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## Indications for Interventional and Surgical Treatment of Necrotizing Pancreatitis

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### Introduction

Whereas interstitial acute pancreatitis is typically a self-limited disease process that usually responds to supportive care, more severe necrotizing pancreatitis can be seen in approximately 20% of patients. This is characterized by necrosis of the pancreatic parenchyma or peripancreatic tissue, manifestations of the systemic inflammatory response syndrome (SIRS), with risks for infection and multiorgan failure [1]. High rates of morbidity are associated with mortality of up to 15% in the setting of necrotizing pancreatitis and as high as 30% in the subset of patients who develop infected pancreatic necrosis [2,3]. A variety of surgical and interventional approaches have been used in an attempt to limit the substantial morbidity and mortality of necrotizing pancreatitis.

Over the last few decades, there has been a significant change in the indications for intervention in necrotizing pancreatitis, timing of intervention, and methods of surgical, minimally invasive, radiologic, and endoscopic intervention. Revision of the 1992 Atlanta classification of acute pancreatitis [4] to describe the clinical behavior and imaging characteristics more precisely [5] has occurred in parallel with a progressively less interventional and less invasive approach to necrotizing pancreatitis. Although no universally accepted management algorithm exists to guide management, evidence-based consensus continues to develop [6,7].

### Interventions for Pancreatic Necrosis: Historical Perspective

Just a few decades ago, the association of pancreatic necrosis with systemic inflammation and secondary infection led to the goal of surgically removing all necrotic

pancreas regardless of the presence of infection [8–10]. In 1991, Bradley and Allen published a small series of 11 patients successfully managed nonoperatively with sterile pancreatic necrosis [11]. The general acceptance of nonoperative management for sterile pancreatic necrosis was facilitated by the publication of a large series demonstrating favorable overall mortality and complications [12,13]. In this new paradigm, intervention was primarily limited to surgical debridement for cases of infected pancreatic necrosis as demonstrated by computed tomography (CT)-guided fine-needle aspiration (FNA) of the pancreas. Banks et al. showed a sensitivity and specificity of 96.2% and 99.4%, respectively, for detection of infected necrosis, with a positive predictive value of 99.5% and a negative predictive value of 95.3% [14]. The presence of infection or positive Gram stain on CT-guided pancreatic aspiration was considered an absolute indication for debridement, as superinfection of the necrotic parenchyma had been associated with a mortality of virtually 100% without debridement [15].

The absolute necessity of surgical debridement for infected necrosis was subsequently questioned with the demonstration of successful nonoperative management in some patients. Runzi et al. [16] showed in a series of over 80 patients with documented infected pancreatic necrosis that initial conservative therapy can be instituted, including antibiotic therapy and maximal supportive care. Mortality in patients managed with surgery was identical to that in those managed nonoperatively. Surgical therapy, when required, was often delayed to a later stage of disease, when the systemic inflammatory response stabilized, and necrotic pancreas had become demarcated. In other patients, surgical therapy was avoided altogether. Subsequent studies have confirmed this strategy: Garg et al. describe a 10-year series of 80 patients with infected pancreatic necrosis in whom 47 were treated with

antibiotics alone [17]. The paradigm of urgent surgical debridement for all patients with infected pancreatic necrosis is therefore no longer considered valid.

## Definitions and Classification of Pancreatic Necrosis

A classification system for acute pancreatitis was first proposed at the Atlanta Symposium in 1992. This system defined acute pancreatitis as an acute inflammatory process, associated with elevated pancreatic enzymes, with variable involvement of other organ systems [4]. A further distinction was made between acute interstitial pancreatitis and sterile or infected necrotic collections [18]. Unlike the prior delineation of pancreatic necrosis to infected and sterile versions, the revised Atlanta classification, introduced in 2012 [5], divided collections associated with necrotizing pancreatitis according to time of disease onset. A collection that develops early and lacks a discrete wall is referred to as an acute necrotic collection (ANC), whereas a collection that persists after 4 weeks is referred to as walled-off necrosis (WON). Both forms may be sterile or infected, although no correlation exists between extent of necrosis and risk of infection [5].

## Indications and Timing of Intervention

In principle, interventions for pancreatic necrosis intend to control organ damage by removing necrotic tissue while maintaining functional pancreas. These interventions may be considered in patients with infected pancreatic necrosis or symptomatic sterile necrosis. Although the presence or absence of infection is crucial for prognosis and affects management decisions, the presence of clinical symptoms rather than suspicion of infection is considered paramount for intervention. It should be noted that the management of pancreatic necrosis requires a multidisciplinary approach with clinical expertise from gastroenterologists, surgeons, interventional radiologists, critical care physicians, and dietitians. As such, clinical guidelines recommend transfer to a tertiary care center for management of these patients.

Timing of intervention is dependent on patient factors and clinical stability. Early resuscitative efforts, including fluid resuscitation, initiation of enteral nutrition, and reversal of organ failure, are critical, with most data and practice guidelines recommending delaying intervention for 3–4 weeks after onset of acute pancreatitis. In one retrospective series of 305 patients with necrotizing pancreatitis, early intervention (defined as <4 weeks from disease onset) was associated with longer

hospitalization (37 vs. 26 days,  $P=0.01$ ) and higher mortality (13% vs. 4%,  $P=0.02$ ), compared to delayed ( $\geq 4$  weeks) treatment [19]. A randomized trial has shown that early surgical intervention is associated with higher morbidity and mortality, compared to intervention at least 12 days after onset [20]. Other reviews have confirmed lower mortality with delayed surgical intervention [21,22] with data suggesting that early surgery is an independent predictor of poor outcome in necrotizing pancreatitis [23]. More recently, a randomized, multicenter, superiority trial (POINTER), comparing immediate and postponed intervention in patients with infected pancreatic necrosis, observed more interventions in the immediate drainage group, compared to the postponed drainage group, with no difference in adverse events [24].

Significant retroperitoneal inflammation, mediated by cytokine release, is hypothesized to contribute to these observed differences in outcomes. Moreover, early debridement may lead to incomplete excision of necrotic tissue and increased risk of injury to surrounding normal tissues, with associated increases in morbidity and mortality. Conversely, increasing time for clinical stabilization and decreased inflammatory response by delaying debridement improves outcomes for these patients.

## Pancreatic Necrosis with Infection

Mortality rates for patients with pancreatic necrosis and superimposed infection approach 30%. Pancreatic infection occurs via bacterial translocation or seeding from bacteremia, and is most commonly caused by gut bacteria, including *Escherichia coli*, *Enterobacter*, *Enterococcus faecalis* and *faecium*, and anaerobes [25]. Infected necrosis is suspected with clinical deterioration of a previously stable patient with pancreatic necrosis. These patients may present with one of the following clinical features: fever, bacteremia, worsening leukocytosis or organ failure, or hemodynamic deterioration. Abdominal imaging in these patients may demonstrate gas within necrotic debris due to the presence of gas-forming organisms or via a fistula to the colon, small bowel, or stomach. Alternatively, infection may be proven by culture or Gram stain obtained by image-guided FNA [26]. Although a Gram stain positive for organisms was previously thought to mandate early surgical intervention [12], patients with suspected infection are increasingly managed with antibiotics and supportive care to allow less invasive and delayed management of a walled-off collection [3]. Diagnostic FNA is therefore used less routinely in the management of suspected infection.

Currently, first-line treatment for patients with infected pancreatic necrosis includes the initiation of

broad-spectrum antibiotics with high penetration into the pancreas, such as carbapenems, quinolones, and metronidazole. Empiric fungal coverage is not routinely recommended. Notably, while antibiotics are critical in the management of pancreatic necrosis with infection, empiric use of antibiotics for prevention of infected necrosis is not supported. Multiple prospective, randomized trials have concluded that the administration of prophylactic broad-spectrum antibiotics does not impact rates of developing infected necrosis, systemic complications, or mortality [27,28]. As such, prophylactic use of antibiotics is discouraged.

Despite demonstrated success with nonsurgical management for infected necrosis, many if not most patients with infected pancreatic necrosis require some form of intervention. Some series suggest that clinically stable and relatively asymptomatic patients with infected necrosis can be managed with antibiotics alone [16,17,29]. Nonetheless, patients with infection are prone to clinical decline and require surgical, endoscopic, or radiographic intervention with the onset of clinical signs not responding to medical management. As mentioned above, in the era of surgical management, delayed intervention is far preferable to early surgery for patients with infected necrosis. Expedited intervention may be required in patients demonstrating progressive systemic sepsis or hemodynamic instability. In the absence of such systemic signs, clinically stable patients may generally be managed at least temporarily with antibiotics to allow further organization of the inflammatory process. Delayed surgical, endoscopic, or radiologic management may then proceed if clinical symptoms do not improve [6].

Delayed surgical intervention of infected pancreatic necrosis has been facilitated by the use of percutaneous catheter drains. A 1998 series by Freney et al. [30] demonstrated that some patients with infected pancreatic necrosis might have surgical management delayed or potentially avoided altogether with the use of large-bore percutaneous catheters placed under CT guidance. This strategy was validated in a multicenter trial in which patients were randomized to standard pancreatic debridement versus a “step-up” approach in which debridement was used only if necessary [31]. Using a “step-up” approach, complications were significantly lower, and about one-third of patients were treated with catheter drainage alone.

### **Sterile, but Symptomatic, Pancreatic Necrosis**

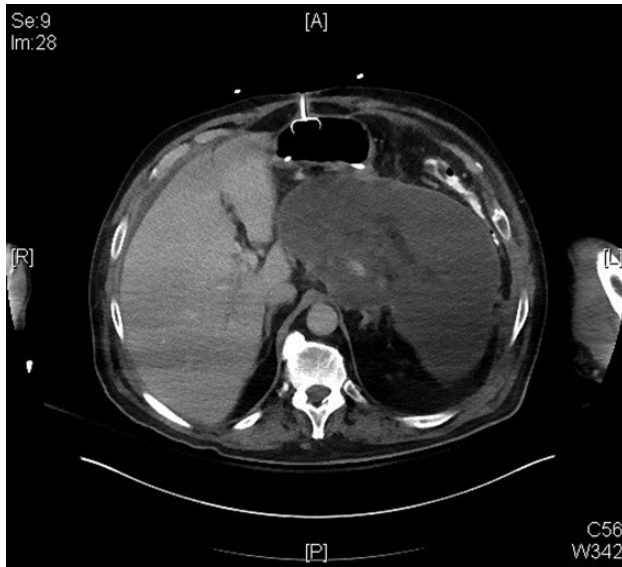
The precise role of radiographic drainage, endoscopic or surgical debridement in sterile pancreatic necrosis is less clear. Although most patients with sterile pancreatic necrosis respond to supportive care without the need

for intervention, others will experience clinical decline, including organ failure despite the absence of demonstrable infection. Historically, some authors had therefore suggested the need for surgical debridement in patients with progression of disease or failure to improve, regardless of the status of infection [32,33]. Unfortunately, no uniform criteria have defined which patients with sterile pancreatic necrosis might benefit from debridement. In the era of surgical debridement as the primary intervention for necrotizing pancreatitis, some authors suggested criteria for intervention including the extent of necrosis of more than 50% of the pancreatic parenchyma [32], rapid clinical deterioration with multiple organ failure [34], or the presence or persistence of organ failure [35,36]. However, evidence is lacking to support the use of these criteria as an absolute indication for debridement or drainage. Close analysis of one study of 89 patients with severe sterile necrosis identified only two patients who died that might have theoretically benefitted from earlier surgical debridement, though no clinical parameters were able to easily differentiate these patients from others with severe sterile necrosis [13].

As noted above, in the absence of clinical confirmation of infection by image guided FNA or suggestive imaging, intervention is typically based on the clinical course and trajectory. Patients are therefore often brought to intervention for not just documented infection, with positive pancreatic FNA, but also for suspected infection based on persistent sepsis or progressive clinical deterioration [36]. Given the additional morbidity and mortality associated with open surgery, radiologic or endoscopic drainage is used prior to surgical intervention [37].

The process of walled-off pancreatic necrosis recognized in the revised Atlanta classification was previously described by Baron as “organized pancreatic necrosis” [38]. In this condition, an intrapancreatic or extrapancreatic heterogeneous semisolid collection develops in the context of acute necrotizing pancreatitis and has an encapsulated wall [5]. A subset of patients with WON may experience a prolonged clinical course marked by persistent pain, malaise, and inability to eat. This symptom complex was described by Warshaw as “persistent unwellness” [39]. The precise indications and timing of intervention are not precisely defined for these patients.

Asymptomatic WON does not require intervention regardless of the size of the collection and may resolve with conservative management (Fig. 27.1). Symptomatic WON, however, can be marked by pain, intestinal, or biliary obstruction, or later infection. In one series, approximately 10% of patients with sterile pancreatic necrosis underwent surgery for persistent pain and organized necrosis at a mean of 29 days after initial presentation [13].



**Figure 27.1** Walled-off necrosis. A 55-year-old man presented with severe acute pancreatitis and an acute necrotic collection. He was managed conservatively, and imaging 6 weeks after presentation revealed a large area of walled-off necrosis involving the entire body and tail of the pancreas. The patient remained asymptomatic, and no intervention was pursued.

### Preoperative Evaluation and Imaging Considerations

The approach to debridement is dependent on imaging characteristics, including the extent and pattern of pancreatic necrosis. Involvement of the mesenteric root or extension down the paracolic gutter have historically been challenging to treat endoscopically. While some techniques have been described [40], wide surgical debridement and drainage is routinely employed in these cases to ensure adequate debridement. Extension of pancreatic necrosis into the mesocolon presents an additional challenge, as debridement of these tissues may compromise colonic blood flow. Patients with extensive colonic or mesenteric involvement may require partial colectomy at the time of surgical debridement.

Close examination of the pancreas on CT imaging is also key, as patients with isolated necrosis of the pancreatic neck or body may be at an increased risk for developing disconnected pancreatic duct syndrome (DPDS). In this condition, the disconnected pancreatic segment continues to secrete pancreatic fluid, which can in turn lead to the development of new pancreatic collections, fistula formation and recurrent pancreatitis [41]. In one retrospective series, fluid collections recurred in 42% of patients with DPDS, despite endoscopic drainage [42]. While rare with a reported prevalence of 10% to 31% [42], prompt diagnosis of DPDS is key to reducing morbidity. Diagnosis requires necrosis of at least 2 cm of pancreas

and viable upstream pancreatic parenchyma [41]. While imaging modalities can be suggestive of DPDS, ERCP, which may visualize extravasation of contrast from the pancreatic duct, remains the gold standard for diagnosis.

Management includes conservative therapy with nutritional optimization, endoscopic treatment, and/or surgery. The routine use of octreotide in these patients is not supported [43]. While surgery was once considered the mainstay of treatment for these patients, advances in endoscopic treatment modalities have provided less-invasive alternatives for select patients. Transpapillary pancreatic duct stent placement has been previously described with successful outcomes [44,45]. In a series of 43 patients, 58% had resolution of the disruption after stent placement. Stents bridging the disruption and longer duration of stent therapy were associated with improved outcomes. In another series endoscopic treatment improved outcomes for patients with DPDS with a failure rate of 23% [42]. While long-term plastic stent placement has been associated with improved outcomes, risks include stent migration and infection. The prophylactic use of pancreatic stents in acute necrotizing pancreatitis remains controversial, with data from a recent prospective randomized superiority trial suggesting a high risk of infection in these patients and advising against routine prophylactic use [46].

Although DPDS can be temporized with EUS-guided transmural stenting [47], many patients may ultimately require consideration of definitive surgical management. Surgical options include distal pancreatectomy for removal of the viable distal segment or internal drainage procedures such as cyst-gastrostomy, which may better preserve pancreatic function.

### Surgical and Interventional Procedures

The use of various radiologic, surgical, and endoscopic interventions for necrotizing pancreatitis will vary among institutions [6]. Although open surgical necrosectomy was previously considered the definitive management, a number of minimally invasive techniques have been developed. As noted above, delayed intervention is preferable in all patients, if possible, particularly when open surgical management is used [48]. However, interventional radiologic techniques may be performed earlier with suspected infection [22]. Even in the setting of suspected or known infection, there is a growing trend to treat with supportive care and antibiotics unless there are signs of sepsis, until the pancreatic collection becomes walled off [3].

Owing to the efficacy of minimally invasive approaches and associated reductions in mortality, the

treatment paradigm for necrotizing pancreatitis has shifted to a predominantly nonsurgical approach. The original “step-up approach” to management of infected pancreatic necrosis was popularized by randomized data suggesting that percutaneous drainage followed by minimally invasive retroperitoneal necrosectomy improved morbidity and mortality [31]. This has further evolved based on a recent multicenter, randomized trial assessing an endoscopic step-up approach, defined as transluminal drainage followed by endoscopic necrosectomy. When compared to patients treated with the traditional “step-up” approach, patients in the endoscopic group were found to have lower rates of pancreatic fistula and length of hospitalization [49]. These data have been reproduced in a single-center trial comparing patients treated with minimally invasive surgery or an endoscopic step-up approach. In this trial of 66 patients, the endoscopic approach was associated with reduced complications, cost, and increased quality of life [50]. Taken together, these data suggest an evolving treatment paradigm for patients with pancreatic necrosis, and a key role for both percutaneous and endoscopic procedures.

### Percutaneous Catheter Drainage

Percutaneous catheter drainage (PCD) can be performed either as a “step-up” toward endoscopic or surgical necrosectomy once WON has developed, or in some cases as definitive therapy [31]. PCD may be further considered when endoscopic drainage is unfeasible due to the anatomic distribution of the pancreatic necrosis. For example, in patients with necrotic extension into the pelvis or the paracolic gutters, PCD may be necessary to access these dependent collections, which are inaccessible from the gastric or duodenal lumen [7].

Catheters are placed using either a transperitoneal or retroperitoneal approach under CT or ultrasound guidance. Multiple catheters are often required, with follow-up procedures to place additional or larger catheters [51]. One significant advantage of PCD is the opportunity to address symptomatic or infected necrotic collections before WON has developed. This may be particularly useful for patients who are failing conservative management or who require rapid source control due to clinical signs of sepsis. PCD may be of additional benefit in patients deemed unfit for surgical intervention, or to address residual collections after surgical or endoscopic debridement [6]. Placement of large (24Fr or greater) percutaneous drains may also assist with later minimally invasive debridement methods, such as video-assisted retroperitoneal debridement (VARD) [7].

One potential risk of percutaneous drainage is the development of pancreatocutaneous fistulas. In a prospective study comparing endoscopic and percutaneous approaches, fistula formation was observed in 32% of the percutaneous group compared to 5% in the endoscopic group [49]. Simultaneous endoscopic drainage with percutaneous drain placement may help minimize this risk [52].

As noted, catheter drainage alone is often effective without necrosectomy. Success of PCD has been associated with necrosis <50% and absence of extrapancreatic infection [53]. In the PANTER trial, use of catheter drainage resulted in significantly decreased morbidity with equal mortality compared to surgical necrosectomy [31]. Other studies have shown an approximately 50% success rate in treating necrotizing pancreatitis, whether sterile or infected [54]. PCD is less likely to be successful as a definitive intervention in patients with duct disruption, who may require eventual surgical or endoscopic therapy [55].

### Direct Endoscopic Necrosectomy

Initially described in 1996, endoscopic necrosectomy is a recognized alternative to surgical debridement, though its availability is limited to specialized centers. A series of 104 patients at six centers showed resolution of WON in 91% with endoscopic necrosectomy, with only 4% requiring surgical debridement [56]. Furthermore, data suggest that endoscopic necrosectomy is associated with fewer complications, less organ failure, and decreased peri-procedural inflammation [36]. Another meta-analysis including 400 patients with infected pancreatic necrosis concluded that a step-up approach with endoscopic debridement should be preferred, followed by step-up with delayed surgical debridement [57].

Similar to PCD, multiple procedures may be required, and not all patients may be candidates for endoscopic therapy. Ideally, collections for endoscopic access are not only walled off but also are adjacent to the gastric or duodenal lumen. Some acute necrotic collections cannot be approached endoscopically due to lack of abutment of the stomach or duodenum. As mentioned above, while endoscopic approaches can be started less than 4 weeks from onset of pancreatitis, patients who can wait  $\geq 4$  weeks prior to endoscopic intervention have been shown to have decreased mortality. Furthermore, early collections are not ideally suited for endoscopic therapy due to the risk of intra-abdominal spread of an infected collection. Multifocal collections are also less easily approached in this manner.

Traditionally, double-pigtail plastic stents (DPPS) were placed from the gastric lumen into the pancreatic

collection. EUS-guided transmural entry is generally preferred to reduce rates of bleeding, which have been reported in up to 20% of patients [56,58]. Given the narrow caliber of these stents, DPPS without subsequent endoscopic necrosectomy provides suboptimal treatment for most patients [59]. To address this limitation, there has been increased interest in use of larger caliber self-expanding metal stents (SEMS). In one series evaluating 94 patients who received SEMS vs. DPPS, treatment with SEMS decreased the need for repeat necrosectomy and risk of intervention-related hemorrhage [59]. The development of lumen-apposing metal stents (LAMS) has also demonstrated favorable results. Due to their shorter length and larger diameter, these stents facilitate endoscopic necrosectomy and are at lower risk for migration [60]. The placement of double-pigtail plastic stents through LAMS has also been proposed as a method to reduce the risk of stent occlusion and/or migration [7].

Direct endoscopic necrosectomy (DEN) may be performed via stents, with passage of forceps, polypectomy snares, and retrieval nets. In general, serial imaging after debridement is performed every 1–2 weeks to follow evolution of necrosis. Routinely, repeat debridement and irrigation is indicated for management of residual solid, necrotic material. The use of acid-suppressive medications is generally discouraged after drainage, with some data suggesting that discontinuation of proton-pump inhibitors reduces the number of endoscopic procedures required [61].

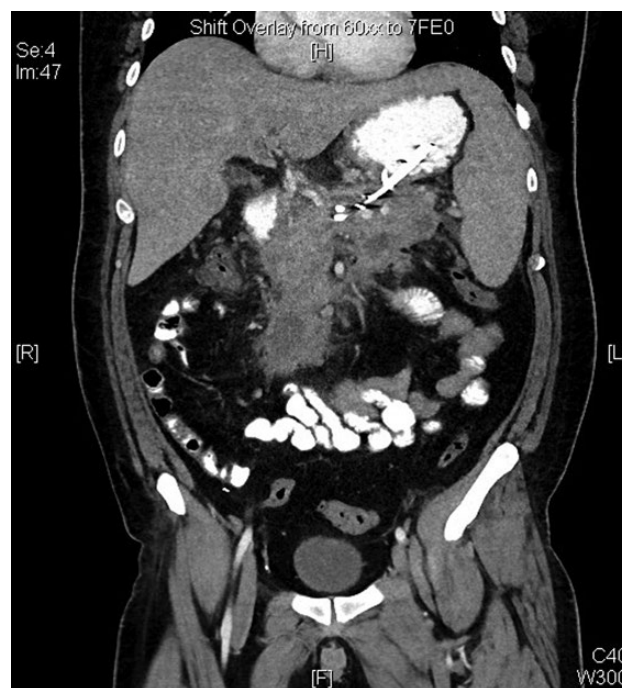
While DEN has been associated with reductions in morbidity and mortality, compared to more invasive techniques, mortality rates remain high at 7.5%. Similarly, complications include bleeding, perforation, sepsis, or organ failure, with an estimated morbidity rate of 14–26% [62]. As these high rates of morbidity have been mostly attributed to procedural and provider variability, standardized techniques for DEN have been proposed [62].

## Surgical Debridement

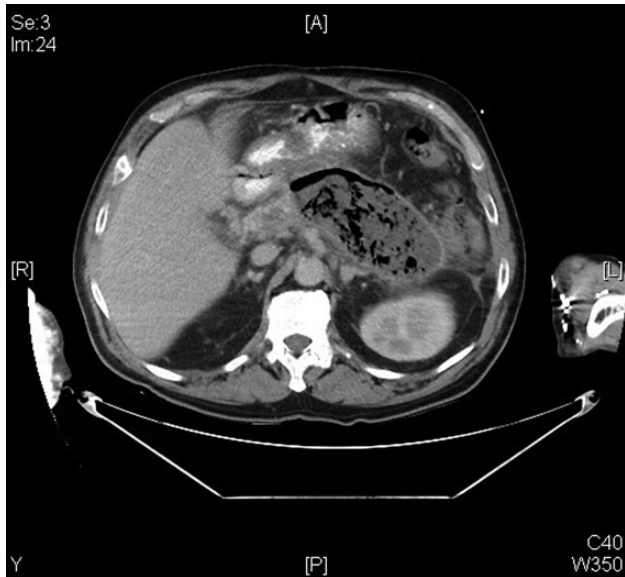
Open surgical debridement for years was considered the gold standard of surgical intervention for pancreatic necrosis, by removing necrotic pancreatic and peripancreatic tissue and establishing a means of postoperative drainage while preserving viable pancreatic parenchyma. Methods have included debridement with closure over drains, debridement with open packing of the pancreatic bed, debridement with internal drainage and cyst gastrostomy or debridement with closure over irrigation drains [10,63–65]. Mortality and complication rates for published series utilizing these techniques vary widely,

although comparisons between studies are confounded by the lack of standardization of disease severity or operative indications.

In the setting of minimally invasive options such as image-guided catheter drainage and direct endoscopic necrosectomy as described above, several important potential indications for surgery remain. Due to its invasiveness and associated perioperative complications, open surgery is typically reserved for patients in whom less invasive methods have failed. One advantage of open surgical necrosectomy is that it may offer the best chance to completely remove all necrotic tissue and address other associated complications in a single procedure. In some cases, collections may not be accessible via image-guided techniques, may be multifocal, or persistent after minimally invasive necrosectomy (Fig. 27.2). In other instances, a patient may not be deemed clinically stable for minimally invasive measures. Surgical therapy in these instances should be delayed as long as possible given the increased risk of early surgical intervention. Other indications for surgical debridement include the presence of bowel perforation, obstruction, fistula to a hollow viscus such as the colon, and abdominal compartment syndrome [66] (Fig. 27.3).



**Figure 27.2** Undrained mesenteric abscess after endoscopic debridement. A 50-year-old man underwent uncomplicated endoscopic debridement for symptomatic walled-off pancreatic necrosis. He represented with fevers, pain, leukocytosis, and a phlegmonous abscess tracking down into the small bowel mesentery. Endoscopic debridement and CT-guided drainage were not felt to be possible. Surgical debridement was required.



**Figure 27.3** Infection of walled-off necrosis with fistula to colon. The patient in Fig. 27.1 presented 12 months after his original episode of pancreatitis with fever and bacteremia. Imaging demonstrated gas in the area of walled-off necrosis, consistent with infection. Endoscopic debridement was attempted, though contrast injection to the cavity demonstrated a fistula to the transverse colon. Open surgical debridement was pursued.

Of the available surgical approaches, open debridement with external drainage has been considered the gold standard, with operative morbidity of 72% and mortality of 4% [67]. Consideration of enteral access (i.e., jejunal feeding tube placement) during open debridement is reasonable to support postoperative nutritional optimization. Alternatively, internal drainage with cyst-gastrostomy may be performed in patients with WON. Other surgical techniques such as open packing with planned return to the operating room in 48–72 hours may be considered when early surgical intervention is required, or in cases when complete debridement cannot

be obtained during the index procedure. Although this approach can effectively control intra-abdominal sepsis, it has inherently higher risk due to the need for multiple procedures and prolonged intubation time. Trans-gastric debridement is similar to endoscopic debridement and can be performed laparoscopically or open.

Of note, minimally invasive forms of surgical debridement have been used in addition to traditional “open” necrosectomy. Laparoscopic approaches are well described and may be more successful in completely removing all necrotic material compared to other minimally invasive methods [68]. Laparoscopic-assisted transperitoneal debridement has been described with placement of three ports for debridement, although this approach increases the chances of peritoneal contamination. Video-assisted retroperitoneal debridement (VARD) is a procedure by which the retroperitoneal collection is accessed via the tract of a large percutaneous catheter [51]. Patients with central necrosis may benefit from VARD, although this approach has limited efficacy for drainage of necrosis to the right of the mesenteric vessels [7]. Notably, VARD avoids pneumoperitoneum and peritoneal seeding possible with a laparoscopic procedure. This approach is not preferred for patients who may require simultaneous cholecystectomy or jejunostomy tube placement [6]. While open necrosectomy can be avoided in many patients, limited data are available comparing outcomes of these procedures [51].

Surgical debridement has several associated complications. Persistent or recurrent intra-abdominal fluid collections are a common postoperative complication, and often require intervention such as additional percutaneous drainage procedure. Bleeding is the most common postoperative complication requiring reoperation after debridement. Early bleeding is often due to injury of the peripancreatic vessels whereas late bleeding may be due to pseudoaneurysm rupture. Pancreatic fistulas and pancreatic insufficiency are also common side effects of the procedure.

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