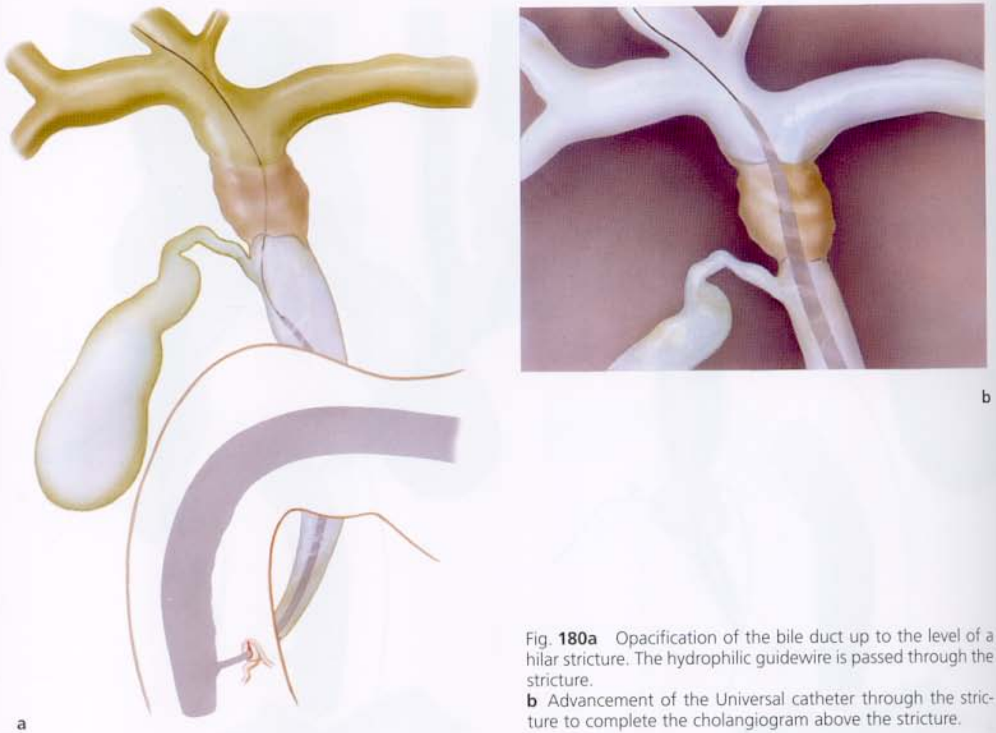

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Fig. **180a** Opacification of the bile duct up to the level of a hilar stricture. The hydrophilic guidewire is passed through the stricture.
b Advancement of the Universal catheter through the stricture to complete the cholangiogram above the stricture.

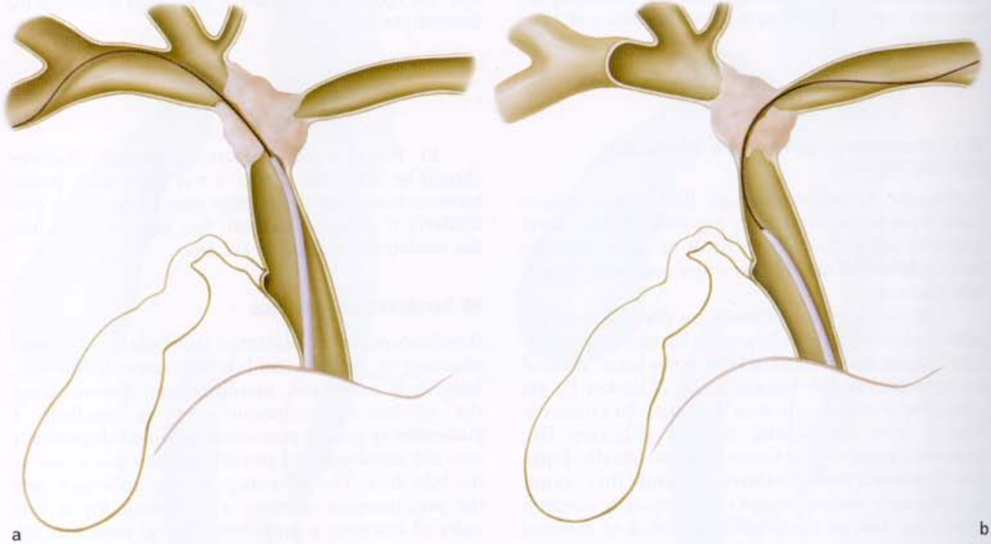
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Fig. **181a,b** Hilar stricture involving both hepatic branches (Klatskin II).
a Negotiation of the right hepatic duct by positioning the Universal catheter immediately below the stricture.
b The left hepatic duct is usually cannulated by positioning the Universal catheter slightly below the lower pole of the tumor, allowing the hydrophilic wire to bounce off the right side of the bile duct wall in the desired direction.

a

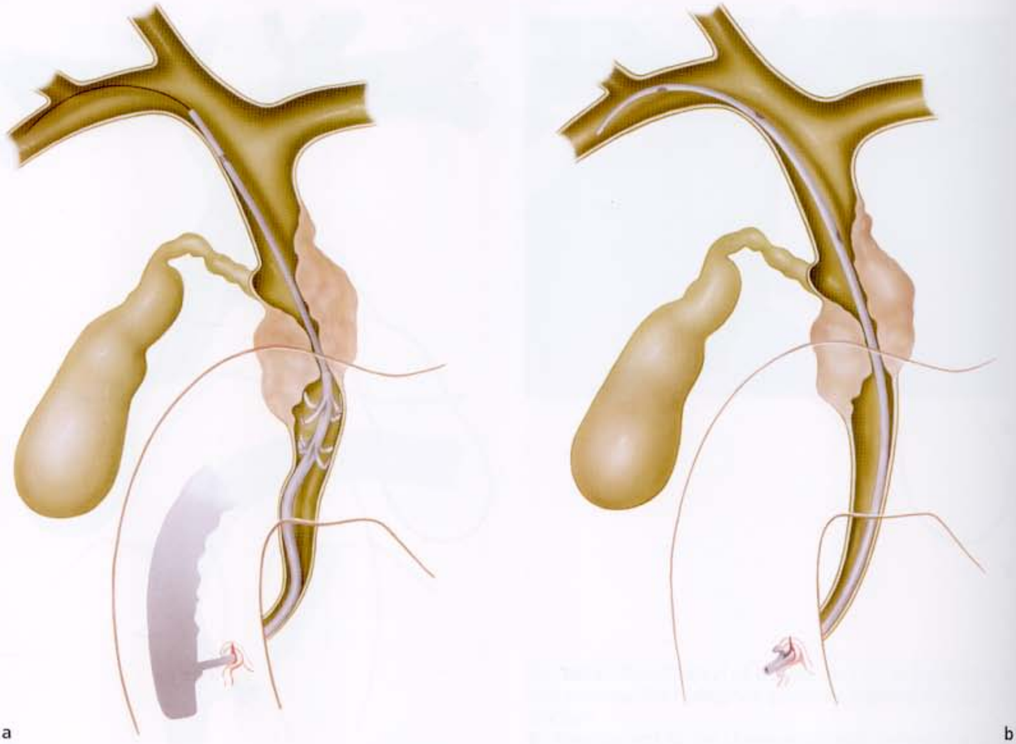
b

c

d

Fig. **182a–c** Bilateral drainage of a Klatskin II type bifurcation stricture.
a Drainage of the right hepatic branch using a 7-French Tannenbaum stent. The left hepatic branch is cannulated with the guidewire for subsequent insertion of a second 7-French Tannenbaum stent.

b Initially, bilateral drainage is often only possible with 7-French caliber stents. The stents can be exchanged 3 to 4 weeks later for a 10-French caliber. It is important that the stent is long enough to allow anchorage in the hepatic ducts.
c Endoscopic view of two 7-French Tannenbaum stents.
d Placement of a 10-French stent may require prior stricture dilatation. This can be performed with a 10-French Retriever.



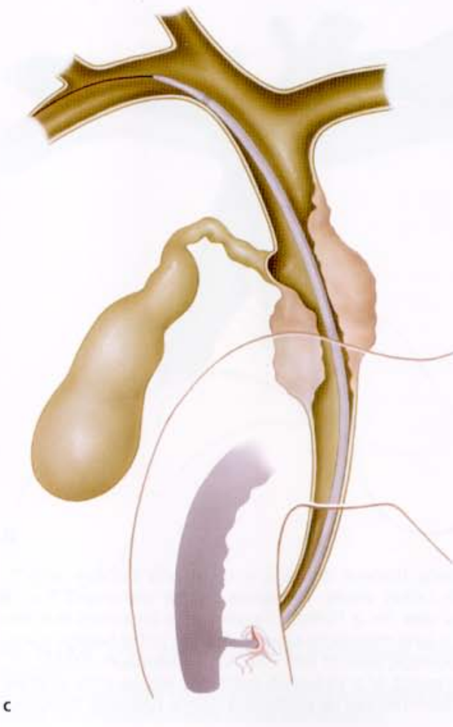
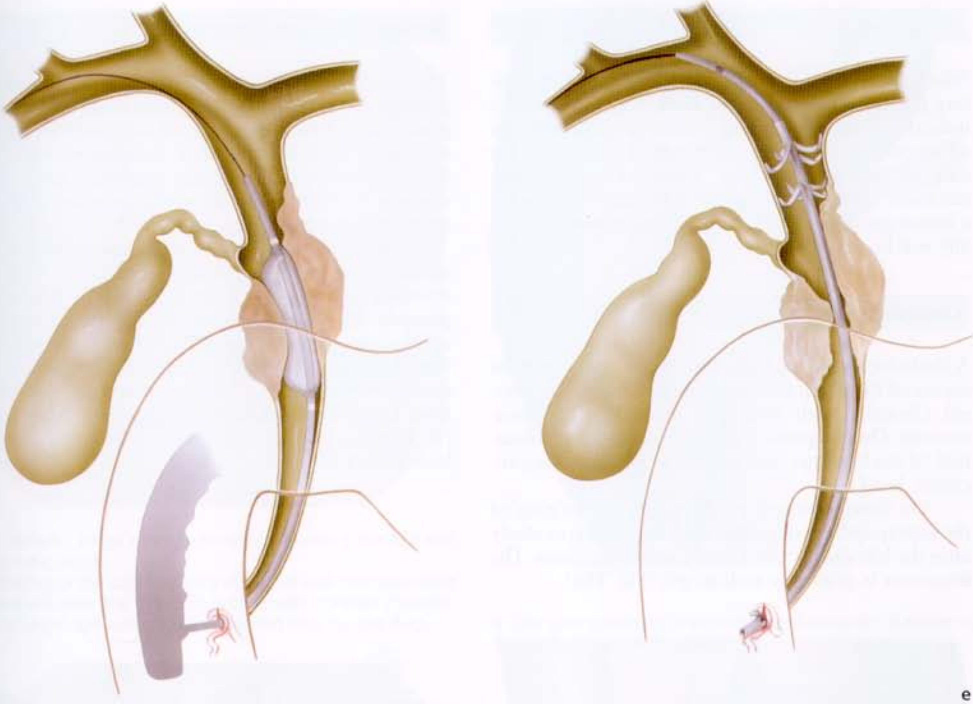


Fig. **183a–e** Negotiation of a tight hilar stricture with a straight 10-French stent is occasionally unsuccessful.
a To maintain the path through the stricture, the Retriever is used over the guidewire to remove the stent. The pusher tube is first removed, then the 6-French guiding catheter, leaving the guidewire positioned across the stricture; the Retriever is then used to engage and remove the stent through the endoscope working channel.
b A pigtail stent will often traverse a stricture that cannot be passed with a straight stent. This is because of the gradual tapering of the pigtail tip. It can be exchanged for a straight stent after 3 to 4 weeks.
c,d An alternative approach is to dilate the stricture over the guidewire using dilating catheters or hydrostatic balloon-tip catheters of incremental size. Stent insertion can then be reattempted.
e Use of a more stable 0.038-in stainless steel guidewire may also be helpful.



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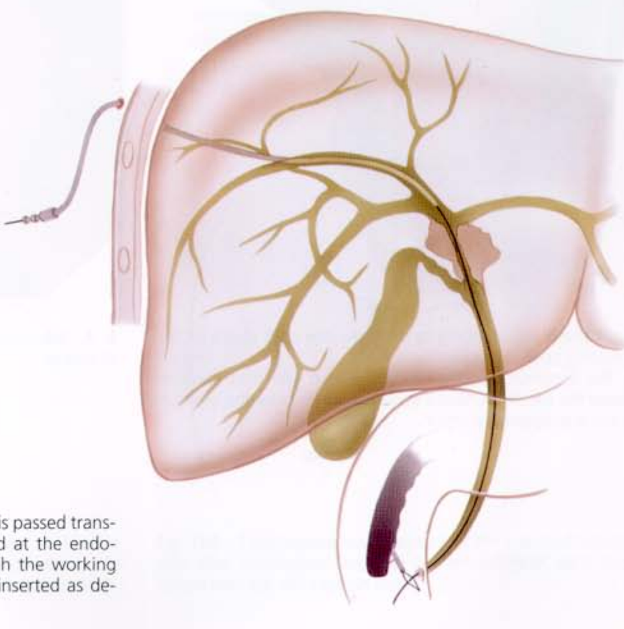


Fig. **184** Rendezvous technique. A guidewire is passed transhepatically into the duodenum, then captured at the endoscopic end with a snare and retrieved through the working channel of the endoscope. The stent is then inserted as described above.

Fistulotomy

Biliary fistulotomy is an incision into the suprapapillary portion of a dilated bile duct. This procedure is indicated when the papilla is obstructed, usually by an inoperable ampullary carcinoma (Fig. **185**). In the case of an intrapapillary carcinoma, a sphincterotomy is required to obtain adequate biopsies for a histologic diagnosis. Hence, a fistulotomy will usually not be required.

Choledochocele

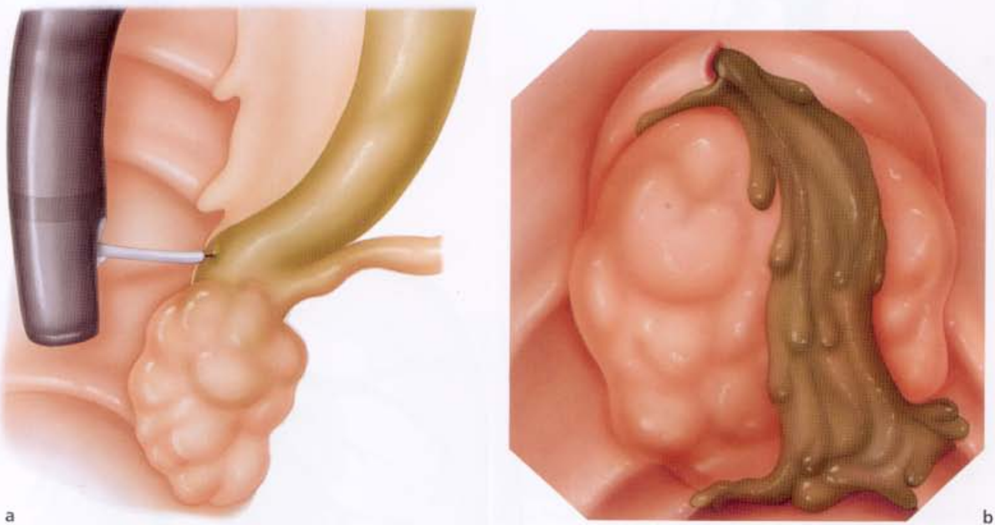
A choledochocele is a rare cystic malformation in the region of the distal common bile duct that may present clinically with recurrent cholestasis and pancreatitis. On computed tomography the cystic dilatation of the bile duct may appear as a cyst in the pancreatic head.

On duodenoscopy, prominent cystic bulging of the suprapapillary duodenal wall is seen, particularly after the bile duct is filled with contrast medium. The treatment is primarily endoscopic (Fig. **186**).

Benign Bile Duct Stenosis

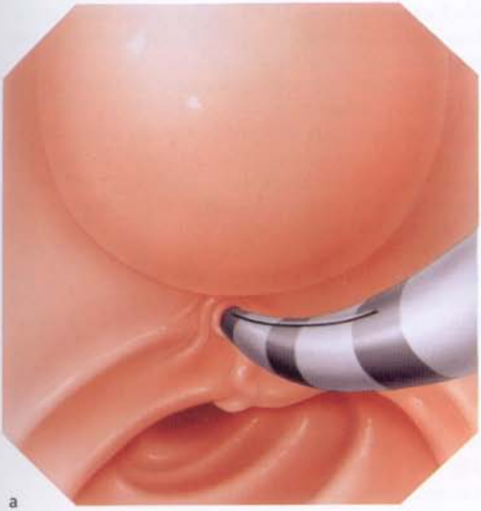
The majority of benign bile duct strictures occur postoperatively. The stenosis may result from iatrogenic injury, T-tube drainage, or may occur at the site of biliary anastomosis after hemihepatectomy or liver transplantation. Benign stenoses may occasionally result from bile duct inflammation (primary or secondary sclerosing cholangitis).

Only short stenoses of the common bile duct are suited for endoscopic treatment. Dilatation with hydrostatic balloon-tip catheters or plastic dilators is possible, but the effect is usually temporary. In most cases a large-caliber stent will need to be placed for at least 6 months to achieve adequate dilatation. If the stenosis is very tight, a 7-French stent can be inserted first. Either the stent is exchanged for a larger stent (10 French), or a second stent is added 4 to 6 weeks later (Fig. **187**).



a b

Fig. **185a,b** Fistulotomy to drain the bile duct above an obstructing ampullary carcinoma.
a The intramural portion of the dilated bile duct is visible above the papilla. A needle knife is used to incise the bile duct in the suprapapillary region.
b A fistulotomy alone usually provides adequate biliary drainage.



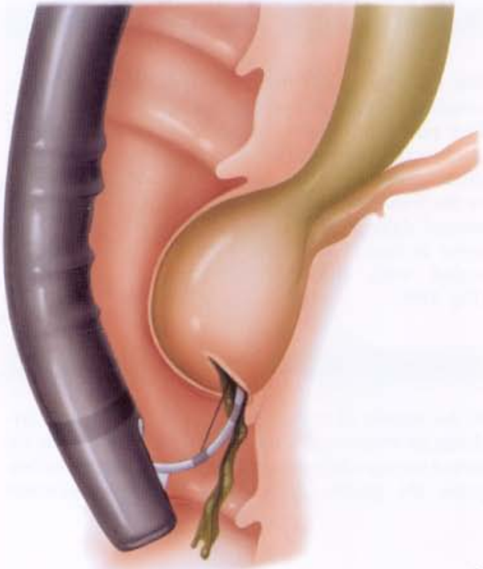


Fig. **186a,b** Large choledochocele obstructing the bile and pancreatic ducts.
a Bulging of the suprapapillary duodenal wall becomes more prominent after the bile duct is filled with contrast medium. An Erlangen sphincterotome is inserted into the bile duct.
b The sphincterotomy is extended until adequate drainage of the choledochocele is established.

Fig. **187** Tight stricture of the common bile duct after cholecystectomy. After 4 to 6 weeks of drainage using a 7-French pigtail stent, a second 10-French stent is added to dilate the stricture in increments.

Fig. **188** Tight anastomotic stricture at the bile duct bifurcation after hemihepatectomy. A 10-French pigtail stent is inserted into the left hepatic duct.

Bile Duct Leaks

Bile duct leaks may occur after abdominal surgery, trauma, or invasive percutaneous procedures (e.g., liver puncture). Endoscopic management consists of a sphincterotomy and elimination of any obstruction distal to the leak. A leak from the cystic duct stump or the T-tube drainage site will usually resolve within several days after the sphincterotomy. Stent placement is rarely necessary. A persistent leak can be sealed with the cyanoacrylate tissue adhesive (Fig. **189**).

Gallbladder Hydrops and Empyema

In the acutely ill or frail patient with gallbladder hydrops or empyema, a nasocystic catheter can be inserted retrogradely through the cystic duct to decompress the gallbladder. More definitive treatment (cholecystectomy or ESWL of an obstructing cystic duct stone) can follow on an elective basis after the patient improves clinically.

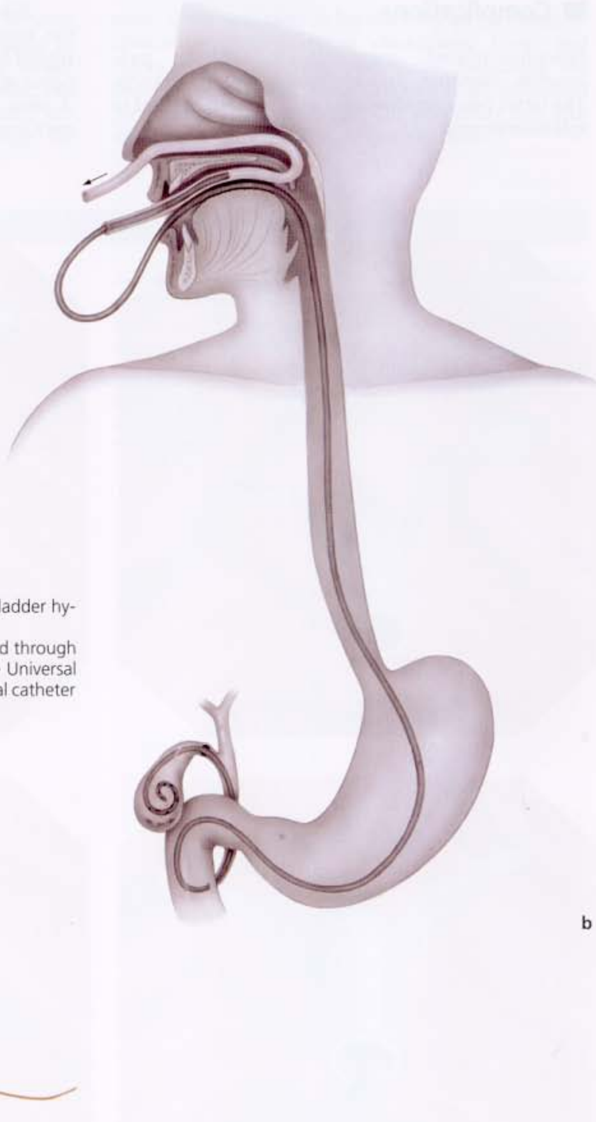
Nasocystic catheter placement is analogous to nasobiliary catheter placement (Fig. **191**). The Universal catheter is positioned below the origin of the cystic duct to direct the J-tipped hydrophilic guidewire into the cystic duct. To-and-fro and twirling movements are implemented under fluoroscopy to negotiate Heister's valves and to bypass the impacted stone. Once the guidewire is in the gallbladder, the Universal catheter follows, and the hydrophilic wire is exchanged for the Teflon-coated stainless steel wire. A nasocystic catheter (5- or 7-French) is inserted over the wire into the gallbladder.

A gallbladder stent is preferable to a nasocystic catheter in patients who are disoriented. If a stent is placed, preliminary gallbladder irrigation is required to clear the infected, often inspissated contents (Fig. **192**). Stent drainage is also indicated for symptomatic tumor obstruction of the cystic duct.

Fig. **189** Biliopleural fistula after a gunshot wound. After placement of a chest drainage tube, the bile duct fistula is sealed with transpapillary injection of 1–2 mL of Histoacryl diluted with Lipiodol mixture (1:1). The appropriate bile duct is cannulated with the hydrophilic wire; the Universal catheter is then positioned with the tip at the site of the fistula. Cyanoacrylate sealing is performed under fluoroscopy.

Fig. **190** Biliary fistula from a hepatic duct stump after a right-sided hemihepatectomy. After sealing the fistula site with cyanoacrylate, a 7-French pigtail stent in placed in the left hepatic duct.

a



b

Fig. **191a**,**b** Nasocystic catheter drainage for gallbladder hydrops or empyema.
a A hydrophilic guidewire (0.032 in, J-tip) is inserted through the cystic duct stone into the gallbladder using the Universal catheter. The wire is exchanged through the Universal catheter for a conventional Teflon-coated guidewire.
b The nasocystic catheter is inserted over the wire.

◀ Fig. **192** After gallbladder irrigation, a 7-French pigtail stent is placed across an impacted cystic duct stone to decompress the gallbladder.

Complications

Procedure-related complications include pancreatitis, bleeding, and retroduodenal perforation. The latter two complications are primarily related to sphincterotomy.

Bile duct injury and the creation of false paths in the region of the stenosis rarely occur with the J-tipped hydrophilic guidewire. Cystic duct injury can occur when attempting to cannulate the gallbladder. A stent extending too far into the duodenal lumen may injure or even perforate the duodenal wall.

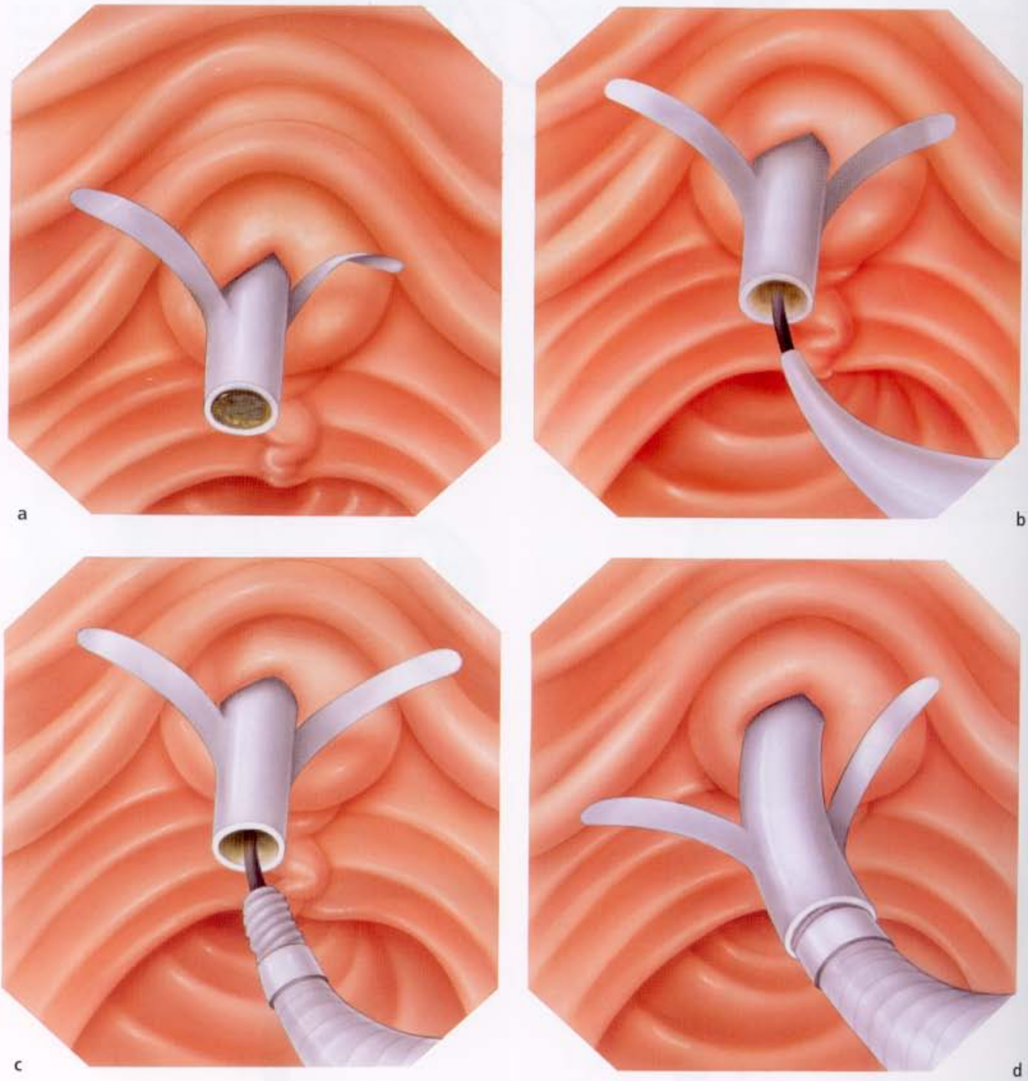


Fig. **193a–d** Stent exchange using the Retriever.
a Endoscopic view of a stent clogged by sludge deposition.
b The stent is cannulated with the Universal catheter for placement of a 0.035-in Teflon-coated stainless steel guidewire through the stent. The wire is advanced into the dilated bile duct proximal to the stent.
c After removing the Universal catheter, the stent Retriever is inserted over the guidewire up to the distal end of the stent.
d The Retriever is screwed into the stent. It is important that the axis of the Retriever is aligned with that of the stent. The stent is removed with the Retriever through the endoscope working channel. During extraction, synchronous advancement of the wire under fluoroscopic and endoscopic guidance is required to maintain the position of the wire in the bile duct.

The most common late complication is stent clogging. Plastic stents occlude after an average of 4 months; expandable metal stents have longer patency rates because of their larger diameter, but they are not removable. If an expandable stent occludes, a plastic stent can be inserted through the stent. Stent occlusion is heralded by an elevation of laboratory parameters of cholestasis. Fever and rigors may accompany cholestasis, indicating the onset of cholangitis. Stent clogging is an indication for prompt stent exchange. The procedure can usually be performed on an outpatient basis.

Stent Replacement

A number of techniques are available for the replacement of clogged plastic stents. The stent can be grasped with a forceps, snare, or basket and withdrawn. In some cases a new stent can be inserted alongside the clogged one, after which the clogged stent is removed.

We prefer to replace a stent over a guidewire using the stent Retriever. The Retriever consists of a 200-cm metal spiral catheter with a threaded tip that can be screwed into the end of the prosthesis. A 0.035-in Teflon-coated guidewire is placed through the clogged prosthesis, over which the Retriever is inserted through the endoscope channel. The blocked prosthesis is removed while keeping the guidewire in place, thereby maintaining access for placement of a new prosthesis (Fig. **193**).

Stent Migration

Stent migration is a relatively rare complication following endoscopic stent placement. Distal migration into the duodenum may be complete or partial. A completely migrated prosthesis will usually pass spontaneously with the stool. Incomplete migration may cause injury to the contralateral duodenal wall. The partially dislodged stent is easy to retrieve. A new stent with better anchorage or insertion of two stents will usually prevent further migration.

In contrast to distal migration, proximal migration poses a greater challenge as retrieval is "blind." A variety of instruments can be used to assist in retrieval.

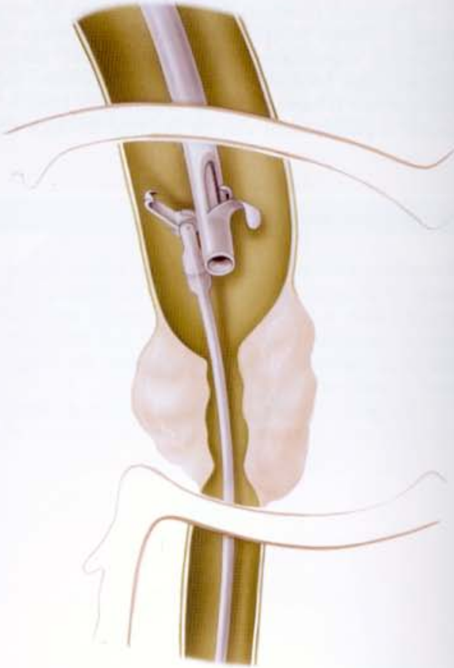
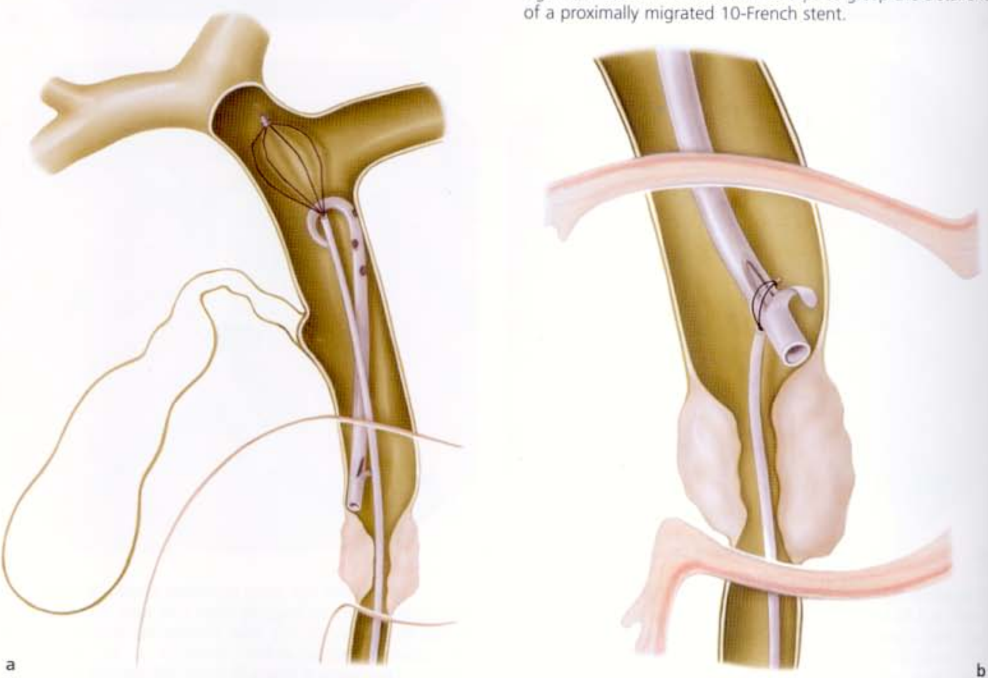
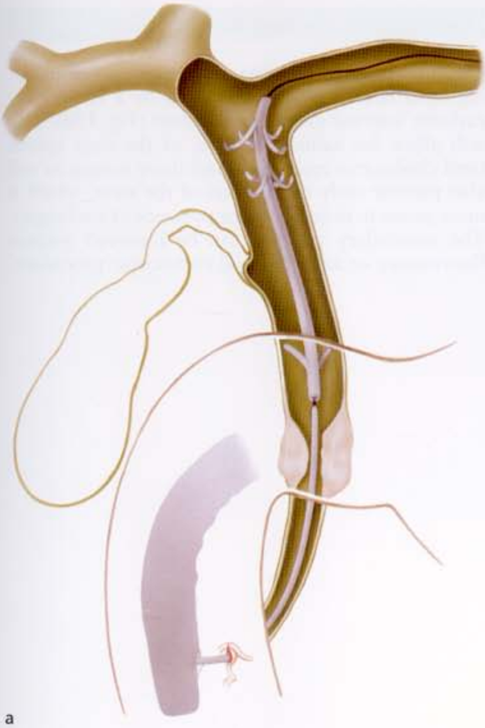


Fig. **194** Use of the rat-tooth forceps to grasp the distal end of a proximally migrated 10-French stent.



a b

Fig. **195a,b** Use of the basket to capture the stent either from the proximal **(a)** or distal end **(b)**. A round basket with stiff wires (Segura basket) is preferable. Only the distal end of the stent should be grasped to avoid perforation during its removal.



a

b

Fig. **196a**,**b** Use of the stent Retriever to remove a proximally migrated stent.
a Cannulation of the stent with the Universal catheter under fluoroscopy to pass the guidewire through the stent.
b The stent Retriever is advanced into the bile duct and screwed into the distal end of the stent.

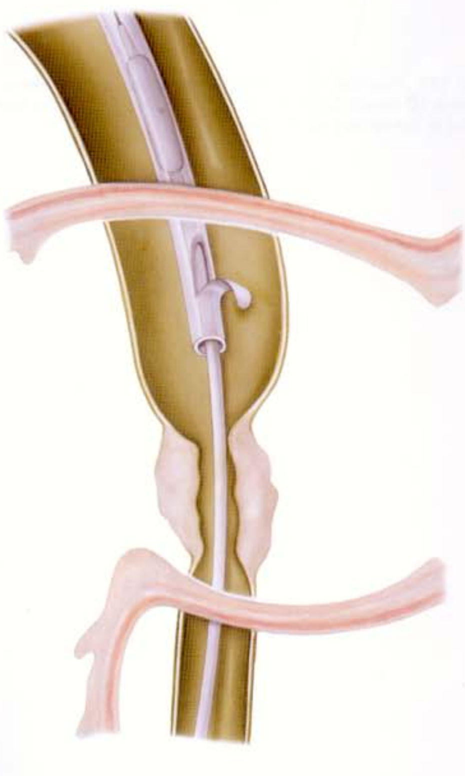


Fig. **197** The migrated stent is removed with a small balloon-tip catheter inserted over a previously placed guidewire. ▶

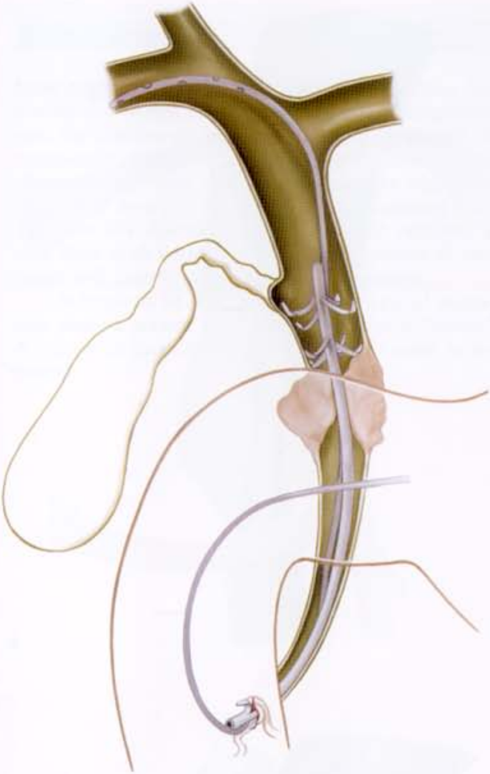


Fig. **198** Insertion of a 7-French nasobiliary catheter alongside a 10-French Tannenbaum stent for irrigation of the bile duct in the setting of cholangitis.

Treatment of Cholangitis

Cholangitis accompanying a stricture or complicating stent occlusion is best treated by a nasobiliary catheter inserted alongside the stent (Fig. **198**). This will allow for saline irrigation of the duct system until cholangitis resolves. Nasobiliary irrigation will also prevent early reocclusion of the stent, which is more prone to clogging in the presence of cholangitis. The nasobiliary catheter can be removed without fluoroscopy or an additional endoscopic procedure.

12

Pancreatic Duct Stenting and Stone Extraction

Stenting

General

Like chronic alcohol abuse, postinflammatory obstruction of the main pancreatic duct may contribute to the pathogenesis of chronic pancreatitis and the severe pain associated with this disease. An acute attack of pancreatitis (irrespective of the etiology) may result in a postinflammatory stricture of the main pancreatic duct, which, in turn may sustain a recurrent or chronic inflammatory state due to obstruction of pancreatic juice outflow.

Stenting of the pancreatic duct is the most common endoscopic intervention for symptomatic recurrent or chronic pancreatitis. The primary goal is the relief of pain.

Indications

Ductal stenting is indicated for short postinflammatory strictures associated with proximal ductal dilatation. Operative therapy is indicated if chronic inflammation is associated with stenosis of the bile duct and/or duodenum. Suspicion of associated malignancy also warrants surgical treatment.

Prerequisites

Experience and skill in diagnostic and therapeutic ERCP is a fundamental prerequisite. Pancreatic duct intervention can be time-consuming and requires a great deal of patience. The pancreatic duct is relatively thin with a multitude of side branches, and the strictures are usually high-grade and angulated.

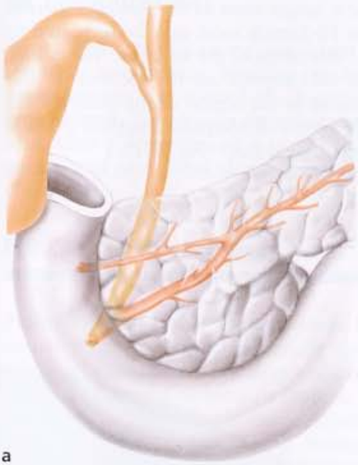
The stricture of chronic pancreatitis is notorious for its resistance to dilative treatment. Bougienage or hydrostatic balloon dilatation are usually ineffective as single treatments. Transpapillary stenting will usually provide pain relief, but it rarely eliminates the stenosis. In general, the stent should be removed within 3 months of placement. Longer-term drainage may be complicated by stent occlusion and therefore mandates regular follow-up.

It is important that the endoscopist has a thorough understanding of normal pancreatic duct anatomy. Knowledge of the embryologic development contributes to an understanding of anatomic variants (Fig. 199). The most common embryologic anomaly is pancreas divisum. Annular pancreas is an unusual occurrence (Fig. 200).

a

b

Fig. **199a,b** Embryologic development of the pancreas.
a Part of the pancreatic head (uncinate process) derives from the ventral pancreatic anlage, which is joined to the common bile duct. The remainder of the pancreas derives from the dorsal anlage.
b The ventral and dorsal components fuse during the 2nd to 3rd month of embryologic development.



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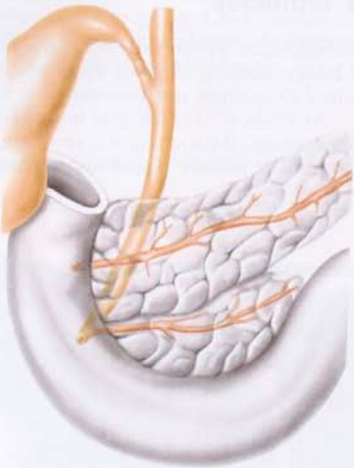

b

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Fig. **200a–c** Anatomy of the pancreatic duct.
a Normal pancreatic duct. The main duct (Wirsung's duct) joins the common bile duct to drain through the major papilla. The accessory duct (Santorini's duct) drains through the minor papilla. Santorini's duct may be absent.
b Pancreas divisum. Failure of the ducts of the embryologic dorsal and ventral anlage to fuse will result in separate ductal systems. The dorsal main duct drains through the minor papilla. This anomaly is often associated with an enlarged pancreatic head.
c In annular pancreas, part of the ventral pancreas encircles the duodenum. The anomalous segment is often a rudimentary bandlike strip of pancreatic tissue. The pancreatogram typically shows a thin, circular duct.

Fig. **201** Incomplete pancreas divisum represents an intermediate fusion anomaly that is more common than pancreas divisum. The main dorsal duct is connected to the ventral duct but drains primarily via the minor papilla. Cannulation is therefore easier from the minor papilla than the major papilla.

Instruments

Practically all of the accessories used for biliary drainage are required. In addition, an assortment of ultrathin guidewires (0.018 and 0.025 in), special catheters, and small-caliber stents (5 or 6 French) are required for tight strictures and special situations such as minor papilla instrumentation. A universal catheter with a long, drawn-out, and maximally tapered tip is another useful accessory.

Pancreatic stents differ from biliary stents in that they have multiple side-holes along their length for drainage of side branches. The stent we prefer to use is tapered at the intraductal end and has a single-side flap at the duodenal end to prevent proximal migration.

■ Technique

The technique of pancreatic stenting is similar to that of biliary stenting. A short sphincterotomy is performed to facilitate instrumentation in the duct.

As a rule, a 7-French stent is used for pancreatic duct drainage. If the stricture is very tight, a 5-French stent can be initially placed and exchanged several weeks later for a larger stent as the stricture dilates. Placement of a 10-French stent may be indicated to achieve further dilatation of the stricture. The choice of stent length will depend on the location of the stricture. Strictures in the region of the genu should be treated with a stent of adequate length to provide anchorage in the dorsal duct (Fig. **202**).

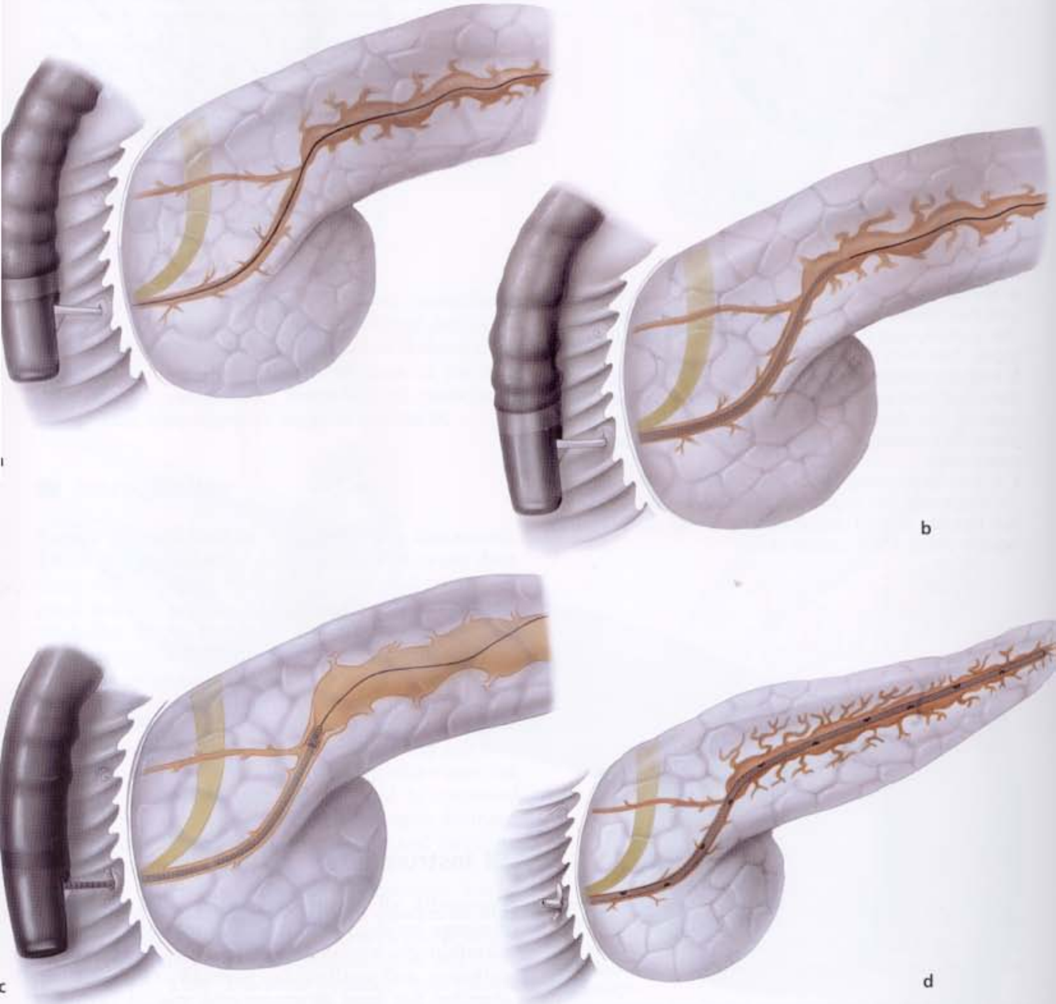


Fig. **202a–d** Pancreatic stent placement to decompress a dilated pancreatic duct secondary to a stricture in the genu region.
a With the aid of the Universal catheter, a hydrophilic guidewire (260 cm long, 0.032 in, J-tip) is manipulated through the stricture and advanced to the tail end of the pancreas.
b The 7-French Universal catheter is advanced over the hydrophilic guidewire to dilate the stricture. Contrast medium can be injected through the catheter at this point to define the ductal anatomy proximal to the stenosis. The hydrophilic guidewire is exchanged for a 0.035 in Teflon-coated stainless steel guidewire.
c If the stricture cannot be passed with the Universal catheter, a 7-French Retriever can be inserted to dilate the stricture.
d A 7-French pancreatic stent is thread over the guidewire and advanced through the stricture with the help of a pusher tube. Immediate drainage of contrast medium confirms stent decompression of the ductal system.

■ Complications

Apart from complications associated with sphincterotomy pancreatitis, bleeding, perforation), most complications are related to clogging of the pancreatic stent. This occurs on average 4 to 5 months after stent placement and is usually heralded by recurrence of pain. Stent clogging may produce ductal changes, but for the most part these are reversible after stent removal. Infection of the pancreatic duct is a rare complication of clogging. Close clinical surveillance to detect symptoms and signs of clogging is mandatory to avoid these complications.

Pancreatic Duct Stones

Pancreatic duct stones are a common finding in obstructive pancreatitis. Occasionally they are mobile within a dilated pancreatic duct and can be extracted with a balloon-tip catheter or Dormia basket. More commonly, they are firmly impacted and require preliminary fragmentation. Using sonography-guided extracorporeal shock-wave lithotriopsy (ESWL), the majority of pancreatic duct stones or calcifications can be pulverized without any significant complication (Fig. 203). The minuscule fragments spontaneously pass into the duodenum. A prior sphincterotomy will facilitate spontaneous passage.

Fig. **203** ESWL of pancreatic duct stones under sonographic guidance. With the patient in the supine position, the shock waves are applied from the ventral side.

13

Pancreatic Pseudocyst Drainage and Treatment of Pancreatic Fistulas

Pancreatic Pseudocyst Drainage

General

Pancreatic pseudocysts usually develop following acute necrotizing pancreatitis or an acute attack of pancreatitis superimposed on chronic pancreatitis. Occasionally, pseudocysts may result from trauma to the pancreas.

Pseudocysts often spontaneously resolve, but they may persist if the cyst compresses the pancreatic duct and impedes drainage, or if a ductal leak causes pancreatic juice to preferentially flow into the pseudocyst. An acute pseudocyst, which is localized and well demarcated, must be differentiated from a peripancreatic fluid collection or pancreatic ascites. Ductal leakage may give rise to a pancreatic fistula that extend internally to a neighboring cavity (e.g., pleural or mediastinal space) or externally to the skin (e.g., postoperative).

A pseudocyst may become spontaneously infected, resulting in an abscess. The abscess, in turn, may form a fistula to neighboring structures.

Large (6 cm) pseudocysts may cause symptoms relating to compression of neighboring structures. Obstruction of the gastric outlet may be caused by compression of the stomach or duodenum, and jaundice may result from compression of the bile duct. Compression of the pancreatic duct by the pseudocyst may further exacerbate pancreatitis and pain.

Indications

The principal indication for pseudocyst drainage is to relieve pain and the symptoms of compression. Drainage of an asymptomatic but persistent cyst may be indicated to prevent potential complications such as infection, hemorrhage, or rupture.

In our practice, pseudocyst drainage is generally preceded by an attempt to evacuate the contents by percutaneous aspiration. Percutaneous aspiration is less invasive than endoscopic drainage, and may result in permanent resolution of the cyst. If the cyst recurs, endoscopic drainage is performed.

Endoscopic drainage of an acute pseudocyst may be indicated when pancreatitis fails to resolve. An ERP should be performed first to evaluate for a ductal leak feeding the pseudocyst. If this is present, a transpapillary stent is inserted to bridge the leak. An infected cyst is treated by nasocystic irrigation in addition to stent drainage.

Prerequisites

Prior to drainage, diagnostic investigation with standard imaging techniques (abdominal sonography, computed tomography), and upper GI endoscopy should be performed to define the location of the pseudocyst and its anatomic relation to the gut wall. Endosonography is also desirable to identify vessels that may be interposed in the puncture pathway. ERCP is indicated to determine if the pseudocyst communicates with the pancreatic duct. A communicating pseudocyst is a common cause of cyst persistence and recurrence.

Percutaneous puncture is a simple and rapid method to acquire cyst fluid for diagnostic study. The contents are evaluated for amylase content and parameters of infection and malignancy. A high amylase content suggests pseudocyst communication with the pancreatic duct. As mentioned above, an attempt should be made to evacuate the entire contents as this can be therapeutic and obviate the need for subsequent drainage.

Instruments

Transmural pseudocyst puncture and stent placement is best performed with a therapeutic (4.2-mm working channel) duodenoscope. The side-viewing optic provides an en face view of the bowel wall, and the elevator facilitates stent placement.

Cyst puncture is performed with a special needle catheter that allows for puncture as well as immediate guidewire placement without an exchange of instruments. Needle entry into the cyst is confirmed by aspiration of pseudocyst contents or contrast injection of the pseudocyst under fluoroscopy (Fig. 204).

An Erlangen sphincterotome is used to create a cystoenterostomy. The instruments used for pseudocyst stent drainage are the same as for bile duct drainage. We use a modified 10-French pigtail stent with opposing flaps for proper anchorage.

A 7-French nasocystic catheter is used for irrigation of infected cysts and abscesses.

Pseudocyst puncture under EUS guidance requires a curved-array echoendoscope with color Doppler capability.

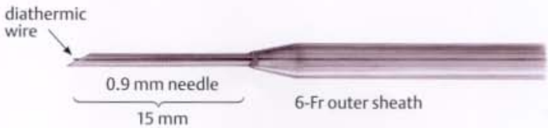


Fig. **204** Diathermic needle catheter for transmural pseudocyst puncture. The needle catheter consists of a retractable inner injection catheter contained in an outer Teflon sheath. Current is applied to the needle (1.5 cm long, 0.9 mm thick) through a thin diathermic wire that runs through the inner catheter. The tip of the outer sheath tapers from 6- to 4-French, enabling easier passage into the pseudocyst. A 0.035-in guidewire can be passed through the outer sheath.

Technique

Similar to biliary and pancreatic ductal drainage, the procedure is performed under fluoroscopic guidance. Endosonographic guidance is optional and primarily reserved for transmural drainage of pseudocysts that do not produce prominent mural bulging.

Depending on the anatomic conditions, pseudocysts can be drained through the stomach or duodenal wall (transmural route), or the pancreatic duct (transpapillary route).

Transmural Drainage

The cyst is punctured through the stomach or duodenal wall depending on where it is in maximal contact with the bowel wall. From the stomach, the cyst is usually approached from the posterior wall of the antrum or midbody; from the duodenum, the cyst is approached from the greater curvature of the duodenal bulb. Prerequisites for transmural drainage are a visible bulge produced by the cyst and the absence of vessels interposed between the pseudocyst and bowel lumen. The latter can be best excluded by endosonographic examination, which should be mandatory in patients with suspected segmental portal hypertension secondary to splenic vein thrombosis (Fig. 205).

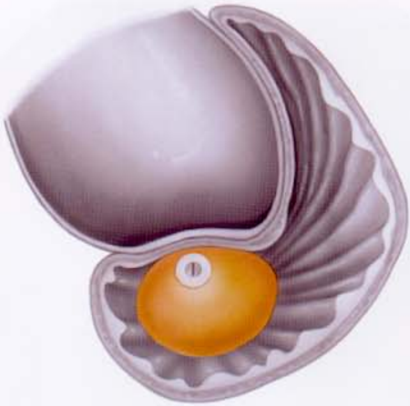
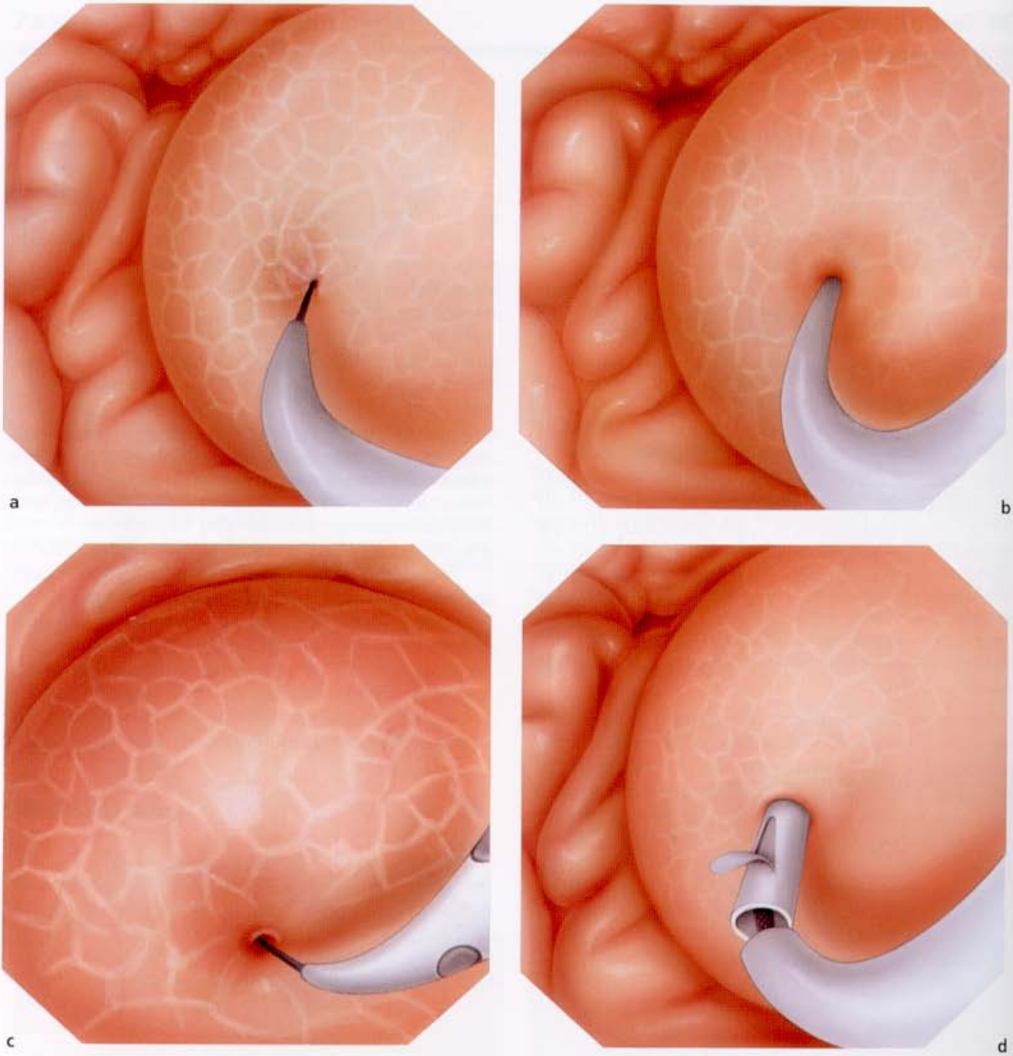


Fig. **205** Cross-sectional, radial scanning endosonographic image of a pseudocyst. The mechanically rotating transducer is placed along the posterior wall of the stomach. A water-filled balloon surrounds the transducer. This is an important investigation to look for vessels that may be interposed between the pseudocyst and the bowel lumen. This instrument, however, does not have color Doppler capability.

Fig. **206** Cross-sectional view of the abdomen showing the typical position of a large pseudocyst compressing the posterior wall of the stomach. Computed tomography provides similar topographic representation.

Fig. **207** Corresponding endoscopic view showing a distinct bulge on the posterior wall of the stomach. The mucosa shows loss of folds and a mosaic pattern. In such cases, pseudocyst puncture can be performed with a negligible risk of bleeding.



a b c d

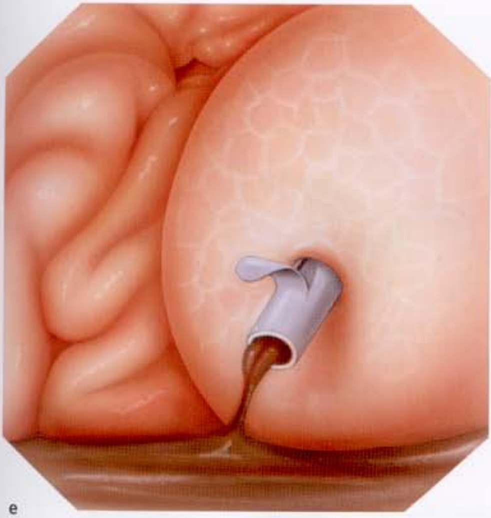
Fig. **208a–f** Transgastric puncture and drainage of a large pseudocyst.

a The pseudocyst is punctured with the diathermic needle catheter at the site of a maximal bulge. With the application of cautery, the needle easily penetrates the interposed tissue. Entry into the pseudocyst is typically signalled by a sudden give in resistance.

b Following puncture, contrast medium is injected under fluoroscopy, or pseudocyst contents are aspirated to confirm entry into the pseudocyst. The outer catheter is advanced into the cyst, and the retractable injection catheter is withdrawn. After passing a 0.035-in Teflon-coated guidewire into the pseudocyst, the outer sheath is removed.

c A 10-French pigtail stent (15 cm long) with multiple side-holes is inserted over the guidewire using a pusher tube.

d A side flap at the distal end prevents proximal migration of the stent into the pseudocyst.



e

f

Fig. **208e** A sudden gush of amber to brown colored fluid from the pseudocyst signifies a correct stent position in the cyst.

f Transparent view of a 10-French single pigtail stent with large side-holes. Two opposing flaps separated by 2 cm anchor the stent in the intervening wall. The stent extends approximately 1 cm into the lumen.

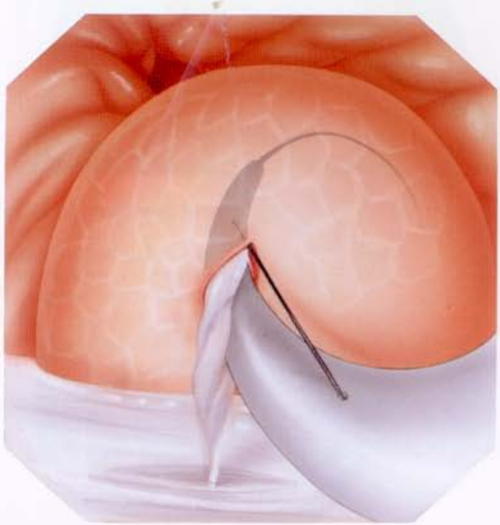
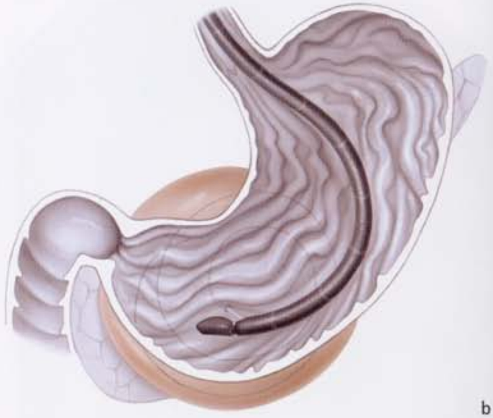


Fig. **209** Endoscopic cystogastrostomy. As an alternative to stent drainage, a cystoenterostomy can be created with a double-lumen sphincterotome over the guidewire. A 10- to 15-mm incision is made with the sphincterotome.

Endosonography-Guided Pseudocyst Drainage

Pseudocysts that do not produce an obvious bulge in the stomach wall or duodenal wall should be drained under endosonographic guidance. These pseudocysts tend to be thick-walled and do not adhere to the bowel wall. Endosonography-guided puncture allows the endoscopist to follow the path of the needle into the pseudocyst. Interposed vessels can be safely bypassed (Fig. **210**).



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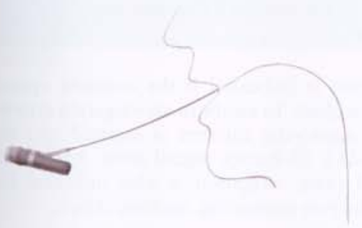
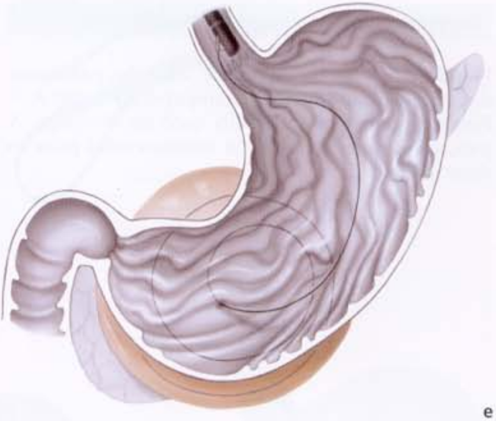
a

Fig. **210a–g** Endosonography-guided pseudocyst puncture and drainage.
a Using an electronic scanning curved-array echoendoscope, the pseudocyst is imaged from the stomach or duodenum and the optimum site for puncture identified. Color Doppler is used to highlight vascular structures. The diathermic needle catheter is visualized lengthwise as it is inserted into the pseudocyst.
b Following confirmation of cyst puncture with contrast injection under fluoroscopy, the outer sheath is advanced into the cyst, and the needle catheter is exchanged for a 0.035-in Teflon-coated guidewire. To ensure proper anchorage, the guidewire should coil several times in the cyst.
c To allow placement of a 10-French stent, the echoendoscope is exchanged over the wire for a therapeutic duodenoscope with a 4.2-mm working channel.





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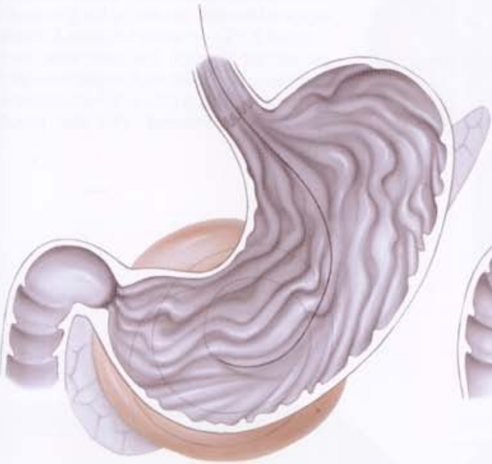

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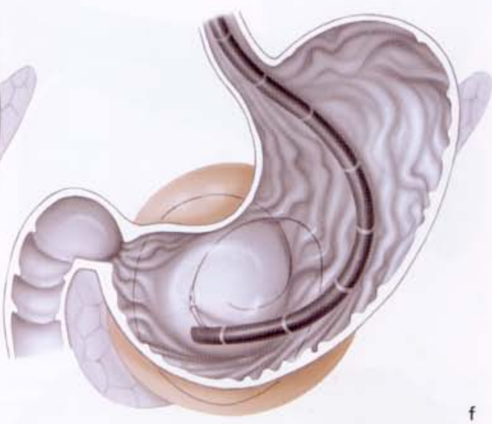

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Fig. **210d** With the aid of a previously inserted 6-French catheter, the guidewire passes through the working channel of the duodenoscope and exits through the inlet port.
e The duodenoscope is advanced over the guidewire under fluoroscopy, straightening the guidewire when necessary.
f Placement of a 10-French pigtail stent using standard technique.
g View of the pigtail stent with multiple side-holes draining the pseudocyst. Two opposing flaps anchor the stent in the intervening wall.

Transpapillary Drainage of Pseudocysts

Pseudocysts that communicate with the pancreatic duct can be drained via the transpapillary route. A 7-French pigtail stent is usually used for drainage. A pancreatic sphincterotomy is recommended prior to stent insertion.

Irrigation of an Infected Pseudocyst or Abscess

Cyst irrigation is indicated if the contents appear cloudy or purulent. To establish an irrigation system, a 7-French nasocystic catheter is inserted into the cyst alongside a 10-French pigtail stent. Apart from for infected cysts, irrigation is also indicated for acute pseudocysts containing necrotic debris.

Fig. **211** Transpapillary drainage of a pseudocyst communicating with the main pancreatic duct in the region of the tail. Guided by the Universal catheter, a J-tipped 0.032-in hydrophilic wire is inserted into the pseudocyst through the pancreatic duct. The hydrophilic wire is then exchanged through the Universal catheter for a 0.035-in Teflon-coated wire. A pigtail stent is inserted into the pseudocyst for drainage.

a

b

Fig. **212a–c** Irrigation of an infected pseudocyst.
a Frank pus draining from a 10-French pigtail stent. A 0.032-in angulated hydrophilic wire is guided with the Universal catheter alongside the 10-French stent into the cyst.

b After the Universal catheter is advanced deep into the cyst, the hydrophilic wire is exchanged for a 0.035-in Teflon-coated wire. A 7-French nasocystic catheter is inserted over the guidewire and loops within the cyst. Before removing the endoscope, saline is injected through the nasocystic catheter to check for a good backflow through the 10-French stent.

Fig. **212c** The nasocystic catheter is directed through the nostril in the usual fashion. Contrast medium is injected through the nasocystic catheter to confirm its patency and position.

■ Complications

The most common complication of internal cyst drainage is early stent clogging resulting in cyst infection. Symptoms of infection mandate immediate endoscopic intervention. Apart from exchanging the stent, a 7-French nasocystic catheter should be inserted for cyst irrigation. Irrigation can be performed by continuous infusion with saline or Ringer's solution but should be supplemented by daily manual irrigation. Contents are aspirated through the nasocystic catheter to confirm clearing of the infection. Systemic antibiotics, best selected on the basis of culture and sensitivity results, are indicated.

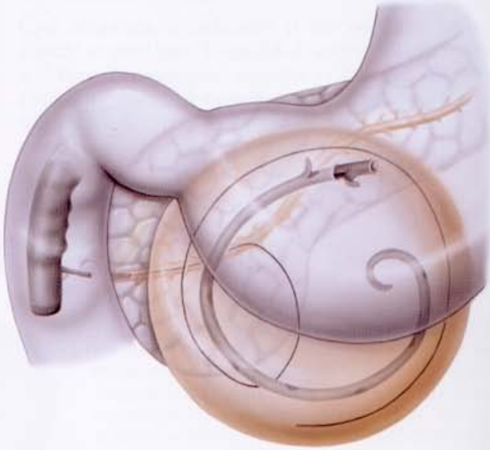
After stent drainage, sonographic examinations are performed daily or every alternate day. Large uncomplicated cysts will resolve within 2 to 3 weeks. Infected or debris-filled cysts may take longer to resolve.

Other complications include bleeding after transmural puncture or drainage, and pancreatitis after transpapillary drainage.

Management of Pancreatic Leaks and Fistulas

Pancreatic leaks and fistulas may have different etiologies. The most common is acute pancreatitis. If fluid collection persists or recurs after a bout of pancreatitis, the possibility of a pancreatic duct leak or fistula should be considered. Pancreatic duct leaks occasionally complicate abdominal surgery or, more rarely, abdominal trauma. The fluid is usually clear, and the amylase content is very high.

A pancreatic leak can be immediately sealed with the cyanoacrylate tissue adhesive (Histoacryl). Alternatively, a leak may secondarily heal after the rupture site has been bridged with a pancreatic stent. The prerequisite for these techniques is that there is no concomitant infection and that the fluid collection is drained externally.



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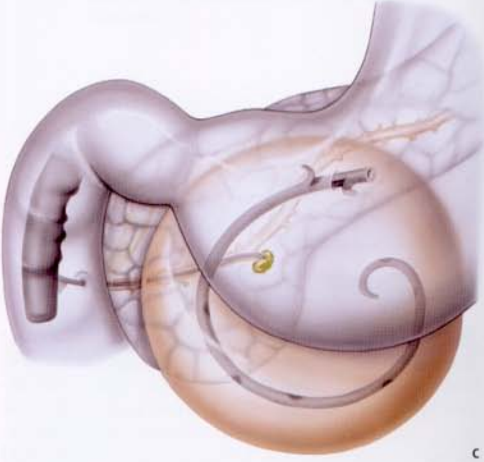

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Fig. **213a–c** Combined transgastric drainage and transpapillary-fistula-sealing of a large recurrent pseudocyst.
a The pseudocyst is drained by transgastric insertion of a 10-French pigtail stent. The pancreatic duct is then cannulated, and the fistula site is identified. A preliminary pancreatic sphincterotomy may be performed at this point to facilitate pancreatic duct instrumentation. Guided by the Universal catheter, a 0.032-in angulated hydrophilic wire is maneuvered across the fistula into the cyst.
b The Universal catheter is advanced to the fistula site. Precise positioning of the catheter tip is important and is monitored by injecting contrast under fluoroscopy.
c A few milliliters of the Histoacryl-Lipiodol mixture (1:1) is injected, followed by a volume of distilled water equal to the dead space of the catheter. Because Lipiodol is radiopaque, deposition of the mixture in the fistula can be radiographically monitored.

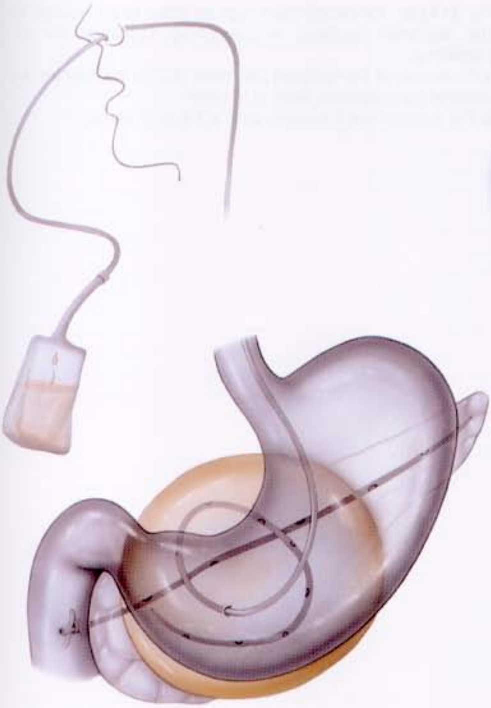

Fig. **214** Management of an acute cyst in the setting of necrotizing pancreatitis. A 7-French nasocystic catheter is inserted across the stomach wall to irrigate and drain the acute cyst. An additional 10-French pigtail stent can be inserted alongside the nasocystic catheter to establish an irrigation circuit. A 7-French stent is inserted into the pancreatic duct to bridge the fistulous communication between the pancreatic duct and the cyst.

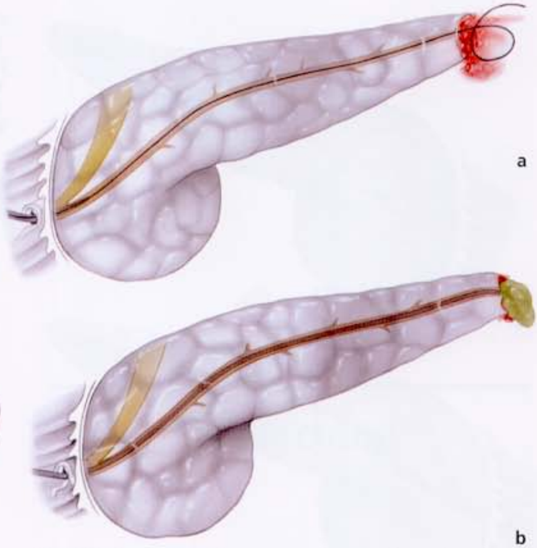

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Fig. **215a,b** Disrupted pancreatic duct in the region of the tail following splenectomy. An external percutaneous drain is already in place. The leak is sealed with the cyanoacrylate tissue adhesive.

a After a pancreatic sphincterotomy, the hydrophilic guidewire is advanced up to the site of the leak.

b The leak is sealed with a few milliliters of the Histoacryl-Lipiodol mixture (1:1).

Fig. **216** Abscess in the left upper abdomen complicating a pancreatic duct disruption after a pancreatic tail resection. An irrigation circuit is established by inserting a 7-French nasopancreatic catheter and an external percutaneous drain. The leak is sealed with the cyanoacrylate tissue adhesive after the infection clears. ▼

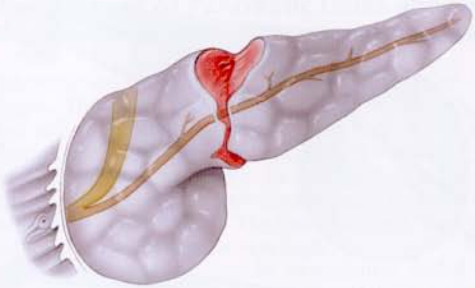

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Fig. **217a,b** Pancreatic duct rupture after blunt trauma to the abdomen (without a compelling indication for laparotomy).
a Continuity of the ruptured pancreatic duct is maintained. An external percutaneous drain is in place.
b The rupture site is bridged with a 7-French stent.

14

Papillectomy

General

Endoscopic papillectomy is the local excision of an adenoma involving the major or minor papilla. Like colonic polypectomy, the therapeutic value depends on the histology of the resected specimen and the completeness of endoscopic excision. If completely excised, the histologic absence of invasive malignancy qualifies the procedure as therapeutic. The endoscopic approach has the inherent advantage of being far less invasive than surgery.

Indications

Only well-demarcated exophytic lesions are amenable to snare excision. Lesions smaller than 30 mm can be excised with a very low complication rate. Lesions growing into the bile duct or pancreatic duct cannot be completely removed and should therefore be treated surgically. Lesions with endoscopic features of coexistent malignancy (e.g., ulceration, friability, and induration) should also be treated surgically.

Prerequisites

Papillectomy is too risky to serve as a diagnostic procedure alone. Careful selection of lesions that are likely to be cured by endoscopic treatment is necessary. The procedure should be restricted to lesions that appear benign and are amenable to complete endoscopic excision. Proper tissue processing and reliable histopathologic evaluation of the resected specimen are absolute prerequisites. Surgical treatment is indicated if invasive carcinoma is identified. Endoscopic surveillance at regular intervals is required to detect and treat recurrent adenoma.

Instruments

A therapeutic duodenoscope with a 4.2-mm working channel is recommended. A standard polypectomy snare is used for excision, whereby we prefer to use a monofilament wire snare. Pure cutting current (setting of 3 to 4) should be used to minimize accompanying tissue edema.

The resected specimen is retrieved with a snare or a three-pronged grasper. Small pieces can be suctioned through the working channel of the duodenoscope and collected in a polyp trap. Accessories for endoscopic hemostasis, such as an injection catheter and clip applicator, should be available.

A 7-French pancreatic stent is used to drain the pancreatic duct after the papillectomy.

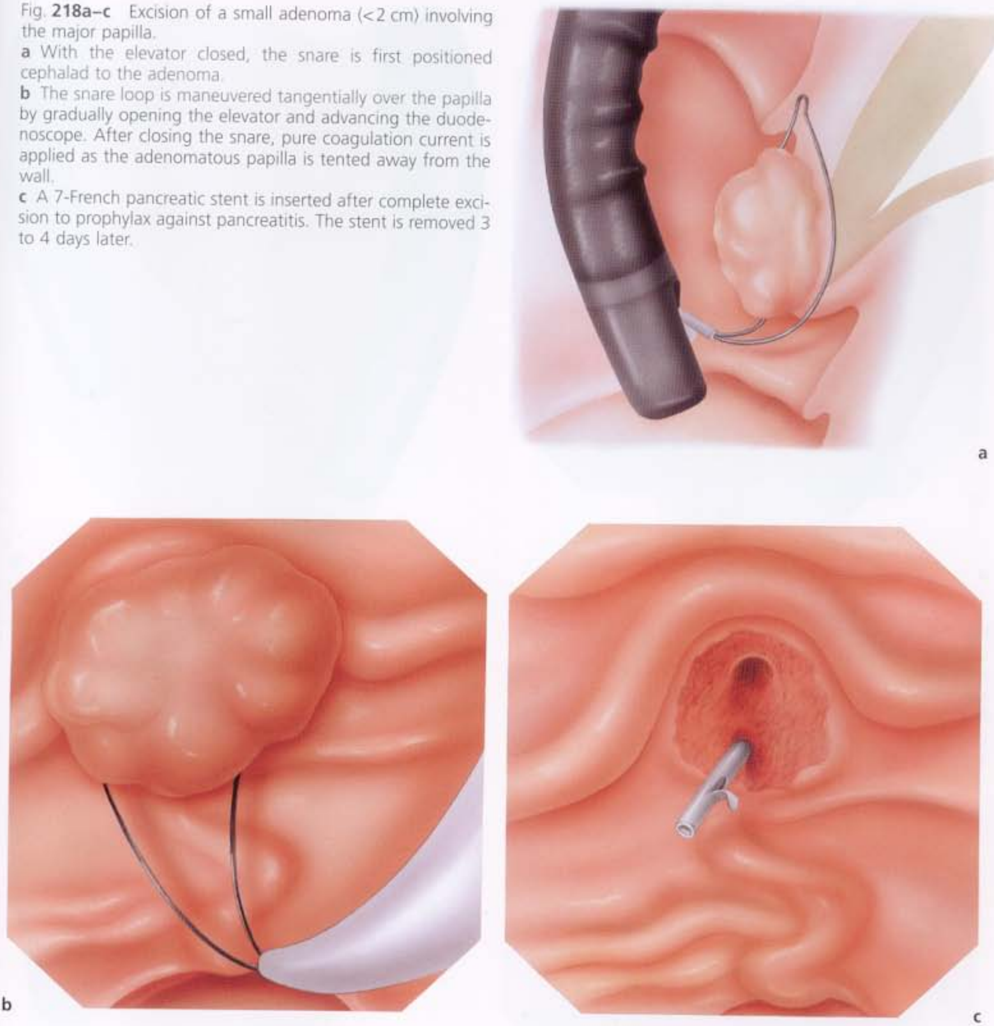
Technique

If the adenoma is small, the papilla is completely ensnared and excised (Fig. **218**). Larger adenomas require piecemeal resection (Fig. **219**, 220).

Complications

Possible complications include bleeding, pancreatitis, and perforation. Bleeding can usually be managed with injection of diluted epinephrine. Arterial bleeding is rare and can be arrested with clips. The risk of acute pancreatitis can be minimized by placing a 7-French pancreatic duct stent for 3 to 4 days. Perforation is rare if careful technique is used. If it occurs, treatment is generally surgical.

Fig. **218a–c** Excision of a small adenoma (<2 cm) involving the major papilla.
a With the elevator closed, the snare is first positioned cephalad to the adenoma.
b The snare loop is maneuvered tangentially over the papilla by gradually opening the elevator and advancing the duodenoscope. After closing the snare, pure coagulation current is applied as the adenomatous papilla is tented away from the wall.
c A 7-French pancreatic stent is inserted after complete excision to prophylax against pancreatitis. The stent is removed 3 to 4 days later.



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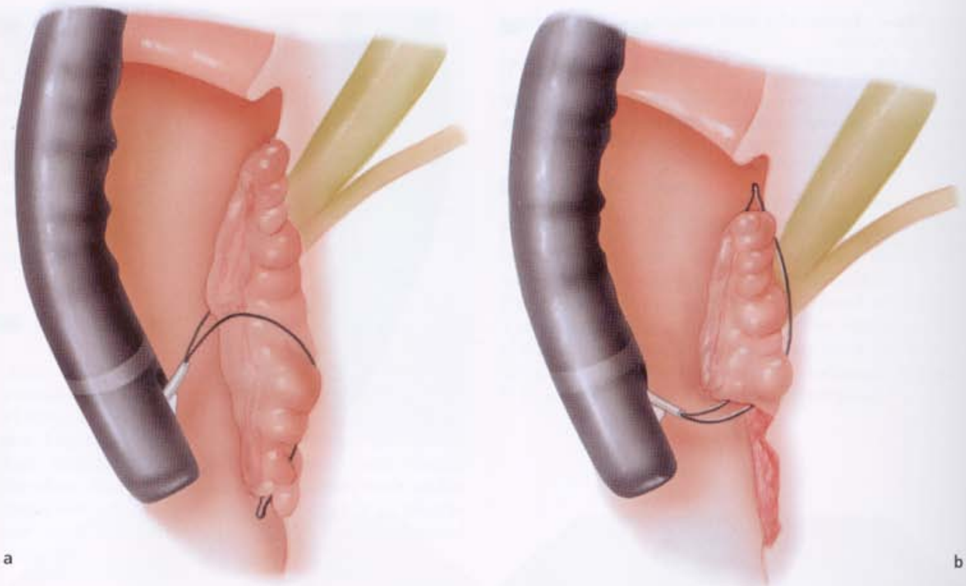


Fig. **219a,b** Piecemeal resection of a 2- to 3-cm sessile polyp adenoma involving the major papilla.
a The duodenoscope is slightly withdrawn to access the lower edge portion of the adenoma. This is ensnared and excised.
b The remaining cephalad portion is removed using the fulcrum technique. The tip of the snare is impacted cranial to the adenoma and used as a fulcrum to pivot the snare over the papilla. The elevator is gradually opened as the snare is advanced and pressed flat against the wall. Slight advancement of the endoscope will provide a more tangential orientation. As the snare is closed, it is simutaneously advanced an equal amount to prevent the encircled tissue from slipping out of the snare.

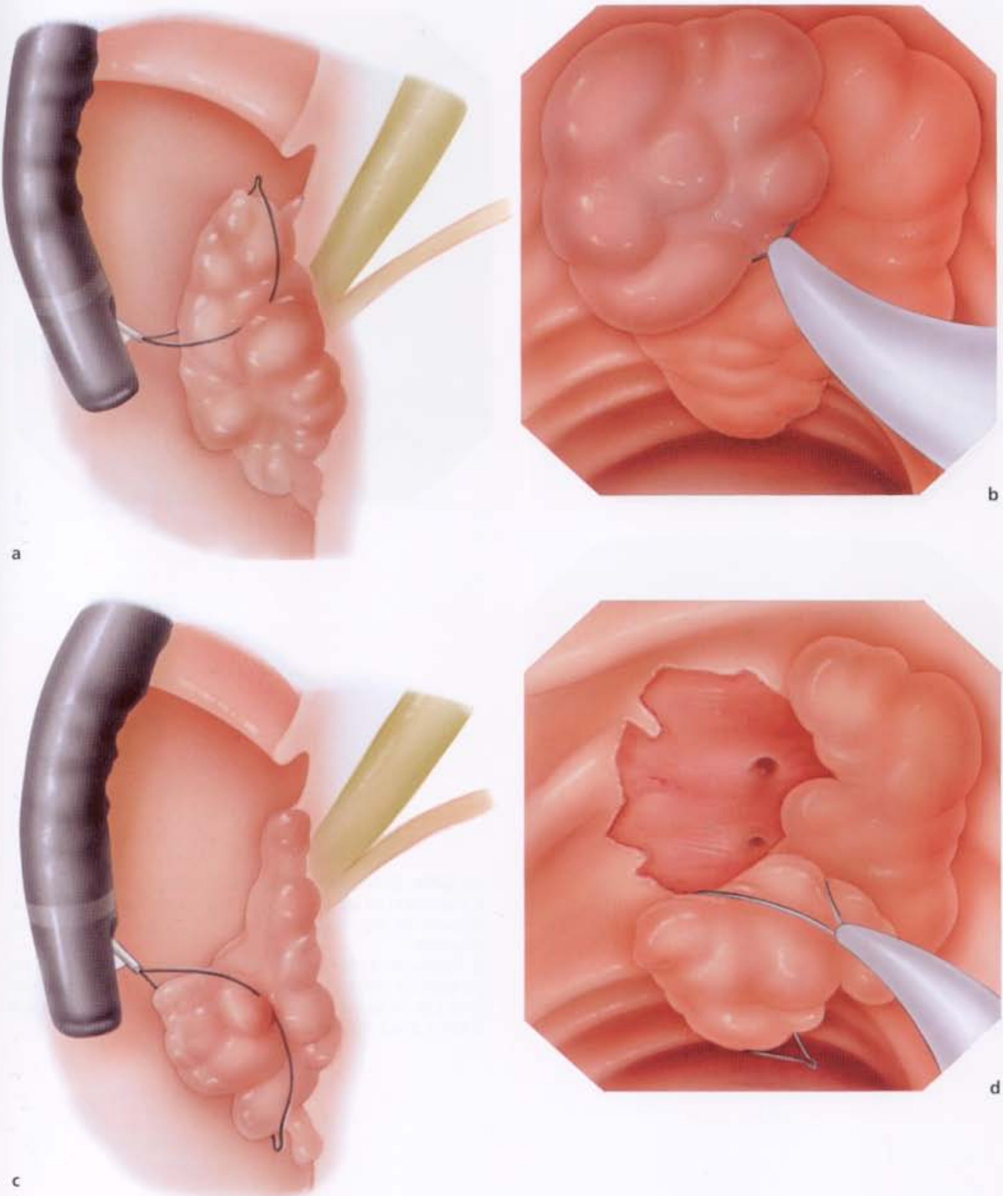
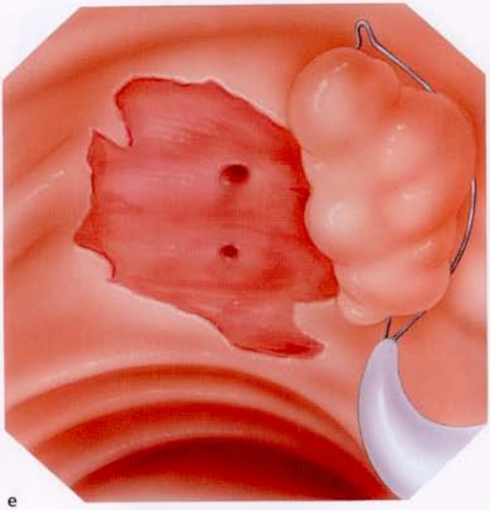


Fig. **220a–g** Piecemeal resection of a large adenoma involving the major papilla.
a,**b** The cephalad portion of the adenoma is resected first.

c,**d** The caudad portion is then excised. The pieces should be no larger than 1 cm to enable aspiration through the endoscope working channel.

Fig. **220e–g** ▶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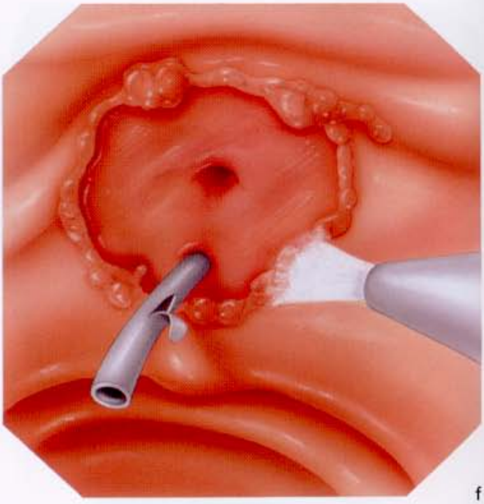
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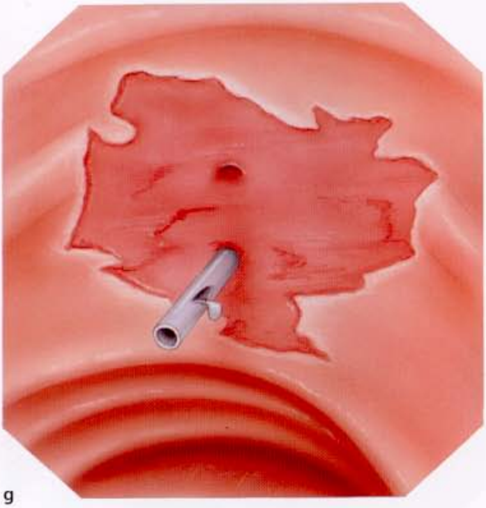
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Fig. **220e** Excision of residual tissue along the lateral borders.
f Placement of a 7-French stent in the pancreatic duct before fulgurating the resection margins with the argon plasma-coagulator.
g Appearance after complete excision of the adenoma. Multiple sessions may be required to remove a large adenoma. Sessions can be repeated at weekly intervals. The pancreatic stent is left in place for the duration of treatment.

15

Polypectomy in the Colon

General

Polypectomy should be viewed first and foremost as a diagnostic procedure. It is well-known that superficial biopsies can miss areas of malignancy. Snare resection of the entire polyp provides the only guarantee that malignancy has not been overlooked. The histopathologic evaluation of the polyp will determine if polypectomy qualifies as a therapeutic procedure. Endoscopic polypectomy is an effective measure to prevent colorectal carcinoma.

Indications

Carcinomatous transformation of adenomatous polyps can occur irrespective of their size; hence, all polyps encountered in the rectum and colon should be removed. Polyps measuring greater than 5 mm can usually be removed with the diathermic snare. Smaller polyps are difficult to ensnare and are therefore removed with the biopsy forceps.

Prerequisites

The histopathology of the resected polyp will determine the therapeutic adequacy of endoscopic resection. Proper processing of the resected specimen is therefore a fundamental prerequisite. After complete excision, the specimen is retrieved and fixed in a 4% formaldehyde solution. Polyps with a short stalk and sessile polyps should be marked prior to fixation to indicate their orientation for histologic sections (for example, a needle can be inserted into the surface where transsection occurred). The location, morphology (pedunculated or sessile), size, and number of polyps excised are documented in the endoscopy report and should be communicated to the pathologist. The pathology report, in turn, should include information regarding the following parameters: number of tissue specimens submitted (multiple polyps versus pieces of a single large polyp), histologic tumor type and differentiation grade, depth of neoplastic involvement, evidence of submucosal lymphatic invasion, and the integrity of the margins of resection (completeness of resection). Each of these parameters contributes to an overall assessment of the risk of possible lymph node metastases.

Polypectomy is a curative procedure when malignancy is limited to the mucosa. If the submucosa is invaded, the malignancy is prone to spread to the lymph nodes, the risk of which will depend on the grade of cell differentiation and the presence of lymphatic invasion. Endoscopic polypectomy alone is likely to be curative if the neoplasia is well differentiated and does not show submucosal lymphatic or vascular invasion (low risk for lymph node metastases). The risk of surgical intervention needs to be weighed against the risk of lymph node metastases. Factors that indicate a high risk for lymph node metastases include poor differentiation grade, submucosal lymphatic invasion, and involvement of the margins of resection. These factors constitute absolute indications for surgical resection.

A multiplicity of polyps in different parts of the colon is common. It is important to perform a total colonoscopy to ensure that there are no synchronous lesions.

A basic prerequisite for polypectomy is an adequately prepared colon. The need for appropriate training in colonoscopy and polypectomy technique is self-evident. In addition, the endoscopist should be capable of managing postpolypectomy bleeding using different endoscopic hemostatic techniques.

Instruments

A medium-length therapeutic colonoscope (130 cm long with a 4.2-mm working channel) can be passed to the cecum and terminal ileum in nearly all cases. The longer 170-cm colonoscope is rarely required; it may have to be used in conjunction with a stiffening tube to reduce a long sigmoid loop (Fig. **221**).

A fine monofilament steel wire snare is recommended for polypectomy. The monofilament wire is stiffer than the braided wire and provides greater stability for ensnaring maneuvers. Pure coagulation current (setting of 3 to 4) is used to ensure that the tissue is well fulgurated, and to provide hemostasis.

Various coagulation probes can be used to fulgurate residual adenomatous tissue at the resection margins of sessile polyps. Argon plasma-coagulation is an ideal modality to achieve a rapid fulguration.

Instruments for the management of postpolypectomy bleeding should be at hand. Depending on the method of endoscopic hemostasis used, these include needle catheters for the injection of diluted epinephrine, and applicators for clip and endoloop hemostasis.

A three-pronged grasper, Dormia basket, and net are necessary to retrieve the resected polyp. Small polyps can be aspirated through the working channel of the colonoscope and collected in a special polyp trap that is attached to the suction outlet of the colonoscope.

Black india ink is used to mark or tattoo the resection site. One milliliter of diluted (1:10) india ink is injected submucosally at contralateral ends near the resection site. This will leave a permanent mark visible both internally and on the serosal aspect of the bowel (Fig. **222**).

Technique

The technical feasibility and risks of endoscopic polypectomy depend upon three factors: polyp morphology (e.g., pedunculated or sessile), size, and location. Pedunculated polyps can usually be removed regardless of size or location. Large sessile polyps present a greater challenge owing to the need for piecemeal resection, which is associated with a

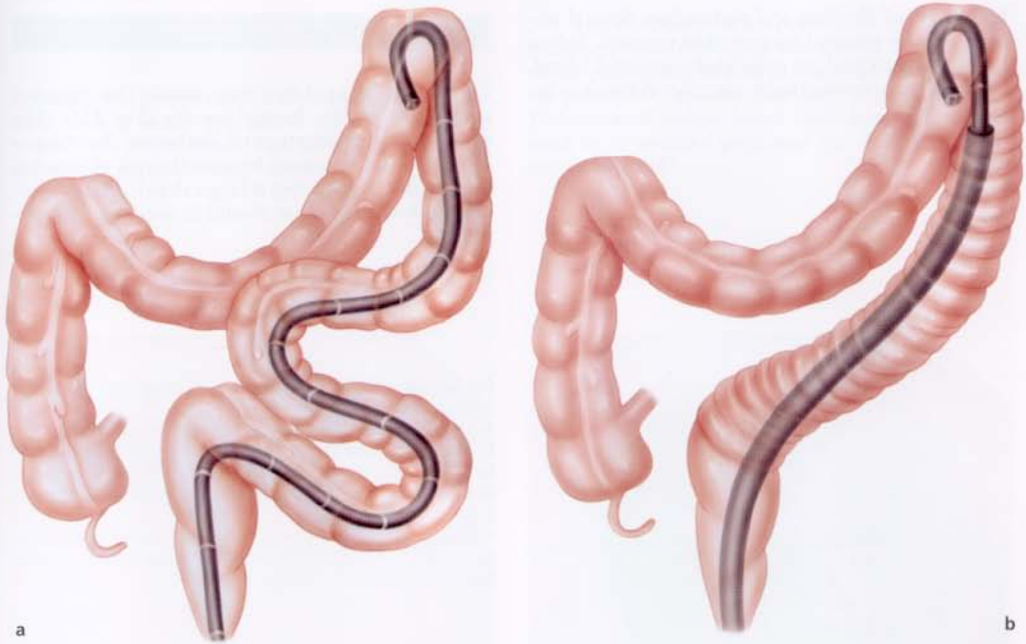


Fig. **221a,b** Use of the stiffening tube to reduce a long sigmoid colon.
a The stiffening tube is placed over the colonoscope before the procedure. The colonoscope is advanced to the splenic flexure, then hooked with the bending section of the insertion tube by maximally deflecting the tip.
b The sigmoid loop is reduced under fluoroscopy by withdrawal and simultaneous clockwise rotation. The stiffening tube is then cautiously advanced under fluoroscopy until it approaches the splenic flexure. It is important that the position of the tube does not shift during the remainder of the procedure as this can result in colon injury. An assistant should hold the tube in a stationary position at the anus.

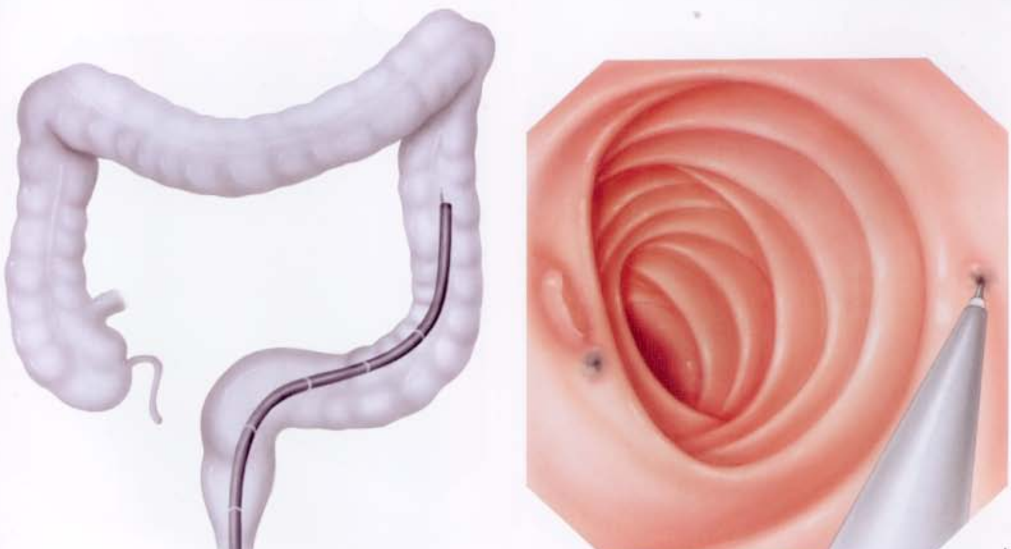


Fig. **222a,b** Endoscopic tattooing of the colon. In the region of the lesion black india ink (diluted 1:10) is injected submucosally at two contralateral points. At least one of the tattoos will be visible intraoperatively along the serosal aspect of the colon.

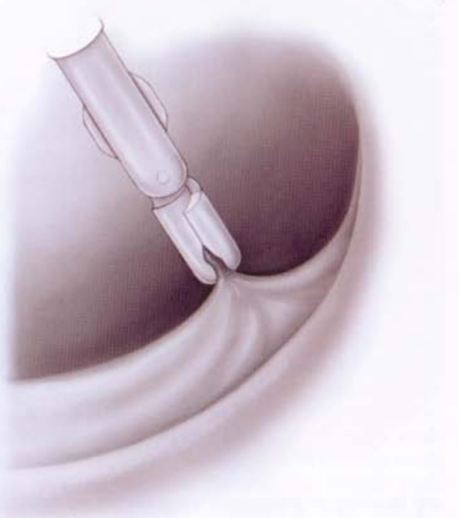
higher risk of bleeding and perforation. Several sessions may be required for complete removal. Polyps located along a fold, an angulated portion of bowel, or behind the ileocecal valve are more difficult to remove.

Diminutive Polyps

Polyps less than 5 mm can usually be removed completely with a biopsy forceps (Fig. 223). The simultaneous application of diathermy (hot biopsy forceps) is not necessary because the risk of bleeding is negligible. If the polyp is larger than the biopsy forceps, a diathermy snare should be used for polyp removal.

Fig. **223a–c** Removal of a diminutive polyp with the biopsy forceps.
a The polyp is smaller than the opened biopsy forceps.
b The polyp is grasped at its base and mechanically resected by pulling away from the bowel wall. If a hot biopsy forceps is used, the polyp must be tented towards the lumen during application of current.
c After removal, a small mucosal defect is seen at the polypectomy site. Minimal, self-limiting bleeding may occur after mechanical resection.

a



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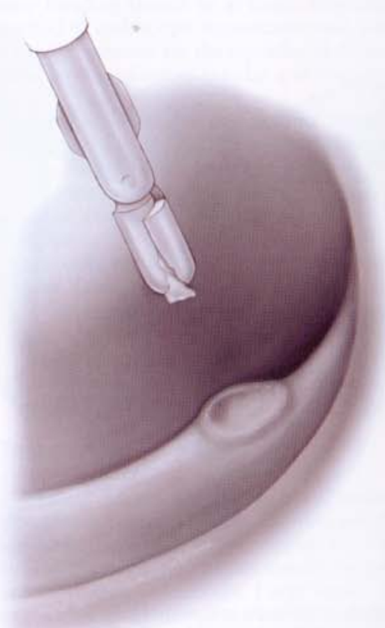


c

Pedunculated Polyps

Pedunculated polyps can usually be transected at the stalk with a single application of the snare loop around the polyp head (Figs. 224, 225). A larger polyp may require a larger snare.

Thicker polyp stalks present a higher risk for postpolypectomy bleeding and should therefore undergo preliminary treatment (e.g., injection, ligature) to prophylax against bleeding (Figs. 226, 227). Pedunculated polyps larger than 4 cm will usually need to be resected piecemeal (see Piecemeal Technique, Fig. 228).

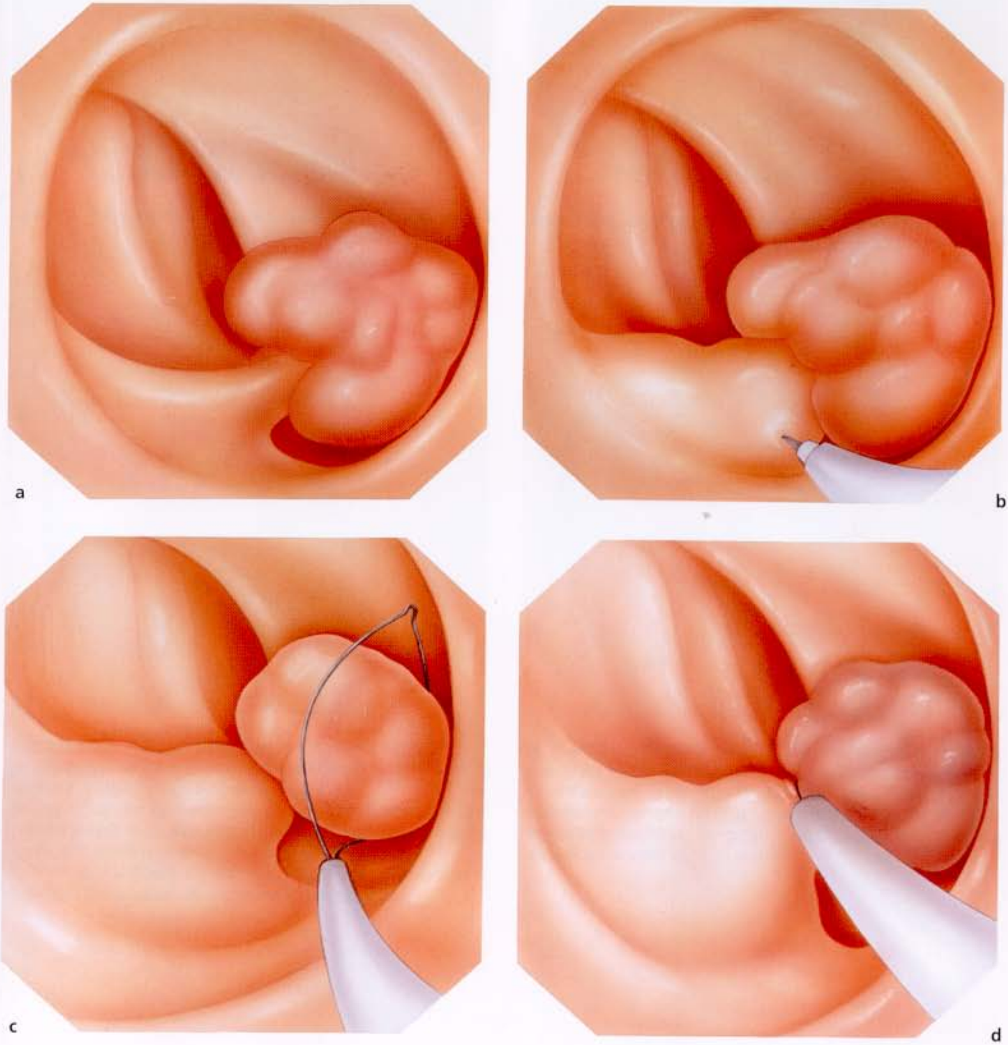
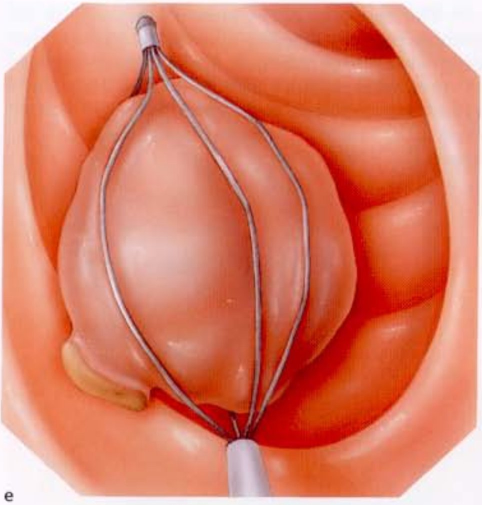


Fig. **224a–e** Removal of a pedunculated polyp.
a The optimal position for polypectomy is the 6-o'clock position (extension of the working-channel axis). This is achieved by rotating the endoscope or the patient.
b Injection of the pedicle with several milliliters of diluted epinephrine (1:20 000).
c The wire loop of the snare is maneuvered over the head of the polyp.
d The snare is closed around the pedicle close to the polyp head, leaving a residual pedicle to avoid perforation.

Fig. 224e–f ►



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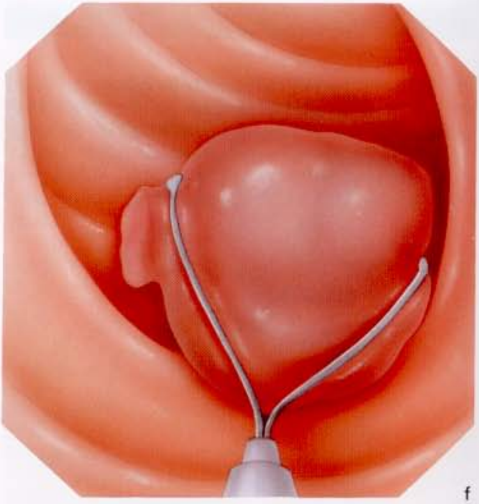

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Fig. **224e** The resected polyp is retrieved with the same snare or a Dormia basket.

f Alternatively, the polyp can be retrieved with a three-pronged grasper.

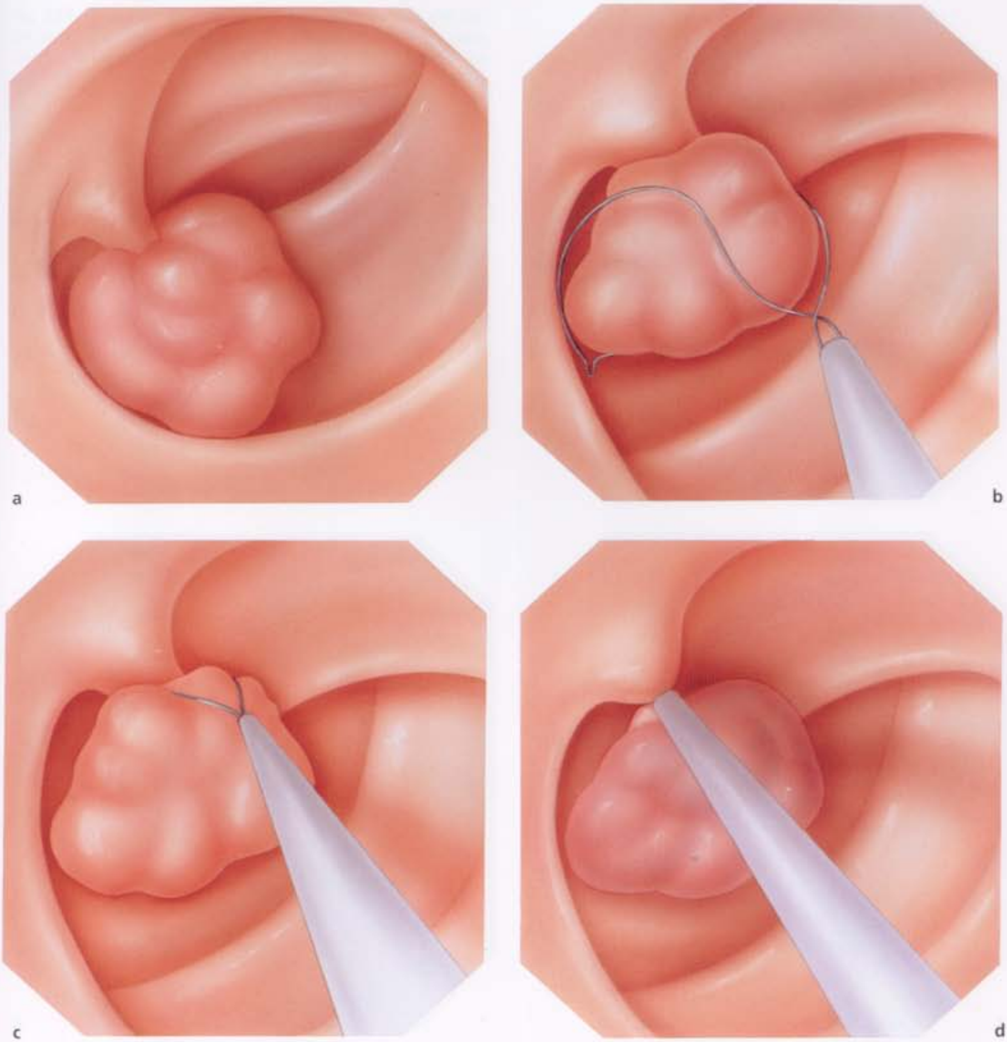


Fig. **225a–d** Fulcrum technique.
a The polyp, located at the 10-o'clock position, is difficult to ensnare using the standard technique.
b The tip of the opened snare is impacted against the contralateral wall, then, keeping the tip fixed and using it as a fulcrum, the snare is pivoted back along its long axis.
c The snare is slowly closed and simutaneously advanced to maintain the position of the snare at the pedicle.
d The snare is tightened around the pedicle close to the polyp head. Before current is applied, the ensnared site is inspected to make sure that neighboring tissue has not been accidentally caught and that the tip of the snare is not in contact with the opposite bowel wall. The polyp is gently pulled away from the wall during application of current.

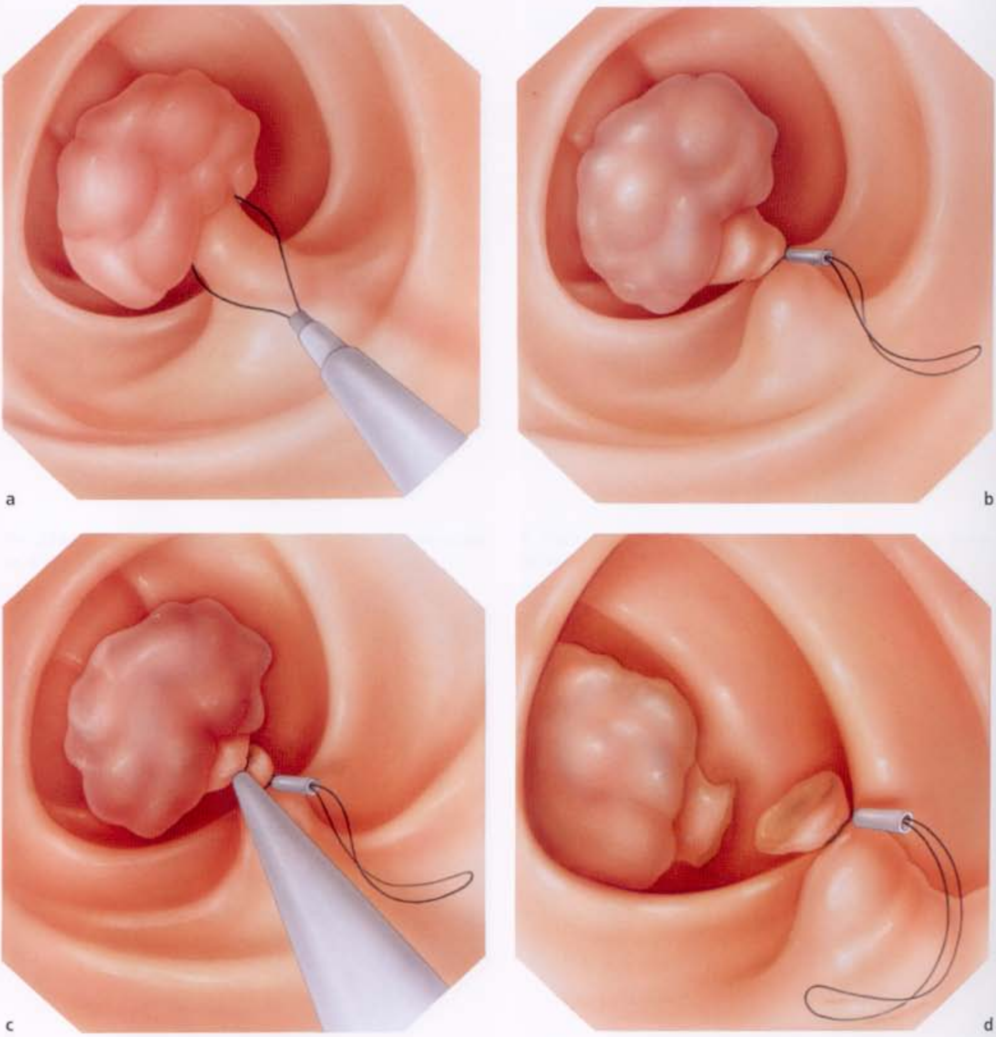
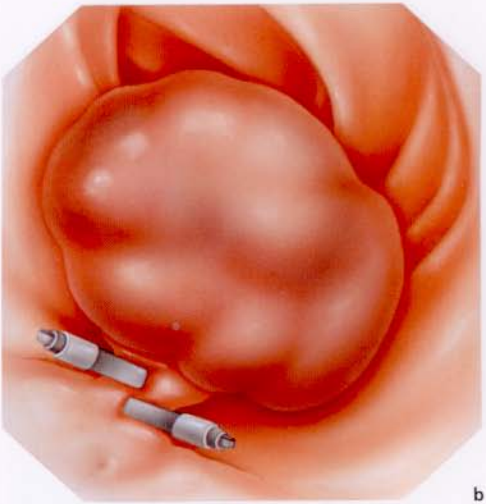


Fig. **226a–d** Endoloop application to a thick pedicle as a prophylactic measure to prevent postpolypectomy bleeding.
a Used like a snare, the endoloop is positioned around the pedicle.
b The endoloop is tightened and detached close to the pedicle attachment at the bowel wall, leaving ample room towards the head for placement of the snare.
c The snare is positioned around the intervening portion of the pedicle close to the polyp head.
d Appearance of the surface of the transected pedicle. There is no bleeding at the transection site.

Fig. **227** As an alternative to the endoloop, a hemoclip can be applied to the pedicle prior to polypectomy. In this case, one hemoclip suffices to ligate the entire circumference of the pedicle.

a

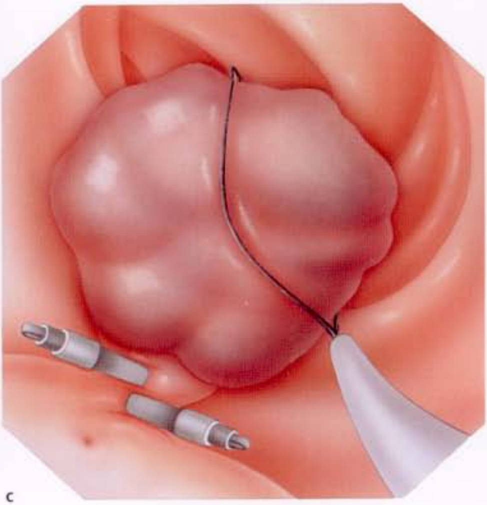


b

Fig. **228a–g** Piecemeal resection of a large pedunculated polyp.
a Through rotation of the endoscope, the pedicle of the polyp is positioned at 6-o'clock.

b To prevent postpolypectomy bleeding, two opposing hemoclips are placed to ligate the full circumference of the thick pedicle. In addition, diluted epinephrine (1:20 000) was injected.

Fig. **228c–g** ►



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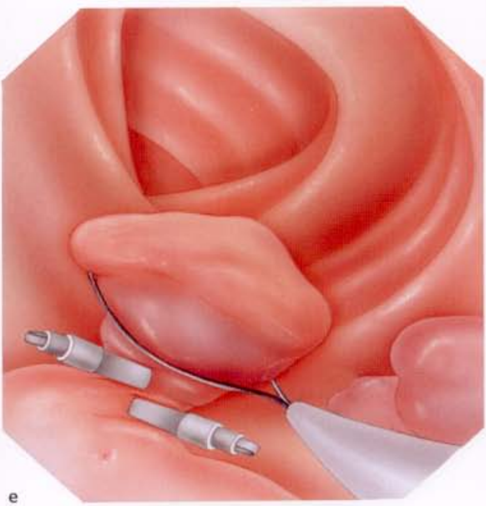

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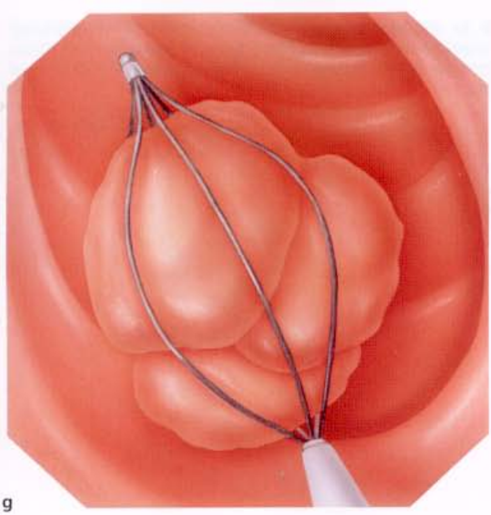


g

Fig. **228c** The polyp head cannot be completely ensnared, making piecemeal resection necessary.
d After removing a portion of the polyp, a second portion is ensnared above the base of the polyp.
e The base of the polyp is resected last. The snare is positioned around the pedicle, taking care that the snare is not in contact with the metal hemoclips.
f The transected pedicle shows no bleeding.
g Pieces of the resected polyp are captured in a Dormia basket.

Small Sessile Polyps

Small sessile polyps can usually be resected with a single application of the snare (Fig. 229). Very flat polyps are raised by injecting several milliliters of saline into the submucosal layer. The snare is positioned as tangentially as possible, parallel to the bowel wall. Only the mucosal and submucosal layers are grasped, which can be tented away from the underlying muscularis propria layer. Maximal air inflation of the bowel lumen is necessary to ensure that a bowel fold is not accidentally captured in the snare.

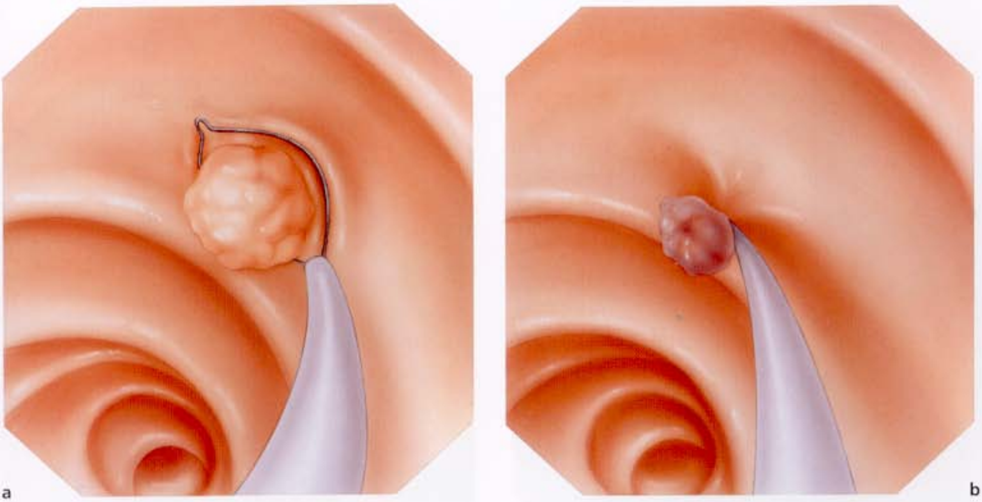
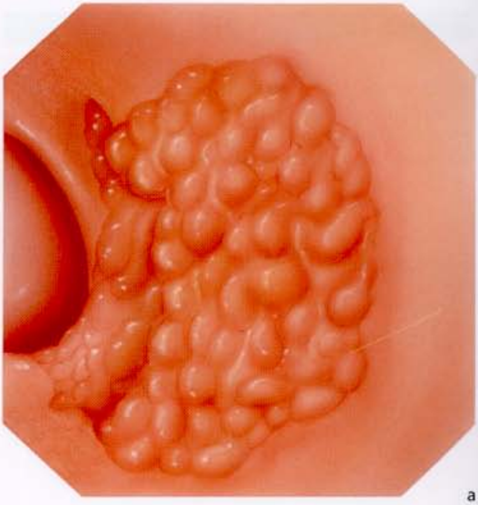


Fig. **229a,b** Polypectomy of a small sessile polyp.
a The opened snare is oriented parallel to the bowel wall and pressed flat around the sessile polyp growth. While closing the snare, care is taken that only the targeted tissue is captured.
b Before application of current, the ensnared tissue is tented away from the bowel wall.

Large Sessile Polyps

The endoscopic removal of large (3 cm or larger) sessile polyps has been generally viewed to be contraindicated. Major concerns include high procedural risk, a high incidence of coexistent malignancy, and the possibility of incomplete removal. The endoscopist with experience in use of the piecemeal resection technique, however, can remove large sessile polyps in a radical fashion (mucosectomy) without a significantly higher complication rate (Fig. **230**). Several sessions may be necessary for complete removal. Endoscopic criteria such as the absence of ulceration, friability, and induration have been found to reliably predict a benign histology. Follow-up at close intervals is indicated until complete healing of the resection site occurs. If malignancy is detected in the resected material, the option of surgical treatment always remains.



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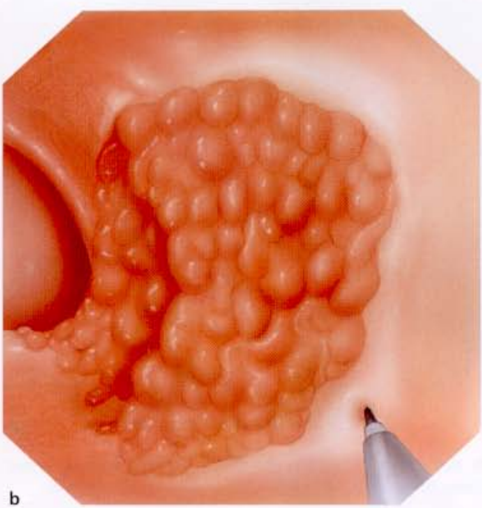

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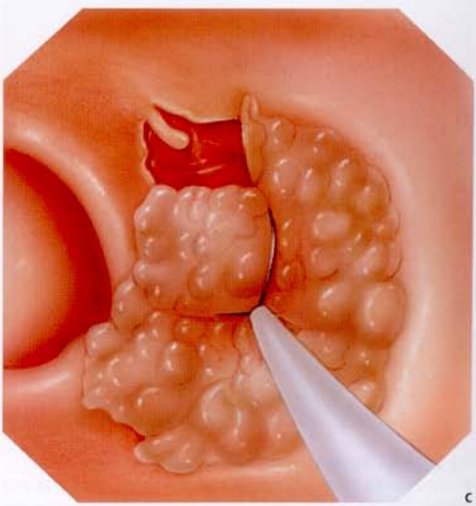


c

Fig. **230a–h** Piecemeal resection of large sessile polyps.
a A 5-cm carpet-like sessile polyp in the rectum.
b Submucosal injection of saline or diluted epinephrine (1:20 000) raises the flat growth.
c Piecemeal resection is begun where the polyp is easiest to access. To avoid accidental capturing of normal tissue, the bowel lumen is insufflated with air until the wall is stretched.

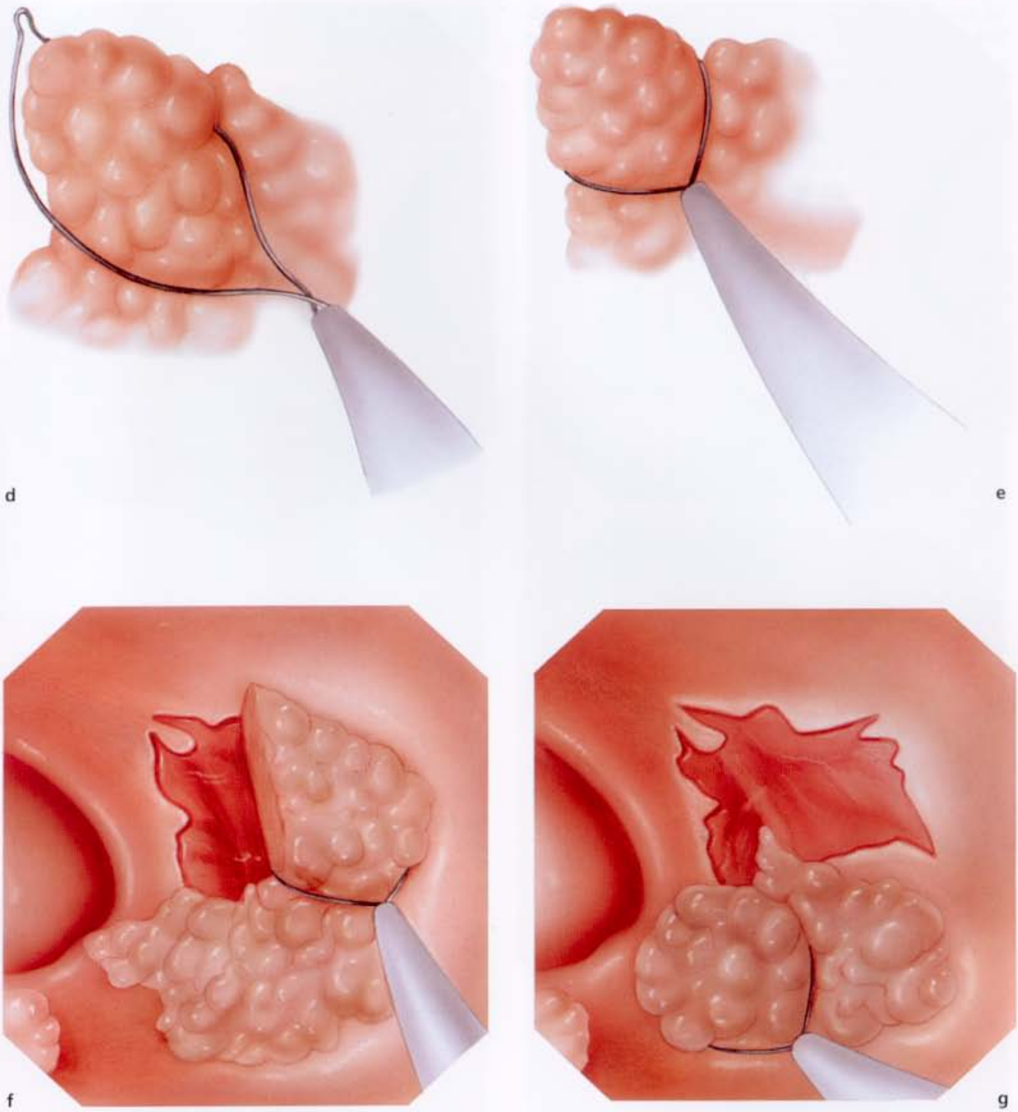
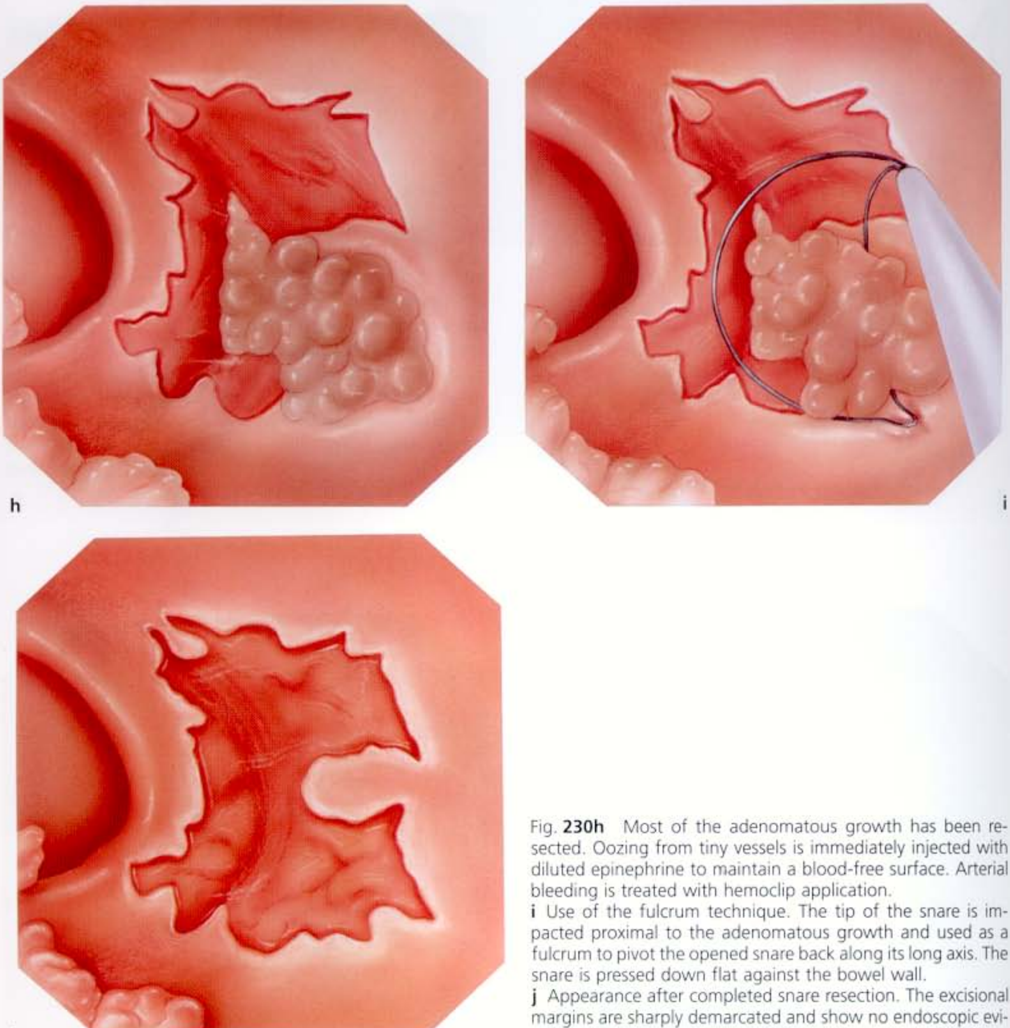


Fig. **230d** The wire loop is pressed flat against the bowel wall to ensnare the mucosal and submucosal layers.
e As the snare is closed, it is simutaneously advanced an equal amount to prevent tissue from slipping out. The ensnared tissue is tented away from the underlying wall during the application of diathermy.
f After a portion of the polyp is resected, the exposed muscularis propria layer guides the depth of resection of the adjacent adenomatous tissue.
g Piecemeal resection is performed in portions small enough to be suctioned through the working channel of a therapeutic colonoscope.

Fig. **230h–j** ▶

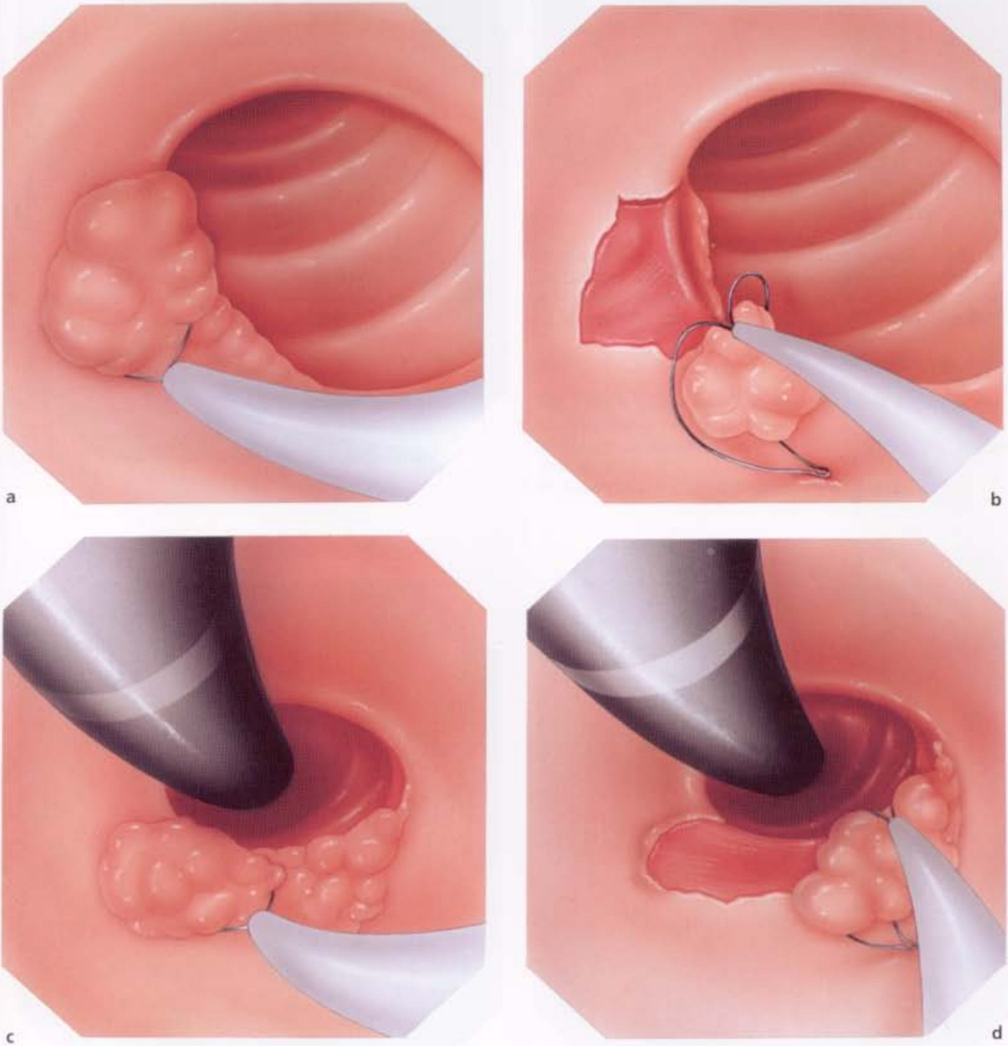


h i j

Fig. **230h** Most of the adenomatous growth has been resected. Oozing from tiny vessels is immediately injected with diluted epinephrine to maintain a blood-free surface. Arterial bleeding is treated with hemoclip application.
i Use of the fulcrum technique. The tip of the snare is impacted proximal to the adenomatous growth and used as a fulcrum to pivot the opened snare back along its long axis. The snare is pressed down flat against the bowel wall.
j Appearance after completed snare resection. The excisional margins are sharply demarcated and show no endoscopic evidence of residual adenomatous tissue.

Piecemeal Resection in the Retroflexed Position

Sessile polyps extending over a haustral fold or involving the rectal ampulla may only be accessible in the retroflexed position. Retroflexion is achieved by maximally deflecting the tip of the endoscope and simultaneously advancing the endoscope. This maneuver is possible in the rectum and straight segments of the colon (Figs. **231, 232**).



a b c d

Fig. **231a–f** Resection of a large sessile polyp extending over a haustral fold in the ascending colon.

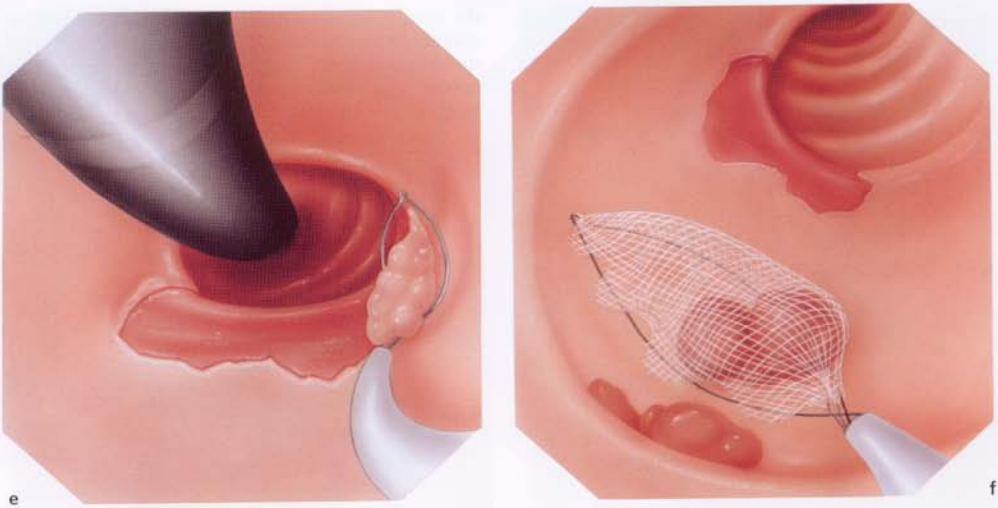
a The bowel lumen is first well insufflated with air to flatten the wall. Piecemeal resection is begun in front of the haustral fold.

b The fulcrum technique is used to safeguard against perforation along the fold.

c The remaining adenomatous growth behind the haustral fold is resected with the colonoscope in the retroflexed position.

d The fulcrum technique is used in the retroflexed position as previously described.

Fig.



e f

Fig. **231e** To avoid perforation, the snare is positioned as flat as possible, parallel to the bowel wall. Only the mucosal and submucosal layers are grasped, which can be tented away from the underlying muscularis propria layer. The tip of the snare should be visible as the loop is closed to ensure that neighboring tissue is not accidentally captured.
f Pieces of the resected polyp are captured in the net device for retrieval.

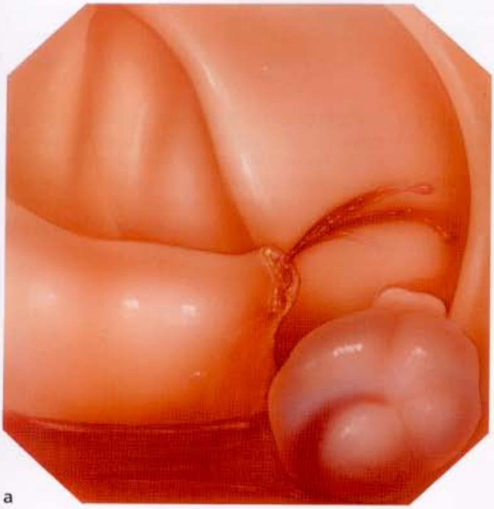
a b

Fig. **232a,b** Polypectomy of small sessile polyps in the lower rectum.
a The small sessile growth is easiest to access in the retroflexed position. The endoscope tip is maximally deflected. While air is insufflated to open the lumen, the endoscope is advanced to obtain the retroflexed position.
b Polypectomy using the technique previously described.

Complications

Bleeding is the most common complication of polypectomy. To minimize this complication, pure coagulation current should be used. A polyp with a thick pedicle will require additional measures to prevent bleeding, including the submucosal injection of diluted epinephrine (1:20 000) and ensnaring the pedicle with the clip or endoloop. Of these, we have found clip ligation to be the most effective. We prefer to use the marking-type clips because these grasp the underlying tissue better (Figs. 233, 234).

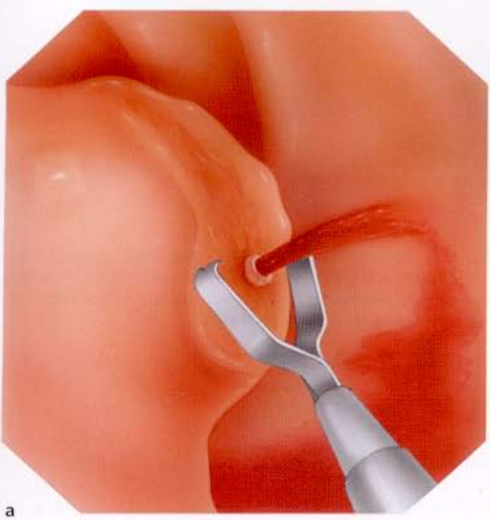
Perforation, the most serious complication, is fortunately rare. The cause is often faulty technique



a

b

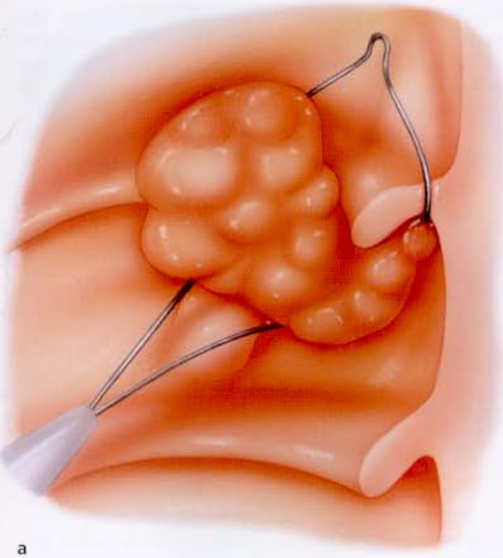
Fig. **233a**,**b** Hemostasis of an arterial bleed after resecting a small pedunculated polyp.
a Postpolypectomy arterial bleeding from the residual pedicle.
b A hemoclip is used to ligate the thin pedicle.



a

b

Fig. **234a**,**b** Hemostasis of an arterial bleed after resecting a thick-stalked polyp. The bleeding artery is identified and ligated with a hemoclip. Severe bleeding may require several clips, in which case two applicators should be used to facilitate sequential clip placement.



a

b

Fig. **235a,b** Perforation of the bowel wall after resection of a short-stalked polyp along a fold. The cause was entrapment of a portion of the fold behind the stalk as the snare was closed. The case illustrates the importance of carefully defining the anatomic boundaries of the polyp before resection. Injecting saline or diluted epinephrine into the polyp stalk will raise the stalk away from the surrounding mucosa.

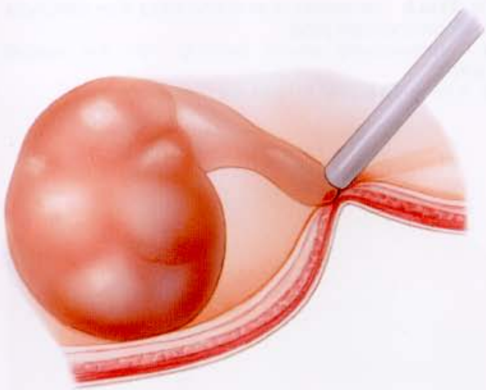


Fig. **236** Perforation after resection of a polyp with a long stalk. The polyp was transected at its attachment to bowel wall, thus leaving no residual stalk. Delayed perforation may also occur in such cases due to the spread of thermal injury to the deeper layers of the bowel wall.

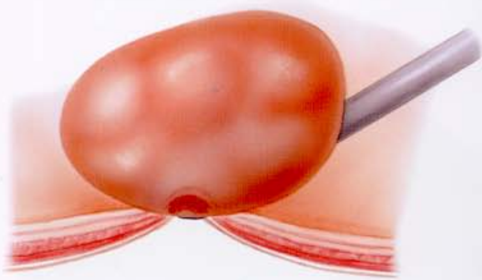
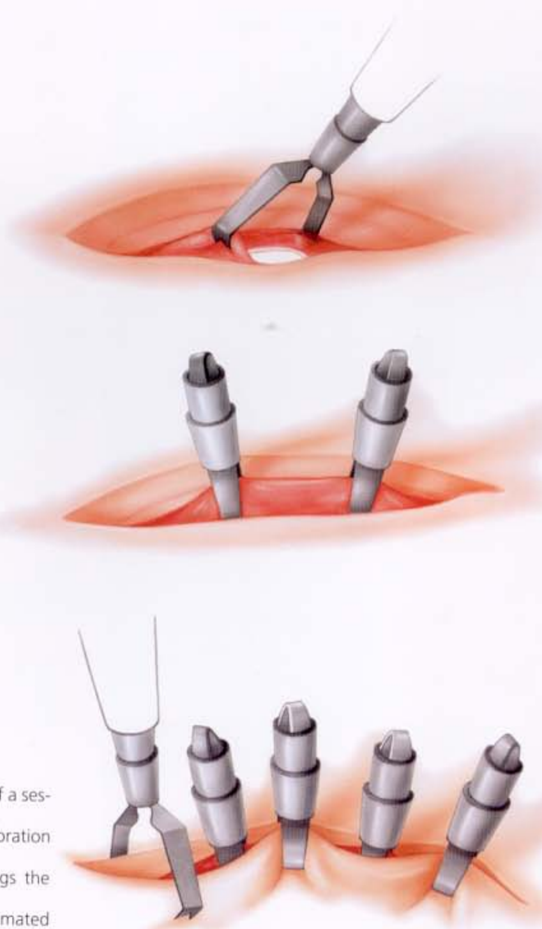


Fig. **237** Perforation after resection of a sessile polyp. A fold in the bowel wall was captured in the snare because of inadequate insufflation of air. Current was applied without tenting the polyp away from the bowel wall.

(Figs. 235, 236, 237). A large perforation is an indication for surgery, which should be performed without delay to avoid the development of peritonitis. Conservative treatment with broad spectrum antibiotics and bedrest is possible if the perforation is small and the bowel is clean. The prognosis is best if the perforation site can be endoscopically closed with clips immediately after perforation occurs (Fig. 238). Abdominal pain, usually due to free peritoneal air, should be relieved with a percutaneous puncture to release the air. The patient must be examined on an hourly basis for signs of peritonitis, which is an indication for immediate surgery.

Fig. **238** Closure of a small perforation with clips. A clip is used to adapt the edges of a small colonic wall perforation



a

b

c

Fig. **239a–c** Closure of a perforation after resection of a sessile polyp.
a Primary closure is possible if the margins of the perforation are well demarcated
b The muscle layer is first approximated, which brings the mucosal layers closer together.
c The margins of the mucosal layer are then approximated with clips.