CHAPTER 126

Diagnostic and interventional endoscopic retrograde cholangiopancreatography

George J. M. Webster and Stephen P. Pereira
University College London Hospitals, London, UK

KEY POINTS

- Diagnostic endoscopic retrograde cholangiopancreatography (ERCP) in a patient with pain alone and a non-dilated common bile duct on ultrasound is associated with a high risk-to-benefit ratio
- For patients with biliary-type pain and a low probability of choledocholithiasis, less invasive diagnostic modalities than ERCP (i.e., MRI/MRCP or endoscopic ultrasound) are indicated
- There is no evidence from meta-analyses to support routine administration of antibiotics
- Procedure-related complications occur in 5–10% of patients; avoidance of unnecessary ERCP is the best way to avoid post-ERCP pancreatitis
- ERCP is the treatment of choice for patients presenting with pain, abnormal liver biochemistry, and duct dilatation due to choledocholithiasis
- Whilst endotherapy in painful obstructive chronic pancreatitis is feasible, randomized data indicate that surgery, rather than ERCP, is the best approach for most patients
- Early ERCP is probably beneficial in severe acute biliary pancreatitis when associated with cholestasis
- ERCP is used for both diagnosis and decompression of the biliary tree by stenting in patients with suspected pancreaticobiliary malignancy

Introduction

The development of side-viewing duodenoscopes in the early 1970s allowed endoscopic visualization of the papilla of Vater (point of entry of the bile and pancreatic ducts) and, when combined with radiography, high-quality visualization of the bile and pancreatic ducts – endoscopic retrograde cholangiopancreatography (ERCP). For many years ERCP was the gold standard for investigating pancreatic and biliary disorders, but with improvement in other imaging modalities, including ultrasonography (transabdominal and endoscopic), multislice helical computed tomography (CT), magnetic resonance imaging/cholangiopancreatography (MRI/MRCP), and intraoperative cholangiography, the need for diagnostic ERCP has declined [1]. Consequently, ERCP has evolved into a predominantly therapeutic modality, used for the removal of bile and pancreatic duct stones, the treatment of biliary strictures, and the palliation of malignancy. However, ERCP still has a diagnostic role in patients with suspected pancreaticobiliary malignancy in whom non-invasive imaging is normal or equivocal, and it also allows tissue to be obtained for diagnosis by endobiliary brush cytology, needle aspiration, and biopsy.

Description of technique

Equipment and staff

To view and **cannulate the duodenal papilla**, sited on the medial wall of the duodenum, it is necessary to use a side-viewing endoscope. A range of video-duodenoscopes are available. The supporting video image processing system is the same as for gastroscopy and colonoscopy. Duodenoscopes have a working shaft of approximately 1.2 m, with an external diameter ranging from 10.5 to 13.5 mm, and a working channel of 2.2–4.2 mm. Control wheels allow 90–120-degree up/down angulation, 90–110-degree right–left angulation, and a variable elevator to alter the angle at which accessories leave the duodenoscope. The smaller-diameter duodenoscopes allow greater maneuverability, and the narrower bridge provides greater catheter stability, but the larger scopes have a working channel that allows the passage of 10-Fr (i.e., 3.3-mm external diameter) plastic stents, metal stents, and large mechanical lithotripters (Figure 126.1).

A range of instruments is available for **biliary cannulation**, including Teflon-coated 5-Fr (1.7 mm) catheters and bowstring sphincterotomes with a variable number of lumens, external diameter, length of leading cannula, and length of exposed wire. In addition to biliary sphincterotomy, sphincterotomes are also useful in the setting of altered papillary anatomy or a difficult duodenal position.

X-ray imaging is a central component of ERCP, and the procedure is performed on an X-ray table, with imaging

Textbook of Clinical Gastroenterology and Hepatology, Second Edition. Edited by C. J. Hawkey, Jaime Bosch, Joel E. Richter, Guadalupe Garcia-Tsao, Francis K. L. Chan.
© 2012 Blackwell Publishing Ltd. Published 2012 by Blackwell Publishing Ltd.

Figure 126.1 Example of a side-viewing duodenoscope, showing the elevator used for controlling the insertion of accessories. A 10-Fr polyethylene stent is seen passing out of the duodenoscope, over a guiding catheter and guidewire. (Courtesy of Olympus Keymed, UK.)

Table 126.1 Risk factors for post-ERCP pancreatitis

- Young age
- Female sex
- Suspected sphincter of Oddi dysfunction
- Normal serum bilirubin level
- Previous ERCP-related pancreatitis
- Recurrent pancreatitis
- Difficult bile duct cannulation
- Pancreatic duct filling
- Precut (needle-knife) sphincterotomy
- Pancreatic sphincterotomy
- Balloon sphincter dilatation
- Pain during ERCP

provided by standard fluoroscopy or using a digital C-arm unit with hardcopy facilities.

The minimum staffing requirements for ERCP are the endoscopist, one assisting nurse to manage the patient's airway and mouthguard, another to assist with endoscopic accessories, and a radiographer/radiologist.

The patient

It is essential that the indication, risks and benefits, and intended outcomes of ERCP are discussed in advance, allowing the patient to provide informed written consent. Procedure-related complications occur in 5–10% of patients, and include acute pancreatitis, bleeding, and perforation, as discussed below. It should be noted that this complication rate is derived mainly from large multicenter studies performed in specialist units [2]. Ideally, units or individuals should be able to provide their own data for complications, thus improving the extent to which consent is truly informed [3]. Clinicians and their patients should also be fully aware of the situations in which the risks of ERCP are increased (Table 126.1).

Contraindications

These are generally similar to those for other types of endoscopy performed under conscious sedation, including lack of informed consent and significant cardiorespiratory disease. Most contraindications to ERCP are relative, and it is vital to weigh up the potential risks and benefits for the individual patient. For example, ERCP in a jaundiced patient with gallstone pancreatitis and systemic inflammatory response syndrome may be high risk, but it is potentially life-saving. In contrast, solely diagnostic ERCP in a patient with pain alone and a normal pancreaticobiliary tree on non-invasive imaging is associated with a high risk-to-benefit ratio.

Special situations

When indicated, therapeutic ERCP in pregnancy is safe provided appropriate pelvic lead shielding is used. The risk of sphincterotomy bleeding is increased in patients taking anticoagulants, and is probably also increased in patients with deranged clotting as a result of underlying disease. In the authors' unit, a prothrombin time prolongation of less than 3 seconds and platelet count greater than 50×10^9/L is required before the procedure, with intravenous vitamin K, fresh frozen plasma, and platelet infusions given as appropriate, in accordance with consensus guidelines in this area [4]. Despite the widespread use of prophylactic antibiotics for ERCP, a meta-analysis concluded that there was no clinical benefit to their routine administration [5]. The risk of cholangitis is very low unless adequate biliary drainage is not achieved at ERCP. Prophylaxis is certainly indicated where there is a risk of contrast injection into poorly draining intrahepatic ducts or a communicating pancreatic pseudocyst at the time of ERCP.

Positioning and analgesia

Patient positioning for the procedure under sedation affects the ease with which ERCP is performed. The patient lies on their front, with the left arm extended behind the body, the right arm flexed, with the hand near to the face, and the head turned to the right, so that the left side of the face lies flat on the pillow. The appearance is that of the "freestyle" swimming position. Oxygen is delivered at 2–4 L/min via nasal cannulae, and pulse rate and arterial oxygen saturation are monitored continuously using a standard finger probe. Intravenous opiate (e.g., fentanyl 50–100 µg or pethidine 25–50 mg) analgesia followed by a benzodiazepine (e.g., midazolam 2.5–5 mg) is given, with the dose titrated to achieve adequate conscious sedation. Higher levels may be required than for upper gastrointestinal endoscopy or colonoscopy. Alternatively, some centers use deep sedation with propofol and/or general anesthesia for ERCP. Intravenous hyoscine butylbromide 20–40 mg or glucagon 0.5–1 mg may also be given to reduce duodenal and biliary sphincter contractions.

Procedure

Esophageal intubation with the duodenoscope is similar to that for standard endoscopy. Examination of the upper

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

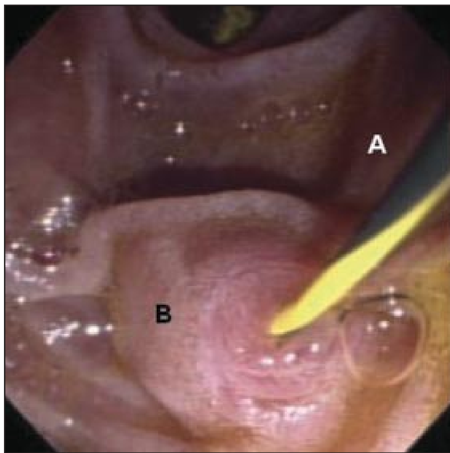


Figure 126.2 Normal major papilla as seen with the duodenoscope in position within the duodenum. A 0.035- inch guidewire (A) is seen within the papilla (B).

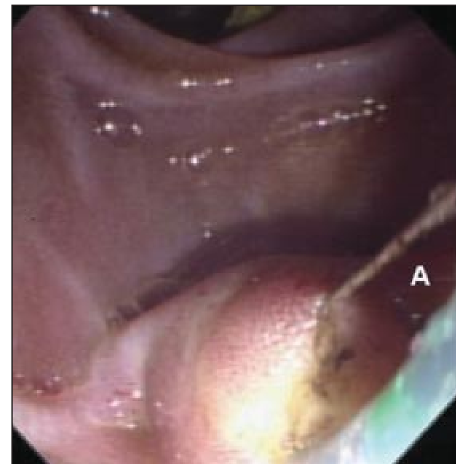


Figure 126.3 Biliary sphincterotomy using a bow-string sphincterotome (A).

gastrointestinal tract is also possible but, because the scope is side viewing, its tip needs to be angled down in order to gain a luminal view. After identifying the pylorus, the tip is angled up (producing a "setting sun" view of the pylorus), so allowing duodenal intubation. In order to identify the major papilla, a complex series of maneuvers of angulation of the scope tip to the right, right torque on the shaft, and pulling back is performed. As with most aspects of ERCP, this procedure is reliably performed only after close supervision and training.

Optimal duodenal positioning is a prerequisite of successful papillary cannulation. The duodenoscope is positioned just below the major papilla (Figure 126.2). On viewing the papilla *en face*, pancreatic duct cannulation is often achieved by cannula insertion into the middle of the papilla, with common bile duct cannulation achieved by insertion in an upwards direction, from below the papilla, aimed at 11 o'clock, and following the line of the bulge of the intramural bile duct. Before ERCP, it is important to decide which anatomy needs to be defined. Pancreatic duct cannulation should not be performed unless of clinical relevance, as repeated attempts at this are an important cause of procedure-related pancreatitis. Once deep cannulation of the desired duct has been obtained, the need for further instrumentation will depend on the indications and findings on cholangiography or pancreatography. Insertion of a 0.018–0.035-inch guidewire through the cannula and into the duct allows the cannula to be exchanged for other ERCP accessories as required.

Biliary sphincterotomy may be indicated for a variety of reasons, including stone extraction, papillary stenosis, and stent insertion (Figure 126.3). The sphincterotome is connected to a standard electrosurgical unit, as used for polypectomy, which has "cut" and "coagulate" settings. The optimal contribution of each during sphincterotomy is debated, with excessive coagulation implicated in thermal damage to the pancreatic sphincter and pancreatitis, and "pure cut" carrying an increased risk of sphincterotomy bleeding. Microprocessor-controlled electrocautery generators use a combined cut and coagulation, and reduces the risk of an uncontrolled ("zipper") cut precipitating bleeding or perforation. Balloon dilatation of the biliary sphincter is an alternative or can be used in conjunction with sphincterotomy for the extraction of bile duct stones, although there are conflicting data on its safety compared with standard sphincterotomy [6,7].

Difficulties and solutions

Bile duct cannulation may be difficult for a range of reasons, such as the papilla being sited within a duodenal diverticulum or the presence of papillary pathology (e.g., impacted stone, ampullary tumor). Repeated attempts at cannulation may lead to edema around the papilla, making cannulation even more difficult. The use of a sphincterotome allows the angle of cannulation to be altered, as may moving the position of the duodenoscope tip relative to the papilla. A needle-knife precut sphincterotomy may facilitate deep cannulation, but in multicenter studies has been shown to carry a greater risk of complications than standard bow-string sphincterotomy, particularly when the bile duct is not dilated. In experienced hands, placement of a pancreatic stent before precutting may increase immediate bile duct access success rates and reduce the risk of pancreatitis [8]. Where endoscopic bile duct cannulation or stent insertion has proved impossible, a percutaneous transhepatic approach and drain insertion may be necessary. Endoscopic access and intervention may then be achieved by a combined ("rendezvous") procedure, with the radiologist passing a guidewire down the transhepatic biliary drain and out of the papilla into the duodenum. The endoscopist can then grasp the wire with a snare and bring it out through the scope to facilitate stent, sphincterotome, or balloon insertion, as required.

Endoscopic stone extraction

There are several approaches to endoscopic stone extraction, including balloon or basket extraction, or mechanical

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

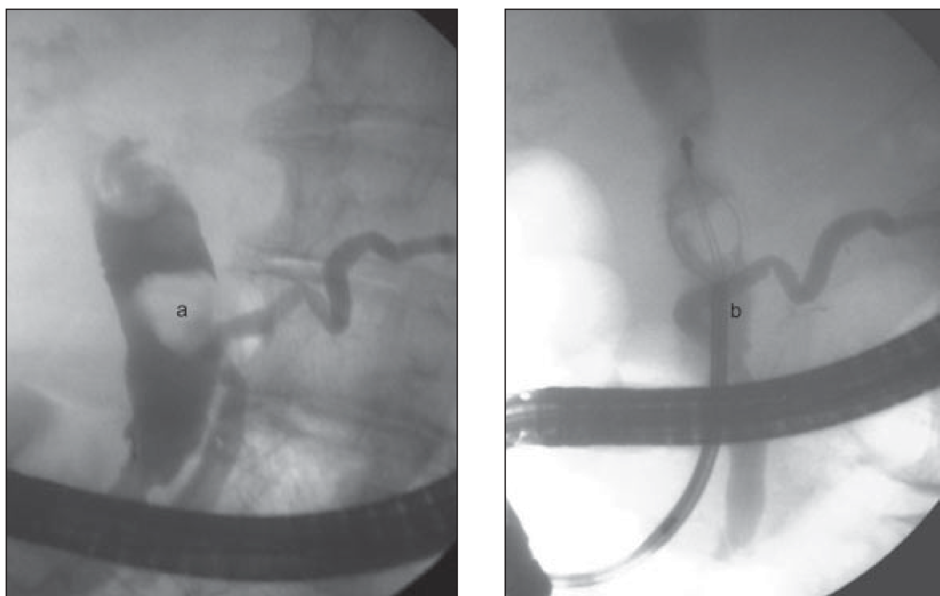


Figure 126.4 Mechanical lithotripsy. At ERCP, a large 1.5-cm stone is seen within the mid common bile duct (a). The stone is engaged by the mechanical lithotripter, followed by advancement of the metal sheath over the basket (b), and fragmentation of the stone prior to removal.

lithotripsy. Stone removal using a **balloon extraction catheter** has the advantage that it may be performed over a wire, allowing easy recannulation of the bile duct. Its main disadvantages are that small stones within a dilated bile duct may "skip past" the balloon as the bile duct is trawled, and larger stones may become impacted at the ampulla. Standard **baskets** allow the extraction of most stones smaller than 1 cm, but carry the risk of not being able to deliver larger stones through the ampulla, or to disengage the stone from the basket within the bile duct, requiring the use of a reel mechanism to crush the stone or snap the basket, thus allowing disengagement. An alternative to either of these techniques is the use of a **mechanical lithotripter**, which is similar to a standard basket but has a metal sleeve that may be advanced over the closed basket, thereby crushing the stone (Figure 126.4). Although the mechanical lithotripter is bulkier and more difficult to maneuver than the standard basket, it avoids the risk of stone impaction. Biliary sphincterotomy is usually performed prior to attempted stone extraction, although mechanical dilatation of the sphincter (balloon sphincteroplasty) also has a role, particularly where bleeding diatheses present an increased risk with sphincterotomy.

If definitive stone clearance cannot be achieved, a **stent** may be inserted to decompress the biliary tree. Three main types of biliary endoscopic stent are in use:

- **Straight polyethylene stents** – available in a range of lengths, with external diameters of 7 Fr and 10 Fr being used most commonly. The stents are slightly curved and have a flange approximately 1 cm short of each end, which helps to prevent slippage above or below a stricture. 10-Fr stents generally last longer and provide better drainage than 7-Fr stents.
- **7-Fr double pigtail stents** – generally used when straight stents might become displaced, such as after sphincterotomy and incomplete stone extraction from a dilated bile duct. 7-Fr stents are inserted directly over a 0.035-inch wire, whereas a 6–7-Fr guiding catheter is first inserted over the guidewire when a 10-Fr stent is used, because of the larger internal stent diameter. With the wire and guiding catheter placed into the proximal biliary tree, the stent is pushed into place using a pushing tube.
- **A range of self-expanding metal biliary stents**, compressed within the tip of a continuous 7.5–10-Fr delivery catheter, can also be inserted endoscopically. On withdrawal of the compressing sleeve, the stent is deployed, expanding up to a maximum diameter of 10 mm (Figure 126.5).

At least one-third of patients with pancreatic cancer will survive long enough for a polyethylene stent to become occluded, in which case a further procedure is performed to remove the blocked stent and replace it with a new one. In patients who are expected to survive longer than 6 months, **self-expanding metal stents (SEMSs)** play an important role in the palliation of malignant biliary strictures. These stents are approximately 20 times more expensive than polyethylene stents, but the 1-cm expanded lumen remains patent for a median of 4–9 months compared with the 3–4 months seen with plastic stents [9]. However, tissue ingrowth through the mesh may lead to further obstruction, necessitating insertion of further metal stents (or more usually plastic stents) inside the lumen of the metal stent. Fully-covered SEMSs have recently been developed for distal biliary obstruction, with the theoretical, but unproven, advantage that reduced ingrowth may prolong patency. They are more expensive than uncovered SEMS, and may be associated with a higher risk of acute

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

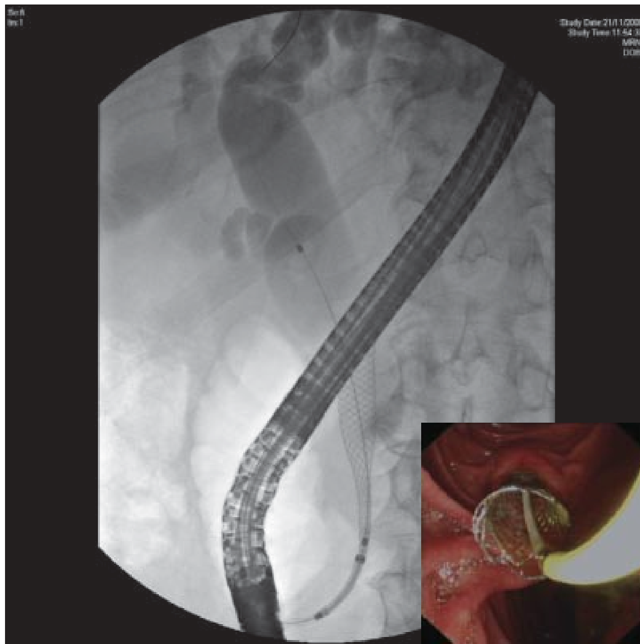


Figure 126.5 Insertion of a metal mesh biliary (Wallflex) stent under radiological control. The 8.5-Fr introducing system has been inserted across the distal biliary stricture into the dilated common bile duct over a 0.035-inch wire. The plastic sheath is then drawn back, allowing deployment of the stent. Inset shows endoscopic view of deployed stent *in situ*. (Reproduced with kind permission of Boston Scientific.)

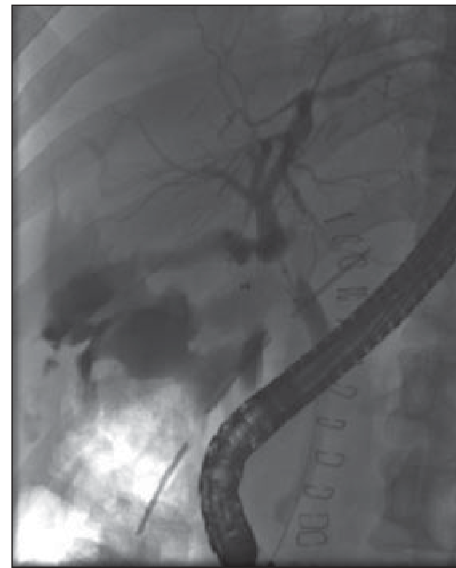


Figure 126.6 Bile leak after cholecystectomy. ERCP in a patient 1 week after open cholecystectomy, showing contrast leak into the gallbladder bed.

cholecystitis, pancreatitis, and stent migration [10]. As fully-covered SEMS may be reliably removed endoscopically weeks after insertion, they have an emerging role in the management of indeterminate or benign low bile duct strictures [11].

Indications

Gallstone disease

Common bile duct stones can be removed by preoperative ERCP, laparoscopic common bile duct exploration, or postoperative ERCP. The endoscopic removal of common bile duct stones at the time of ERCP is the treatment of choice for patients presenting with pain, abnormal liver biochemistry, and duct dilatation. ERCP with sphincterotomy is also the primary treatment for patients with cholangitis resulting from common bile duct stones, with urgent (within 24 hours) ERCP indicated for those who do not respond promptly to immediate resuscitation with intravenous fluids and antibiotics.

Alternatives

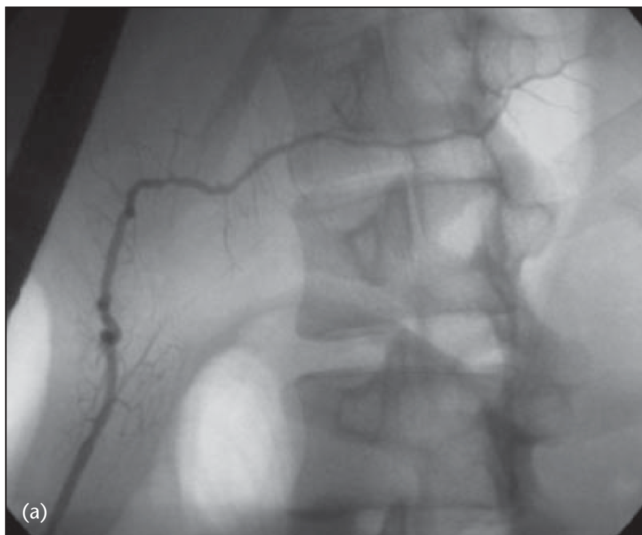
For patients with biliary-type pain and a low probability of choledocholithiasis, less invasive diagnostic modalities than ERCP (i.e., MRI/MRCP or endoscopic ultrasonography) are indicated, or alternatively operative cholangiography at the time of laparoscopic cholecystectomy is performed to demonstrate the presence or absence of common bile duct stones. If surgical expertise in the technique is available, laparoscopic common bile duct exploration is comparable to postoperative ERCP in terms of safety and stone clearance rates, and associated with reduced hospital stay and use of healthcare resources [12]. Otherwise, postoperative ERCP is indicated for patients with retained stones, as well as for the diagnosis and endoscopic therapy of most post-cholecystectomy bile duct injuries (Figure 126.6). In selected patients at prohibitive operative risk, ERCP with stone clearance, but without cholecystectomy, may be the definitive therapy, as may repeated endoscopic stenting beside very large bile duct stones to facilitate biliary drainage. However, in controlled studies the latter approach is associated with an increased burden of biliary symptoms compared with complete stone clearance [13].

Acute and chronic pancreatitis

ERCP has been used for both the diagnosis and treatment of acute, recurrent, and chronic pancreatitis (Figure 126.7).

Diagnosis

In patients who present with the typical findings of acute pancreatitis (abdominal pain and raised levels of pancreatic enzymes), ERCP has little role except in the setting of severe acute biliary pancreatitis with concomitant cholangitis, in which case randomized trials comparing urgent versus delayed ERCP show a benefit for early intervention [14]. In patients with recurrent pancreatitis, when the etiology has not been defined by history, laboratory tests, and non-invasive pancreaticobiliary imaging (CT and MRI/MRCP), further evaluation by endoscopic ultrasonography (see Chapter 125) or ERCP with or without sphincter of Oddi manometry (see Chapter 75) may be considered. Potential causes include biliary stones, microlithiasis, pancreas divisum, small neoplasms or benign pancreatic strictures, or sphincter of Oddi dysfunction. Occasionally, recurrent or chronic pancreatitis



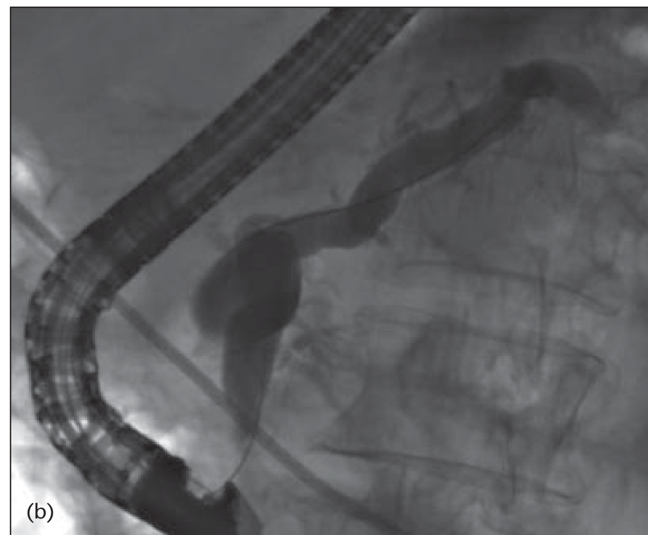


Figure 126.7 Chronic pancreatitis. Comparison of (a) a normal pancreatogram with that in (b) a patient with chronic pancreatitis, showing a dilated, irregular main pancreatic duct with side-branch dilatation.

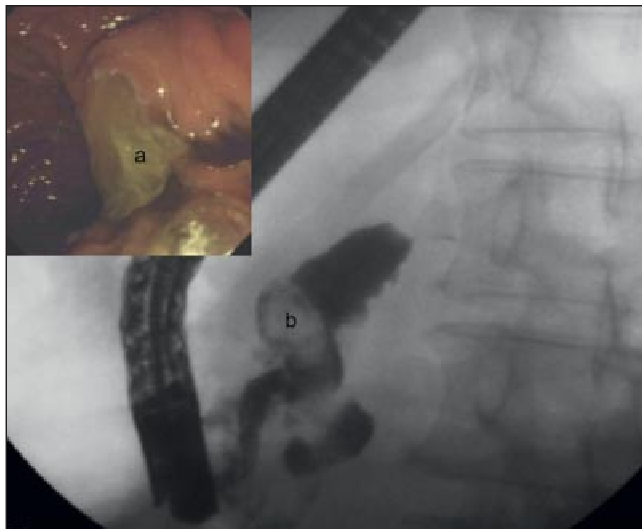


Figure 126.8 Typical appearances of an intraductal papillary mucinous tumor. At ERCP, mucus was seen to be extruding from a patulous papilla (a), with pancreatography showing a filling defect within a dilated duct in the head of the pancreas (b).

may result from the effects of an intraductal papillary mucinous tumor, which may have a typical endoscopic appearance (Figure 126.8).

Treatment

In patients with acute, relapsing, or chronic pancreatitis, a variety of endoscopic therapies have been described. After pancreatic sphincterotomy, stones can be removed from the pancreatic duct, strictures can be stented or balloon dilated, and drainage of the dorsal duct in pancreas divisum can be improved by a combination of accessory papilla sphincterotomy and stent placement, with uncontrolled studies suggesting that both immediate- and long-term pain relief are possible. Peripancreatic fluid collections and pseudocysts can also be managed by pancreatic duct drainage or direct endoscopic cystenterostomy and stenting techniques, with the results of several studies suggesting that ERCP provides a similar rate of pain relief and pseudocyst resolution as surgery, with equivalent or reduced mortality [15,16]. However, there have been no formal randomized comparisons of these ERCP techniques with interventional radiology or surgery. In contrast, randomized studies comparing ERCP with surgery in patients with painful chronic pancreatitis in association with a dilated pancreatic duct demonstrated improved outcomes with surgery [17].

Benign and malignant bile duct strictures

Postoperative anastomotic strictures or those following bile duct damage at the time of cholecystectomy can initially be managed with intermittent biliary balloon dilatation or endoscopic stent placement at the time of ERCP, with surgical reconstruction of the bile duct reserved for patients in whom endoscopic treatment has not led to resolution of the stricture. In patients with **primary sclerosing cholangitis** (Figure 126.9), uncontrolled studies suggest that endoscopic balloon dilatation or stenting of dominant biliary strictures may prolong survival or time to transplantation, but there is also an increased risk of cholangiocarcinoma development during long-term follow-up [18]. **Pancreatic and biliary tract cancer** (cholangiocarcinoma, gallbladder cancer, and ampullary cancer) can all produce stricturing of the biliary tree at different levels (Figure 126.10). ERCP is used for both diagnosis and decompression of the biliary tree by endoscopic stenting in patients known or suspected to have pancreaticobiliary malignancy.

Tissue diagnosis may be achieved at ERCP by using needle aspiration, brush cytology, and forceps biopsy.

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

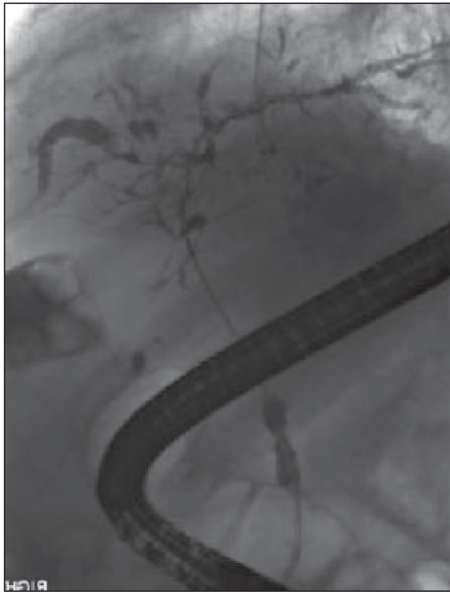


Figure 126.9 Primary sclerosing cholangitis. Cholangiogram showing a narrow common hepatic duct, intrahepatic duct beading and stricturing consistent with primary sclerosing cholangitis. Stones are also seen within the gallbladder and right hepatic duct.

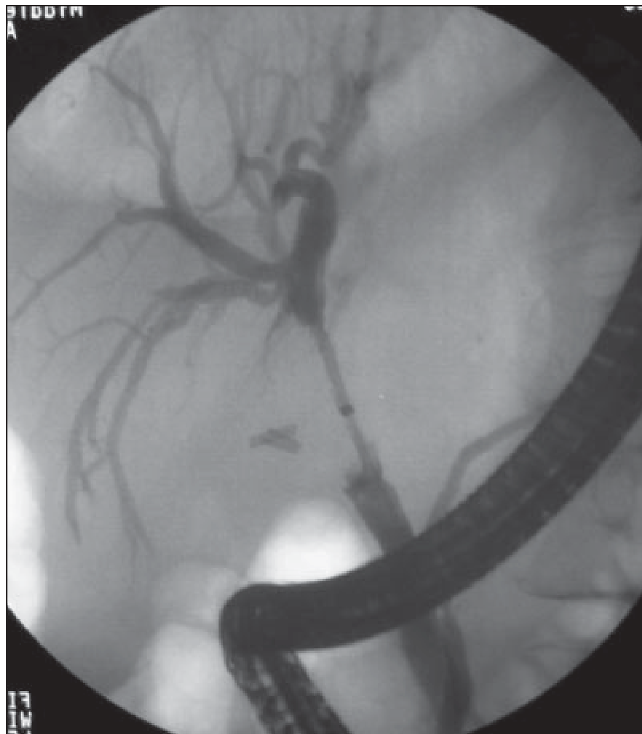


Figure 126.10 Cholangiocarcinoma. ERCP shows a stricture of the common hepatic duct in a patient with painless obstructive jaundice. Endoscopic biopsies confirmed cholangiocarcinoma. Clips from a previous cholecystectomy can also be seen.

Individually, the diagnostic yield from these techniques is low, but their combination improves the ability to establish a tissue diagnosis [19]. Per oral cholangioscopy (Spyglass; Boston Scientific Corporation, USA) is an additional means of visualizing the ducts using a reusable 0.77-mm fiberoptic probe housed inside a single-use 10-Fr catheter which is passed down the working channel of a therapeutic duodenoscope. Four-way deflected steering allows the tip of the cholangioscope to be maneuvered to the area of interest and small biopsies to be taken. Particular uses of the cholangioscope include the assessment of indeterminate strictures, and directed stone dissolution (e.g., using an electrohydraulic lithotripter).

However, the above endoscopic techniques are generally unnecessary for the diagnosis of cancer in a patient presenting with a localized pancreatic mass initially seen on CT if the patient is a candidate for surgery. The use of preoperative stent placement and staging by ERCP in such cases is not supported by evidence from clinical trials, and it may complicate or even preclude surgical intervention. Unfortunately, most cases of pancreatic or biliary tract cancer are not detected at a curable stage, so only palliation can be offered. **Palliative intervention** for malignant biliary obstruction may involve ERCP with stent placement or surgical bypass (Figure 126.11). The available evidence does not indicate a major advantage to either alternative, with the choice depending on the performance status of the patient and local expertise [20].

Pancreaticobiliary-type pain

ERCP is a commonly used technique for the evaluation and management of patients with anatomical evidence of pancreatic or bile duct obstruction. The role of ERCP in patients with pancreaticobiliary-type pain in the absence of obvious obstructive disorders of the pancreatic or bile duct, often referred to as suspected **sphincter of Oddi dysfunction**, is less well defined. The use of ERCP and sphincter of Oddi manometry in the assessment and treatment of such patients is discussed in Chapter 75.

Complications and their management

A number of specific complications are associated with ERCP. Large multicenter studies have reported rates of procedure-related complications of approximately 5–10%, due mainly to pancreatitis and sphincterotomy-associated problems. In general, those endoscopists performing fewer ERCPs have higher complication rates, although no consistent correlation has been found with rates of post-ERCP pancreatitis – due in part to high-volume endoscopists attempting higher-risk cases [21]. Most complications occur within 12 hours, although delayed sphincterotomy-related bleeding may occur several days after the procedure, and late complications such as sphincter stenosis have been reported in up to 5% of patients after sphincterotomy [22]. The mortality rate from diagnostic ERCP is approximately 0.2%, with double the risk for

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

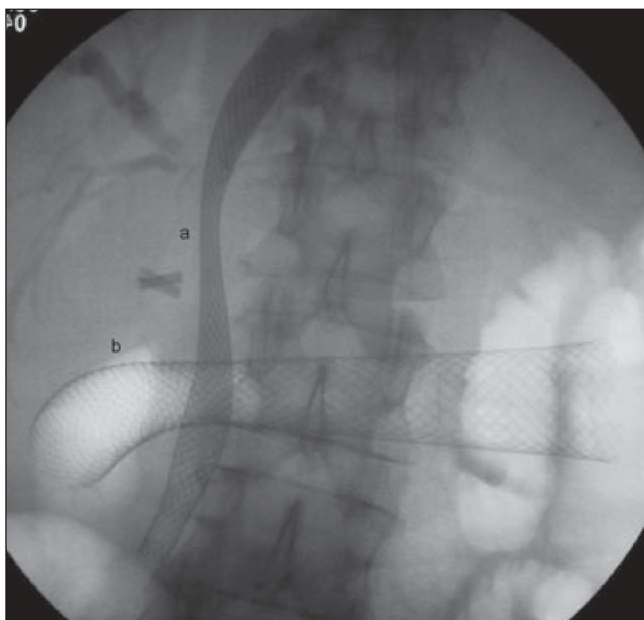


Figure 126.11 Pancreatic carcinoma. An endoscopically placed mesh metal biliary stent (a) and duodenal stent (b) in a patient with obstructive jaundice and duodenal obstruction due to pancreatic carcinoma.

therapeutic ERCP [23]. However, these values must be considered in the context of the potential consequences of not performing an interventional ERCP when necessary.

Pancreatitis

Pancreatitis is the most common complication of ERCP, with prospective studies reporting this in approximately 7% of cases [24,25], although there is a wide range, related in part to differing criteria for diagnosis. One consensus definition is that of new or worsened abdominal pain and a serum amylase level that is three or more times the upper limit of normal 24 hours after the procedure, necessitating at least 2 days in hospital [26]. More than 90% of episodes of pancreatitis are self-limiting, with a severe course in 4.5–7% of cases [24,25].

Severe pancreatitis may be associated with extensive pancreatic necrosis, sepsis, and multiorgan failure, with an overall mortality rate from ERCP-induced pancreatitis of approximately 0.5%. Although the experience of the endoscopist influences the rate of pancreatitis, patient-related factors are vitally important (see Table 126.1). For example, a young woman with abdominal pain, normal bilirubin, a non-dilated common bile duct, and difficult biliary cannulation at ERCP may have a 20–40% chance of developing pancreatitis, irrespective of any intervention. Overall, the risk of pancreatitis is similar for diagnostic and therapeutic ERCP. A pancreatitis risk of approximately 3% in patients requiring fewer than five attempts at biliary cannulation increases to 15% when more than 20 attempts are made [24]. The avoidance of unnecessary ERCP is the best strategy for avoiding post-ERCP pancreatitis.

Prevention

A range of approaches has been studied to reduce ERCP-related pancreatitis. In advanced centers, temporary pancreatic stent placement reduces the risk of pancreatitis in patients undergoing ERCP for suspected sphincter of Oddi dysfunction [27], although failed attempts to insert a stent may be associated with an even higher risk of pancreatitis [21]. With regard to drug treatments, although a meta-analysis suggested that both somatostatin and gabexate (which inhibits proteolytic activity), given as continuous infusions, reduced the rate of ERCP-related pancreatitis [28], a subsequent multicenter randomized placebo-controlled trial showed no benefit with either gabexate or octreotide (a somatostatin analog) [29]. However, a subsequent single-center study reported a benefit in giving a single bolus of somatostatin immediately after ERCP [30]. Agents shown not to be consistently effective include interleukin-10, glyceryl trinitrate, nifedipine, allopurinol, corticosteroids, non-steroidal anti-inflammatory drugs, platelet-activating factor inhibitors, and the use of non-ionic contrast [31–33].

Perforation

Perforation may be retroperitoneal because of extension of a sphincterotomy incision beyond the intramural portion of the bile or pancreatic duct; intraperitoneal as a result of perforation of the bowel wall by the endoscope; or occur at any location because of extramural passage or migration of guidewires or stents. Risk factors for sphincterotomy perforation include a long incision, papillary stenosis, Billroth II anatomy, and needle-knife precut techniques. Clinically important perforation is reported in less than 1% of endoscopic sphincterotomies, but its overall frequency is probably significantly underdiagnosed, as the symptoms and radiological appearances may be difficult to recognize. The development of surgical emphysema following sphincterotomy is indicative of retroperitoneal perforation, but the development of abdominal pain in the absence of a significant rise in serum amylase concentration may also provide a diagnostic clue. In those patients in whom the diagnosis cannot be made by plain abdominal radiography, CT is sensitive in documenting air extravasation into the retroperitoneal space. More than 90% of cases settle with intravenous antibiotics and a strict "nil by mouth" policy, but the development of retroperitoneal collections may require percutaneous or surgical drainage. Bowel wall perforations usually require surgery.

Hemorrhage

Although minor ooze following a sphincterotomy is common, significant bleeding is a rare (0.2–2% of sphincterotomies [34]), but potentially serious complication. Bleeding is more common in those with abnormalities of hemostasis (e.g., cirrhosis, chronic renal failure) or ongoing sepsis, in the setting of papillary stenosis, and in patients treated with anticoagulants within 72 hours after the sphincterotomy. Arterial bleeds may result from cutting the retroduodenal artery as it runs within

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

the transverse duodenal fold, often in association with a long, uncontrolled sphincterotomy. Bleeding that is noted at the time of sphincterotomy and that does not settle spontaneously can be controlled endoscopically, using either epinephrine (adrenaline) (e.g., 1 in 10 000) injected into the cut surfaces of the sphincterotomy, or a hemoclip placed over the bleeding point. Ongoing bleeding may require angiographic embolization of the feeding artery or surgery.

Cholangitis and cholecystitis

These complications occur in approximately 1% of patients after ERCP [35]. Although ERCP may introduce bacteria into a previously sterile biliary tree, clinical cholangitis is rare if effective biliary drainage is obtained. Cholangitis is a particular risk if the intrahepatic ducts are overfilled and cannot be drained adequately because of segmental obstruction. In case–control studies of patients with complex hilar strictures opacified with contrast at ERCP, bilateral intrahepatic duct stenting is associated with a lower rate of cholangitis than unilateral stenting [36].

Stent-related complications

Long-term sequelae of endoscopic biliary sphincterotomy and stent placement include recurrent stone formation, as a result of sphincterotomy stenosis or bacteriobilia caused by duodenal–biliary reflux, and recurrent pancreatitis, presumably because of thermal injury to the pancreatic sphincter. Migration of plastic biliary stents is rarely associated with complications, but stent impaction and bowel perforation may occur. The long-term effects of pancreatic sphincterotomy are largely unknown. Pancreatic stents have the potential to cause ductal injury with stenosis, especially in patients with a normal pancreas.

Cardiopulmonary complications

Although uncommonly related to ERCP, cardiopulmonary complications are the leading cause of death from ERCP and, as expected, occur in older, sicker patients at high anesthetic risk.

SOURCES OF INFORMATION FOR PATIENTS AND DOCTORS

http://www.gastro.org/generalPublic.html
http://www.bsg.org.uk/clinical-guidelines/index.html
http://consensus.nih.gov/2002/2002ERCPsos020html.htm
http://www.library.nhs.uk/Gastroliver/
http://www.gastrohep.com

References

1. Kaltenthaler E, Vergel YB, Chilcott J, *et al*. A systematic review and economic evaluation of magnetic resonance cholangiopancreatography compared with diagnostic endoscopic retrograde cholangiopancreatography. *Health Technol Assess*. 2004;8:1–89.
2. Freeman ML. Adverse outcomes of ERCP. *Gastrointest Endosc*. 2002;56:S273–S282.
3. Cotton PB. ERCP is most dangerous for people who need it least. *Gastrointest Endosc*. 2001;54:535–536.
4. Eisen GM, Baron TH, Dominitz JA, *et al*. Guideline on the management of anticoagulation and antiplatelet therapy for endoscopic procedures. *Gastrointest Endosc*. 2002;55:775–779.
5. Harris A, Chan AC, Torres-Viera C, Hammett R, Carr-Locke D. Meta-analysis of antibiotic prophylaxis in endoscopic retrograde cholangiopancreatography (ERCP). *Endoscopy*. 1999;31: 718–724.
6. Bergman JJ, Rauws EA, Fockens P, *et al*. Randomised trial of endoscopic balloon dilation versus endoscopic sphincterotomy for removal of bileduct stones. *Lancet*. 1997;349:1124–1129.
7. Vlavianos P, Chopra K, Mandalia S, Anderson M, Thompson J, Westaby D. Endoscopic balloon dilatation versus endoscopic sphincterotomy for the removal of bile duct stones: a prospective randomised trial. *Gut*. 2003;52:1165–1169.
8. Tarnasky PR. Mechanical prevention of post- ERCP pancreatitis by pancreatic stents: results, techniques, and indications. *JOP*. 2003;4:58–67.
9. Flamm CR, Mark DH, Aronson N. Evidence based assessment of ERCP approaches to managing pancreaticobiliary malignancies. *Gastrointest Endosc*. 2002;56:S218–S225.
10. Isayama H, Komatsu Y, Tsujino T, *et al*. A prospective randomised study of "covered" versus "uncovered" diamond stents for the management of distal malignant biliary obstruction. *Gut*. 2004;53:729–734.
11. Mahajan A, Ho H, Sauer B, *et al*. Temporary placement of fully covered self-expandable metal stents in benign biliary strictures: midterm evaluation. *Gastrointest Endosc*. 2009;70:303–309.
12. Rhodes M, Sussman L, Cohen L, Lewis MP. Randomised trial of laparoscopic exploration of common bile duct versus postoperative endoscopic retrograde cholangiography for common bile duct stones. *Lancet*. 1998;351:159–161.
13. Tham TC, Carr-Locke DL. Endoscopic treatment of bile duct stones in elderly people. *BMJ*. 1999;318:617–618.
14. van Santvoort HC, Besselink MG, de Vries AC, *et al*. Early endoscopic retrograde cholangiopancreatography in predicted severe acute biliary pancreatitis: a prospective multicenter study. *Ann Surg*. 2009;250:68–75.
15. Mark DH, Lefevre F, Flamm CR, Aronson N. Evidence-based assessment of ERCP in the treatment of pancreatitis. *Gastrointest Endosc*. 2002;56:S249–S254.
16. Lehman GA. Role of ERCP and other endoscopic modalities in chronic pancreatitis. *Gastrointest Endosc*. 2002;56:S237–S240.
17. Cahen DL, Rauws EA, Gouma DJ, Fockens P, Bruno MJ. Removable fully covered self-expandable metal stents in the treatment of common bile duct strictures due to chronic pancreatitis: a case series. *Endoscopy*. 2008;40:697–700.
18. Stiehl A, Rudolph G, Kloters-Plachky P, Sauer P, Walker S. Development of dominant bile duct stenoses in patients with primary sclerosing cholangitis treated with ursodeoxycholic acid: outcome after endoscopic treatment. *J Hepatol*. 2002;36: 151–156.
19. Khan SA, Davidson BR, Goldin R, *et al*. Guidelines for the diagnosis and treatment of cholangiocarcinoma: consensus document. *Gut*. 2002;51(Suppl VI):vi1–vi9.
20. Strasberg SM. ERCP and surgical intervention in pancreatic and biliary malignancies. *Gastrointest Endosc*. 2002;56:S213–S217.
21. Freeman ML, Guda NM. Prevention of post- ERCP pancreatitis: a comprehensive review. *Gastrointest Endosc*. 2004;59:845–864.

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

22. Rabenstein T, Schneider HT, Hahn EG, Ell C. 25 years of endoscopic sphincterotomy in Erlangen: assessment of the experience in 3498 patients. *Endoscopy*. 1998;30:A194–A201.
23. Loperfido S,Angelini G, Benedetti G, *et al*. Major early complications from diagnostic and therapeutic ERCP: a prospective multicenter study. *Gastrointest Endosc*. 1998;48:1–10.
24. Vandervoort J, Soetikno RM,Tham TC *et al*. Risk factors for complications after performance of ERCP. *Gastrointest Endosc*. 2002; 56:652–656.
25. Freeman ML, DiSario JA, Nelson DB *et al*. Risk factors for post-ERCP pancreatitis: a prospective, multicenter study. *Gastrointest Endosc*. 2001;54:425–434.
26. Cotton PB, Lehman G, Vennes J, *et al*. Endoscopic sphincterotomy complications and their management: an attempt at consensus. *Gastrointest Endosc*. 1991;37:383–393.
27. Tarnasky PR, Palesch YY, Cunningham JT, Mauldin PD, Cotton PB, Hawes RH. Pancreatic stenting prevents pancreatitis after biliary sphincterotomy in patients with sphincter of Oddi dysfunction. *Gastroenterology*. 1998;115:1518–1524.
28. Andriulli A, Leandro G, Niro G, *et al*. Pharmacologic treatment can prevent pancreatic injury after ERCP: a metaanalysis. *Gastrointest Endosc*. 2000;51:1–7.
29. Andriulli A, Clemente R, Solmi L, *et al*. Gabexate or somatostatin administration before ERCP in patients at high risk for post-ERCP pancreatitis: a multicenter, placebocontrolled, randomized clinical trial. *Gastrointest Endosc*. 2002;56:488–495.
30. Poon RT,Yeung C, Liu CL, *et al*. Intravenous bolus somatostatin after diagnostic cholangiopancreatography reduces the incidence of pancreatitis associated with therapeutic endoscopic retrograde cholangiopancreatography procedures: a randomised controlled trial. *Gut*. 2003;52:1768–1773.
31. Mallery JS, Baron TH, Dominitz JA, *et al*. Complications of ERCP. *Gastrointest Endosc*. 2003;57:633–638.
32. Murray B, Carter R, Imrie C, Evans S, O'Suilleabhain C. Diclofenac reduces the incidence of acute pancreatitis after endoscopic retrograde cholangiopancreatography. *Gastroenterology*. 2003;124:1786–1791.
33. Cheon YK, Cho KB, Watkins JL, *et al*. Efficacy of diclofenac in the prevention of post-ERCP pancreatitis in predominantly high-risk patients: a randomized double-blind prospective trial. *Gastrointest Endosc*. 2007;66:1126–1132.
34. Masci E, Toti G, Mariani A, *et al*. Complications of diagnostic and therapeutic ERCP: a prospective multicenter study. *Am J Gastroenterol*. 2001; 6:417–423.
35. Freeman ML, Nelson DB, Sherman S, *et al*. Complications of endoscopic biliary sphincterotomy. *N Engl J Med*. 1996;335: 909–918.
36. Chang WH, Kortan P, Haber GB. Outcome in patients with bifurcation tumors who undergo unilateral versus bilateral hepatic duct drainage. *Gastrointest Endosc*. 1998;47:354–362.

10.1002/9781118321386.ch126, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/9781118321386.ch126 by Columbia University Libraries, Wiley Online Library on [10/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License