

Acute Pancreatitis and Peripancreatic Fluid

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CHAPTER

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INTRODUCTION

Acute pancreatitis may be clinically mild or severe. Clinically severe acute pancreatitis is usually a result of pancreatic glandular necrosis. The morbidity and mortality of acute pancreatitis are significantly higher when pancreatic necrosis is present, especially when infection of the necrosis occurs.¹ It is important to identify patients with pancreatic necrosis so that appropriate management can be undertaken. The management of patients with necrotizing pancreatitis has shifted from early surgical debridement (necrosectomy) to aggressive intensive medical care. Specific criteria for operative or nonoperative intervention have been developed.^{2,3} Advances in radiologic imaging, and aggressive medical management with emphasis on prevention of infection have allowed for prompt identification of complications and improvement in outcome for these patients.⁴

Box 50.1 Causes of acute pancreatitis
<p>Most common</p> <ul style="list-style-type: none"> • Cholelithiasis • Ethanol • Idiopathic <p>Less common</p> <ul style="list-style-type: none"> • Endoscopic retrograde cholangiopancreatography • Hyperlipidemia (types I, IV, and V) • Drugs • Pancreas divisum • Abdominal trauma • Hereditary (familial) • Sphincter of Oddi dysfunction

Several types of pancreatic and peripancreatic fluid collections may arise as a result of acute pancreatitis.⁵ These include acute fluid collections, acute pancreatic pseudocysts, pancreatic abscesses, and organized pancreatic necrosis.

This chapter reviews the recent advances in the diagnosis and treatment of acute pancreatitis and peripancreatic fluid collections.

ACUTE PANCREATITIS

Presentation and classification

Acute pancreatitis usually has a rapid onset manifested by upper abdominal pain, vomiting, fever, tachycardia, leukocytosis, and elevated serum levels of pancreatic enzymes. Gallstone- and alcohol-induced pancreatitis are the most common causes in the United States. Causes of pancreatitis are listed in Box 50.1. Several severity of illness classifications for acute pancreatitis are used to identify patients at risk for developing complications (Box 50.2).^{6,7} Ranson's score consists of 11 clinical signs with prognostic significance: five criteria are measured at the time of admission; six criteria are measured between admission and 48 hours later. There is good correlation between the number of Ranson signs and the incidence of systemic complications and presence of pancreatic necrosis.⁶ The Acute Physiology And Chronic Health Evaluation (APACHE) II score is a grading system based on 12 physiologic variables, patient age, and prior history of severe organ system insufficiency or immunocompromised state⁶ (Box 50.2). It allows stratification of illness severity upon admission and may be recalculated daily. Severe acute pancreatitis is

The role of surgery in patients with multisystem organ failure and sterile necrosis remains unproved although this scenario is frequently cited as an indication for surgical debridement.⁴⁷ Additionally, the longer surgical intervention can be delayed from the onset of acute necrotizing pancreatitis, the better the patient survival.⁴⁸ This is probably related to improved demarcation between viable and necrotic tissue at the time of operation. The role of delayed necrosectomy (after resolution of multisystem organ failure) in sterile acute necrotizing pancreatitis likewise remains controversial. Some investigators advocate debridement in patients who remain systemically ill 4–6 weeks after onset of acute pancreatitis with fever, weight loss, intractable abdominal pain, inability to eat, and ‘failure to thrive’.^{2,49,50} Others, however, feel that delayed necrosectomy is unnecessary as long as the process remains sterile.⁵⁰

SURGICAL DEBRIDEMENT

Surgical methods for treatment of necrosis vary. There are three main types of surgical debridement: conventional drainage, open or semiopen procedures or closed procedures.⁴¹ Conventional drainage involves necrosectomy with placement of standard surgical drains and reoperation upon demand (fever, leukocytosis, lack of improvement by imaging studies). Open or semiopen management employs necrosectomy and either scheduled repeat laparotomies or open packing that leaves the abdominal wound exposed for frequent dressing changes. Closed management involves necrosectomy with extensive intraoperative lavage of the pancreatic bed. The abdomen is closed over large-bore drains for continuous high-volume postoperative lavage of the lesser sac. Most surgeons have abandoned the conventional surgical approach of debridement, since inadequately removed necrotic tissue becomes or remains infected and results in a mortality of approximately 40%.³

In all procedures except the closed technique, multiple operations are frequently required to remove the necrotic pancreatic and peripancreatic material.³ Leaving the abdomen open avoids the need for formal laparotomies; packing may be changed in the intensive care unit. Repeated debridement and manipulation of the abdominal viscera using the open and semiopen techniques results in a high rate of postoperative local complications such as pancreatic fistulas, small- and large-bowel complications, and bleeding from the pancreatic bed. Pancreatic and/or gastrointestinal tract fistulas occur in up to 41% of patients after surgical necrosectomy and often require additional surgery for closure.^{51,52} The mortality using open or closed techniques is approximately 20%.³

Alternative debridement methods

Alternative methods for debridement of pancreatic necrosis have been very recently described and require considerable technical expertise. As more data become available, the precise role of these techniques in the management of patients with necrotizing pancreatitis will become better defined.

PERCUTANEOUS (INTERVENTIONAL RADIOLOGY)

Successful percutaneous therapy for infected acute necrotizing pancreatitis has been described using large-bore percutaneous catheters up to 28 French diameter in conjunction with aggressive irrigation.⁵³ A total of 34 patients had percutaneous drainage and irriga-

tion catheters inserted into the pancreatic collection at a mean of 9 days after hospital admission for necrotizing pancreatitis with medically uncontrolled sepsis. An average of three separate catheter sites per patient and four catheter exchanges per patient were necessary for removal of necrotic material. Pancreatic surgery was completely avoided in 16 patients (47%). Control of sepsis with delayed elective surgery for repair of external pancreatic fistulas related to catheter placement was achieved in nine patients. Nine patients required immediate surgery for failure of percutaneous therapy. The mortality was 12% in this ill group, many of whom suffered from multisystem organ failure. In a similar fashion, Echenique *et al.*⁵⁴ described successful percutaneous drainage of necrosis in 20 patients with documented necrosis. Solid debris was removed percutaneously using basket extraction techniques.

ENDOSCOPIC

Successful endoscopic drainage of symptomatic sterile or infected pancreatic necrosis has been described several weeks after the onset of severe necrotizing pancreatitis.⁵⁵ This therapy uses endoscopic placement of internal 10 French transmural (transgastric or transduodenal) drainage catheters plus a 7 French nasopancreatic irrigation tube into the retroperitoneum. The catheters are placed through a tract dilated up to 20 mm (Fig. 50.3). With this method, solid debris flows around the catheters through the transenteric tract.

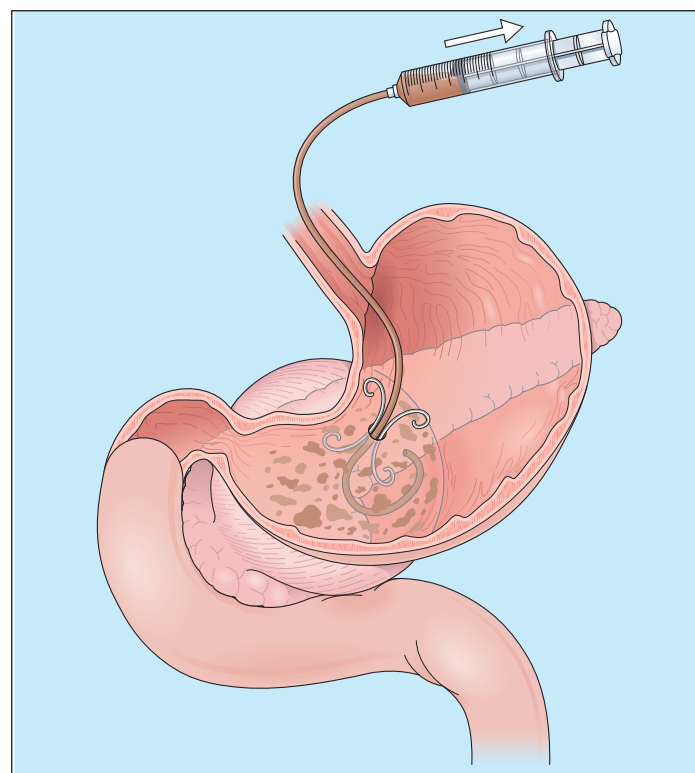


Fig. 50.3 Transmural drainage of organized pancreatic necrosis. Two stents are placed transgastrically alongside a nasobiliary irrigation tube. The transgastric tract is dilated to a large caliber (15–20mm) to allow egress of solid material around the stents. Redrawn with permission from Baron TH, Harewood GC, Morgan DE, Yates MR. Outcome differences after endoscopic drainage of pancreatic necrosis, acute pancreatic pseudocysts, and chronic pancreatic pseudocysts. *Gastrointest Endosc* 2002;56:7–17.

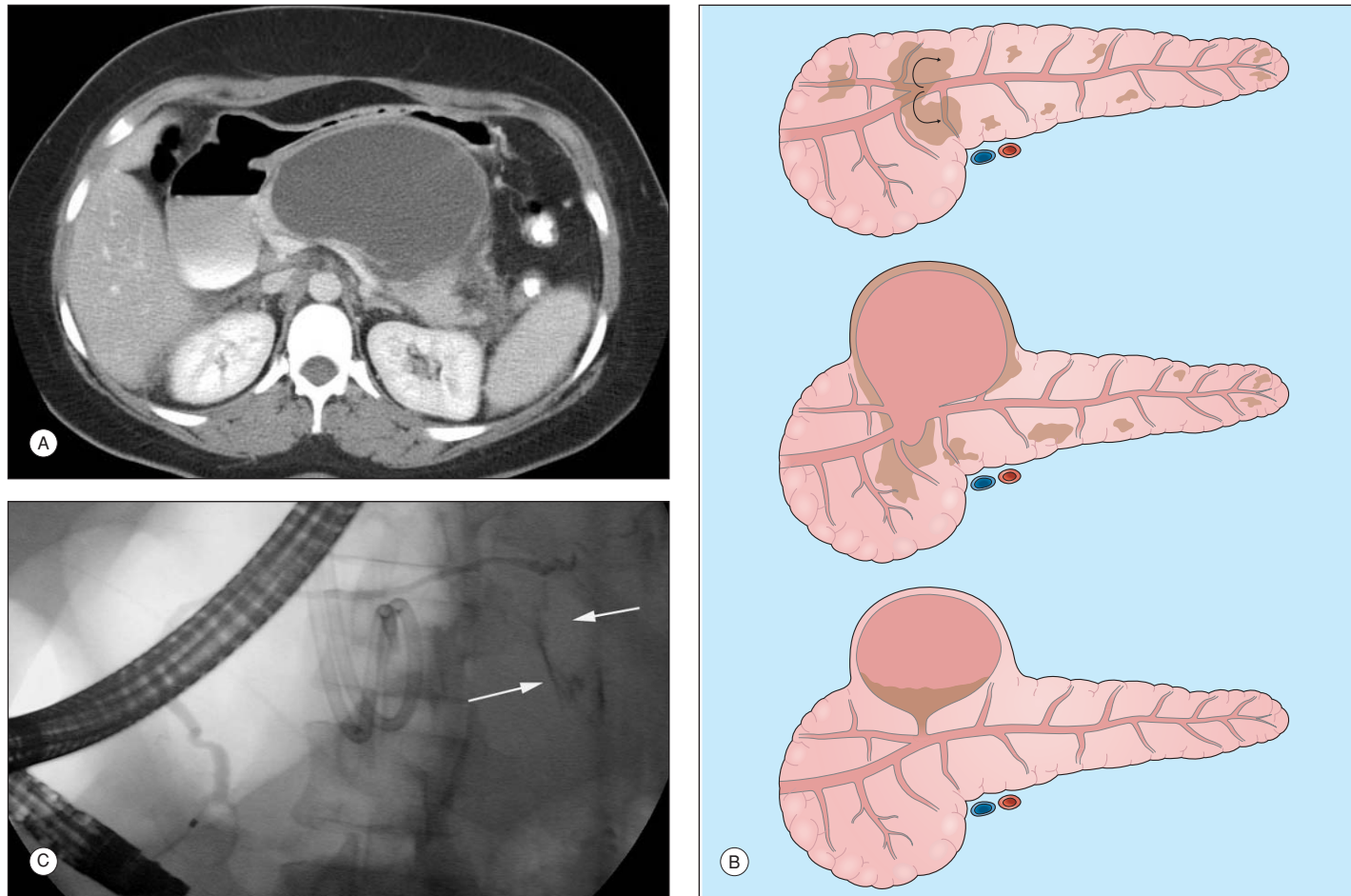


Fig. 50.6 Acute pseudocyst. **A.** CT demonstrates a homogeneous collection arising 4 weeks after clinically mild acute pancreatitis. **B.** Illustration of the mechanism of formation of an acute pancreatic pseudocyst. Limited necrosis of the main pancreatic duct produces a leak with accumulation of amylase-rich fluid. Redrawn with permission from Bradley EL III, ed. *Acute pancreatitis: diagnosis and therapy*. New York: Raven Press, 1994:73. **C.** Pancreatogram in the same patient as in A, showing intact main duct with side-branch leak (arrows).

ORGANIZED PANCREATIC NECROSIS

Pancreatic necrosis is defined as nonviable pancreatic parenchyma, usually with associated peripancreatic fat necrosis.⁸ In the earliest form, this is detected radiographically on contrast-enhanced CT by the presence of non-enhancing pancreatic parenchyma (see Fig. 50.1). Pancreatic necrosis is frequently accompanied by the development of major pancreatic ductal disruptions.⁷³ Over the course of several weeks, the collection may continue to evolve and expand the initial area of necrosis, and contain both liquid and solid debris (Fig. 50.7). We have used the term organized pancreatic necrosis to differentiate this process from the early (acute phase) of pancreatic necrosis.^{55,56,74} As mentioned in the previous paragraph, the radiographic appearance of organized pancreatic necrosis on CT may be similar to that of an acute pseudocyst. Because the underlying solid debris is frequently not discernible by CT,⁷⁵ its homogeneous appearance may lead one to embark on standard pseudocyst drainage methods, which do not adequately remove the underlying solid material. This may result in serious infectious complications.^{55,72,76}

The distinction between an acute pseudocyst and organized necrosis may be made on clinical, radiologic, or endoscopic findings

at the time of drainage. Clinically, if the patient suffered a severe or complicated course of acute pancreatitis, it is likely that pancreatic necrosis occurred and is present within the collection. Radiographically, several features indicate the presence of underlying solid material within the collection. First, if an initial contrast-enhanced CT scan obtained at the time of – or soon after – the initial bout of pancreatitis demonstrated significant glandular necrosis, the collection probably contains solid debris. Second, the evolution of changes on serial CT scans can be traced from the original pancreatic glandular necrosis to the present collection. Third, we have shown that magnetic resonance imaging (MRI) prior to attempted drainage can delineate the solid debris within the collection (Fig. 50.8).⁷⁵ Lastly, a repeat abdominal CT scan after endoscopic drainage will depict solid material once some of the liquid component has been evacuated (Fig. 50.9).⁷⁶

Endoscopic findings at the time of drainage may alert the endoscopist to the presence of necrotic debris within the collection. If the collection is drained transmurally, solid material may be seen to flow from the collection; the presence of chocolate-brown or extremely turbid fluid (in the absence of clinical infection) also suggests the presence of underlying necrosis. During pancreatography,

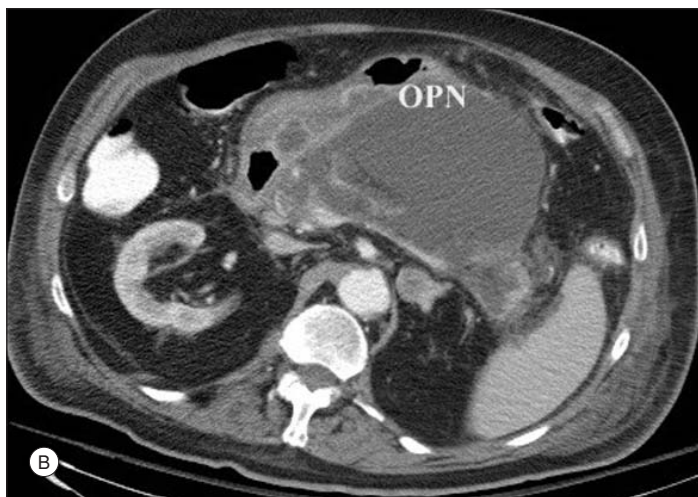
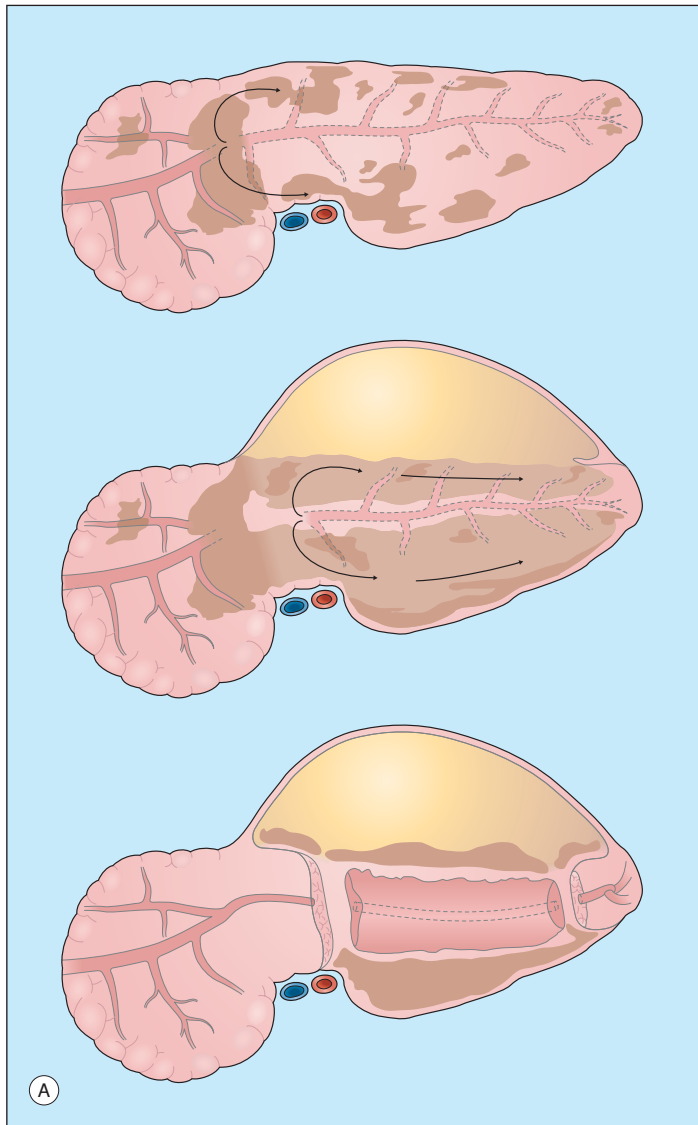


Fig. 50.7 Organized pancreatic necrosis **A.** Formation of organized pancreatic necrosis. Note the mechanism of pancreatic duct disconnection in the lower panel. Redrawn with permission from Bradley EL III, ed. *Acute pancreatitis: diagnosis and therapy*. New York: Raven Press, 1994:73. **B.** Contrast CT scan demonstrating a large collection that has nearly replaced the pancreatic bed. This collection is consistent with organized pancreatic necrosis.

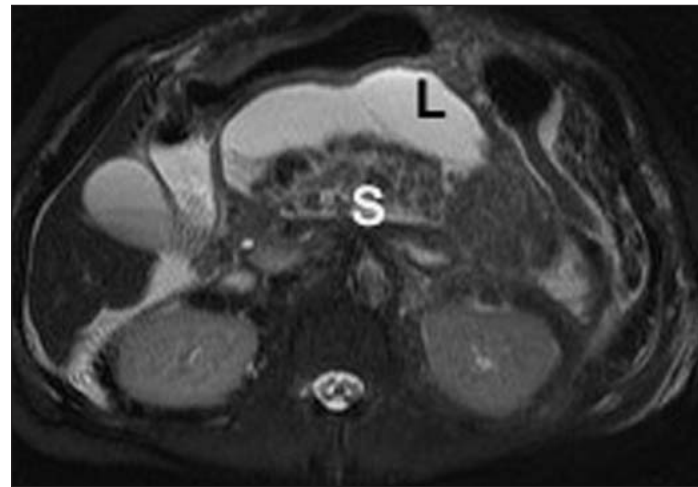


Fig. 50.8 MRI of pancreatic fluid collection that appeared homogenous by CT scan. The patient had suffered severe necrotizing pancreatitis 6 weeks previously. The liquid component (L) has a whitish appearance while the solid component (S) appears black.



Fig. 50.9 CT scan obtained several days after endoscopic placement of a transduodenal drainage catheter into a pancreatic fluid collection. Black arrowheads denote a collection that contains nondependent air and debris.

the finding of complete main pancreatic duct disruption suggests that pancreatic necrosis occurred during the initial course of pancreatitis and may be present in the collection. During contrast injection, either through the main pancreatic duct or transmurally, the finding of large filling defects within the collection denotes the presence of solid material. If any or all of the above findings are recognized, then appropriate steps must be taken to evacuate the underlying solid debris to prevent secondary infection (see drainage methods later). Overall, one should consider the evolution of a pancreatic collection from the early phase of acute pancreatic necrosis toward a pseudocyst as a spectrum, with organized pancreatic necrosis as an intermediate stage, but also realizing that some collections will never become completely liquefied.

- **Oral and intravenous contrast abdominal CT scan.** This allows assessment of the precise location of the collection in relation to the stomach and duodenum in anticipation of possible transmural drainage. Additionally, the relationship of the collection to potential intervening vascular structures can be assessed. Surrounding varices from splenic vein or portal vein thrombosis may also be visualized. The finding of inhomogeneity within the collection suggests the presence of underlying solid debris.⁷⁵
- **Coagulation parameters.**

The following imaging studies should be considered:

- **Endoscopic ultrasound.** EUS can be used prior to considering drainage of a pancreatic fluid collection for two reasons. First, in a patient with a pancreatic collection following a documented episode of pancreatitis, EUS allows assessment of the collection for the presence of significant solid debris that may alter the management strategy. Second, if the endoscopist is uncertain as to whether the collection in question represents a true pseudocyst or other non-inflammatory cystic lesion, EUS allows one to obtain a definitive diagnosis by both using the ultrasonographic features and analyzing cyst contents aspirated during EUS.⁸³ Once the endoscopist is certain that the lesion in question is a pancreatic fluid collection and the decision has been made to proceed with endoscopic drainage, EUS may be used to guide transmural drainage as discussed in the next section under endoscopic drainage methods.
- **Magnetic resonance imaging** to determine the presence of solid debris, in order to plan for irrigation methods or alternative drainage strategy, depending on local expertise and necrosis drainage preferences.⁷⁵

Endoscopic drainage

METHODS

The following methods apply to endoscopic drainage of pancreatic fluid collections that do not have significant underlying solid debris (necrosis), such as acute pancreatic pseudocysts. The endoscopic management of organized pancreatic necrosis will be addressed separately. The endoscopic approaches to pseudocysts are transpapillary drainage^{84,85} transmural drainage⁸⁶ or combined transpapillary and transmural drainage.^{87,78} The decision to proceed with one approach rather than another is based upon the anatomic relationship of the collection to the stomach or duodenum, the presence of ductal communication, and the size of the collection. If the stomach or duodenum is not in close apposition to the wall of the collection (within 1 cm by CT), it is not approachable transmurally. If the collection is very large, attempted transpapillary drainage alone in the presence of a ductal communication may result in infection, since the transpapillary drainage process is relatively slow and contrast injection introduces bacteria and/or fungal organisms into the collection. The endoscopic approach to patients with large pseudocysts (>6 cm) using combined transpapillary and transmural drainage is analogous to the treatment of large bilomas complicating laparoscopic cholecystectomy using percutaneous drainage for the biloma and endoscopic therapy to close the biliary ductal leak.

Transpapillary approach

If the collection communicates with the main pancreatic duct, placement of a pancreatic endoprosthesis with or without pancreatic sphincterotomy is an approach that is useful, especially for collections measuring <6 cm that are not otherwise approachable transmurally. The proximal end of the stent (toward the pancreatic tail) may directly enter the collection or bridge the area of leak into the pancreatic duct upstream from the leak (Fig. 50.11). Recent data suggests that complete bridging of the leak is the best approach.⁸⁸ The diameter of pancreatic stent used is dependent on the pancreatic ductal diameter, but is usually 7 Fr.

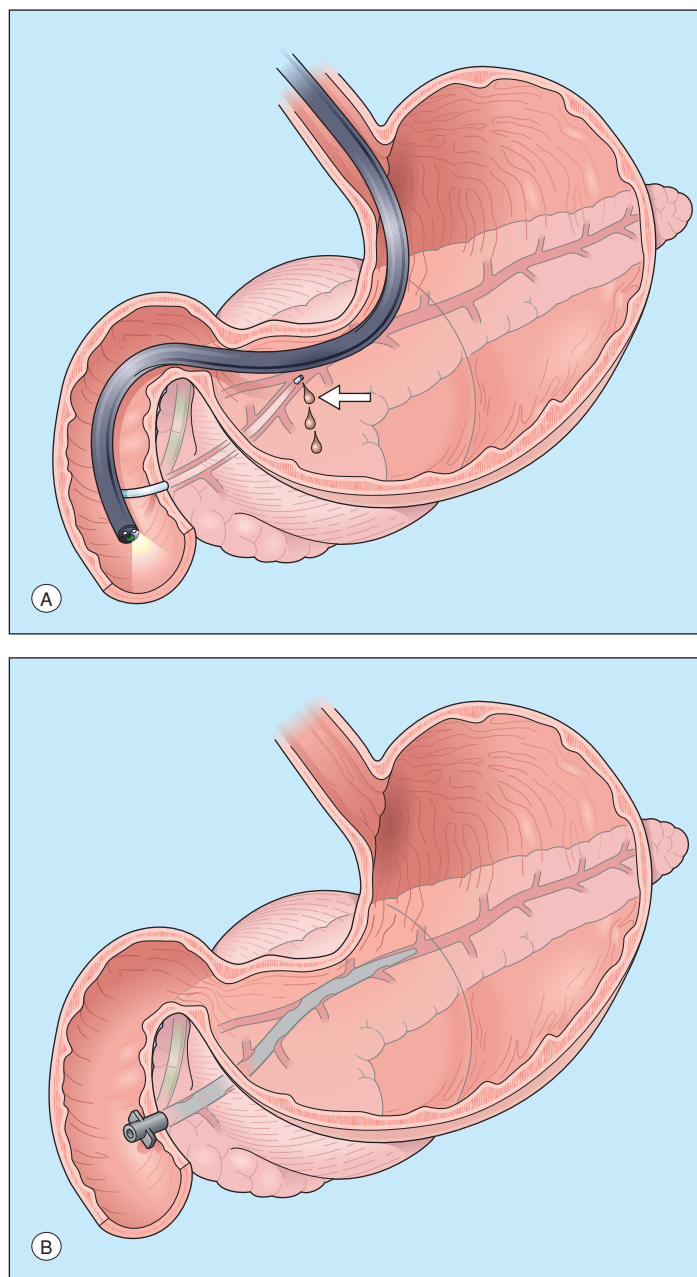


Fig. 50.11 Illustration of transpapillary drainage of a pancreatic pseudocyst. **A.** Pancreatogram showing a leak off a side branch of the main pancreatic duct. **B.** A pancreatic duct stent is in place across the leak.

The advantage of the transpapillary over the transmural approach is the avoidance of bleeding or perforation that may occur with transmural drainage. The disadvantage of transpapillary drainage is that pancreatic stents may induce scarring of the main pancreatic duct in patients whose pancreatic duct is otherwise normal (i.e., patients with acute pseudocysts and small side branch disruption).^{89,90}

Transmural approach

Transmural drainage of pancreatic fluid collections is achieved by placing one or more large-bore stents through the gastric or duodenal wall (Fig. 50.12). There is no standardized approach to this method of drainage and some authorities feel that EUS evaluation is mandatory prior to performing endoscopic transmural drainage of pancreatic fluid collections.⁹¹ EUS-guided and non-EUS-guided drainage will be discussed.

Endoscopic-ultrasound-guided transmural drainage

Although EUS imaging may theoretically reduce complications related to transmural entry of pancreatic fluid collections, this has not been proved in prospective randomized studies. There are two ways EUS can be used for transmural drainage of pancreatic fluid collections.⁹² The first is to use an echo endoscope to localize the collection in relationship to surrounding structures and endoscopic landmarks; the echo endoscope is removed and therapeutic endoscope is used to perform transmural drainage by puncturing into the collection as described under non-EUS-guided drainage below. The second is to perform the evaluation and entry into the collection using direct EUS guidance.

Early reports of EUS-guided drainage using the first approach in order to identify intervening vessels did not demonstrate that bleeding complications were avoided.^{87,93,94} More recently, Giovannini *et al.* described transmural drainage of pancreatic fluid collections performed entirely under EUS guidance using a Doppler-equipped therapeutic channel echo endoscope.⁹⁵ Successful entry was achieved in 35 patients (94%), in 32 of whom there was no endo-

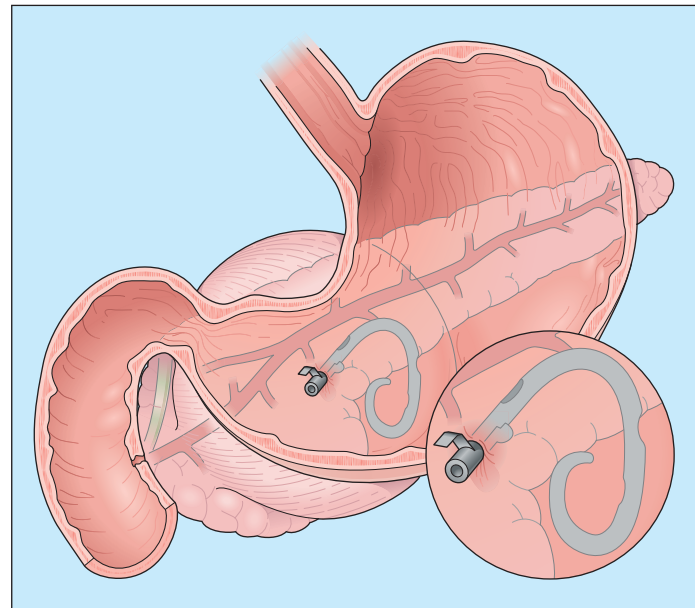


Fig. 50.12 Illustration of transmural stent in place through the posterior gastric wall into a pancreatic pseudocyst.

scopically visible extrinsic compression. No episodes of bleeding occurred, although pneumoperitoneum occurred in one patient. Therefore, if EUS is readily available it should be used to assist with transmural drainage.

Unavailability of EUS, however, should not preclude potential transmural drainage except in the following instances:

- small 'window' of entry based upon CT, especially in the absence of an endoscopically defined area of extrinsic compression or unusual location⁹⁶ (Fig. 50.13)
- marginal, uncorrectable coagulopathy or thrombocytopenia
- documented intervening varices
- failed transmural entry using non-EUS-guided techniques.

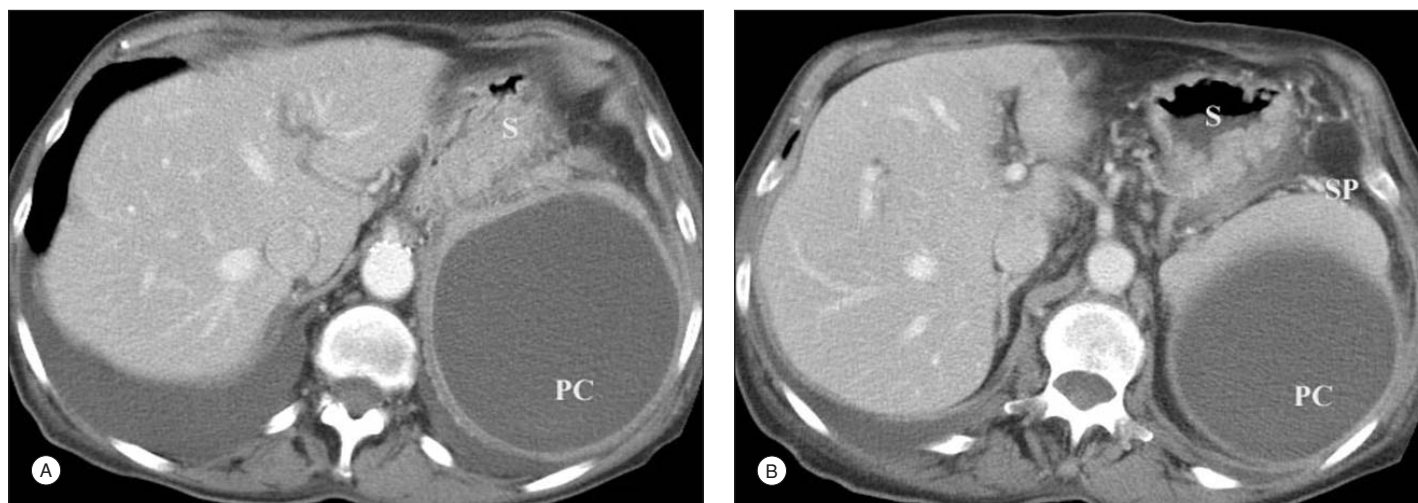


Fig. 50.13 Pancreatic pseudocyst best suited for EUS drainage. **A.** CT showing a pancreatic pseudocyst (PC) adjacent to the collapsed stomach (S). **B.** CT scan 1 cm below the previous image. Note the spleen (SP). The narrow window would make attempted non-EUS-guided transmural drainage of this pseudocyst dangerous.

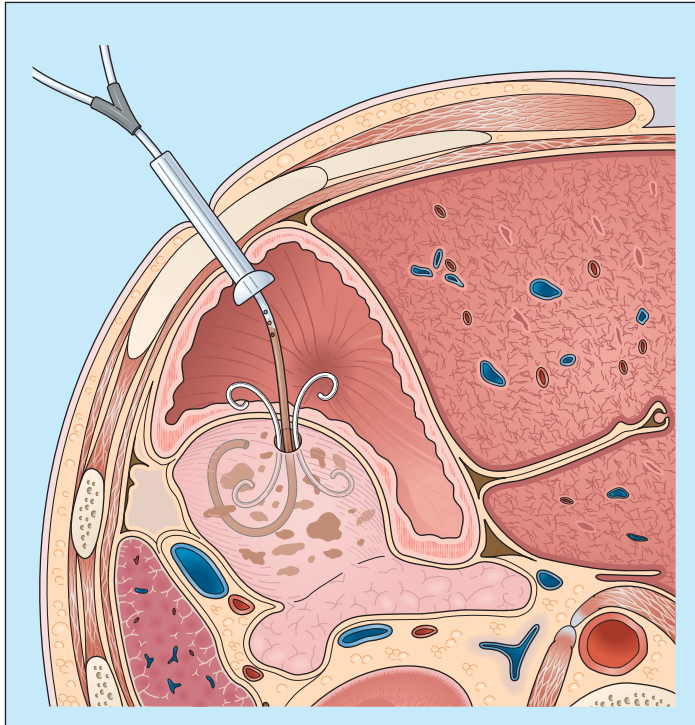


Fig. 50.15 Illustration of percutaneous endoscopic gastroscopy tube with jejunal extension tube placed through the posterior gastric wall into a necrotic pancreatic collection to provide irrigation. Redrawn with permission from Baron TH, Morgan DE. Endoscopic transgastric irrigation tube placement via PEG for debridement of organized pancreatic necrosis. *Gastrointest Endosc* 1999;50:574-577.

COMPLICATIONS

Life-threatening complications may arise following attempted endoscopic drainage of pancreatic fluid collections and are listed in Box 50.4. It is therefore recommended that endoscopic drainage of pancreatic fluid collections should not be performed unless surgical and interventional radiology support is available. The most feared complications of transmural drainage are bleeding and perforation. Bleeding after transmural drainage may be managed supportively, endoscopically, surgically, or with angiographic embolization.⁹⁹ If perforation occurs during attempted transgastric drainage and is limited to the gastric wall (does not involve the collection), it may be successfully managed nonsurgically, assuming that a stent has not been placed through the perforation; the gastric wall rapidly closes with conservative treatment consisting of nasogastric suction and antibiotics. Some authors feel that transduodenal perforation may

Box 50.4 Complications of endoscopic therapy of pancreatic fluid collections

- Bleeding
- Perforation
- Infection
- Pancreatitis
- Sedation complications
- Aspiration
- Stent migration/occlusion
- Pancreatic ductal damage

be managed conservatively, since the perforation is retroduodenal¹⁰¹, although this is not proven.

Infectious complications usually occur from inadequate drainage of fluid and/or solid debris. If endoscopic drainage was performed on a liquefied collection by the transpapillary route, stent exchange and/or upsizing of the stent, or conversion to a transmural approach may resolve the infection. Similarly, if solid material was present and unrecognized during the initial procedure, placement of irrigation tubes or converting to a transmural drainage approach may resolve the infection. Occasionally, some patients will require adjuvant placement of percutaneous drainage and/or irrigation catheters to manage infectious complications. Stent migration into the collection through the gastric or duodenal wall may occur during or after endoscopic stent placement. It is possible to endoscopically retrieve the stent if the collection has not completely collapsed and the transmural tract is still patent.

RESULTS

It must be emphasized that there are no prospective studies comparing endoscopic drainage to conservative (medical) therapy, percutaneous drainage or surgical drainage.

Pancreatic pseudocysts

The success rates, recurrence rates and complication rates following endoscopic drainage of pancreatic pseudocysts are variable. This is probably because most authors have not used standardized criteria for defining pseudocysts, have used variable indications to perform drainage, have tended to lump acute and chronic pseudocysts into a single group, or have combined the results of transpapillary and transmural drainage. Nonetheless, in an excellent review by Beckingham *et al.*¹⁰¹ in 1997 of the cumulative experience to date of endoscopic drainage of pancreatic pseudocysts, successful drainage was achieved in 82–89% of cases with complication rates occurring in 5–10% and recurrence rates ranging from 6% to 18%. Additionally, from that review there appeared to be slightly lower pseudocyst recurrence rates following transduodenal drainage compared to transgastric drainage. This is probably because of the sustained patency of a transduodenal fistula that allows drainage of the main pancreatic duct. Indeed, we have achieved long-term resolution (>5 years) of a pancreatic pseudocyst using transduodenal drainage after it had rapidly recurred following successful transgastric drainage (unpublished). Therefore, in a patient with severe pancreatic ductal disease we perform transduodenal drainage when possible.

Since the review by Beckingham *et al.*¹⁰¹ there have been more recent series of endoscopic drainage of pancreatic pseudocysts with similar results. Libera *et al.*⁷⁸ successfully treated 25 patients using transpapillary and transduodenal approaches with a recurrence rate of 4.2% at 42 ± 36 weeks. Complications occurred in 16% and were managed clinically or endoscopically in all cases with no mortality. Sharma *et al.*¹⁰² published long-term follow-up (mean 44 months, range 24–80 months) after endoscopic drainage of pancreatic pseudocysts in 38 consecutive patients. Pseudocyst recurrence occurred in six patients (16%); three were symptomatic and were successfully retreated endoscopically. Beckingham *et al.*¹⁰³ reported a 7% recurrence rate following successful transmural drainage in 24 patients