Endoscopic management of necrotizing pancreatitis CME

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The endoscopic management of pancreatic fluid collections (PFCs) and necrotizing pancreatitis has increasingly become part of the therapeutic endoscopist's armamentarium in the previous 2 decades.[1-6] With the advent of linear-array EUS and sinus tract retroperitonoscopy, retroperitoneal access via the transgastric, transduodenal, and/or percutaneous approaches has revolutionized the diagnostic and therapeutic management of this condition.[7-11] In many centers, the primary treatment of PFCs has shifted from the operating room to the endoscopy or interventional radiology suite, and increasingly therapeutic endoscopists are intervening in necrotizing pancreatitis.[12]

However, despite these advances, several questions remain with regard to the endoscopic management of necrotizing pancreatitis.[13] Most basic is that there is still not true consensus as to how necrosis should be defined, despite multiple classification systems proposed in the past 2 decades. In fact, a new term, *walled-off necrosis* (WON), has been introduced to replace older terms such as phlegmon and organized necrosis.[14] In addition, the timing and indication for intervention are not universally defined and agreed on. Finally, single-modality endoscopic techniques (ie, by using endoscopy alone to treat necrotizing pancreatitis), with few exceptions, have yet to be comprehensively evaluated against retroperitoneal sinus tract endoscopy (ie, videoscope-assisted retroperitoneal débridement [VARD]) or open operative management. Thus, although it is believed that endoscopic treatment of necrotizing pancreatitis may offer equivalent efficacy and safety, future comparative effectiveness trials are necessary.

This review highlights the techniques used for the endoscopic management of necrotizing pancreatitis. It provides background into the current definition of necrosis, focuses on the indications and complexities for endoscopic treatment, identifies areas of controversy, and suggests areas of uncertainty that require further evaluation. As the intent is not to inform about the epidemiology, natural history, and etiology, the review is written from the perspective that the patient has a symptomatic WON that requires treatment.

Abbreviations: PFC, pancreatic fluid collection; VARD, videoscope-assisted retroperitoneal débridement; WON, walled-off necrosis.

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DEFINTION OF PANCREATIC NECROSIS

Critical to the management of necrotizing pancreatitis is having standardized definitions and criteria; by using the ubiquitous term pseudocyst to describe any PFC is erroneous.[15,16] Necrotizing pancreatitis is defined by the lack of enhancement of the pancreatic parenchyma on cross-sectional imaging after intravenous contrast administration and can involve either pancreatic parenchyma alone (uncommon), pancreatic parenchyma and peripancreatic tissues (most commonly), or peripancreatic tissues alone (least commonly).[17]

The original Atlanta Classification from 1992 was among the first to attempt to categorize PFCs systematically and divide collections into acute fluid collections, acute pseudocysts, chronic pseudocysts, and pancreatic abscesses.[18] Although this classification system was helpful to separate the acute from chronic definition of pancreatic injury, it failed to adequately address the issue of pancreatic solid debris.[19] With the recognition that the original Atlanta Classification had several shortcomings, there has been a concerted recent effort to revise the original Atlanta Classification of acute pancreatitis.[20,21]

In the new Atlanta Classification criteria, which are to be published shortly, fluid collections and necrosis are divided into acute and chronic phases; the acute phase is defined as occurring within the first 4 weeks after pancreatic injury and the chronic phase after 4 weeks. Acute collections include (1) acute fluid collections that arise in the setting of interstitial pancreatitis and (2) acute necrotic collections, which occur in necrotizing pancreatitis, can be intra- or extrapancreatic, contain solid material with varying amounts of fluid, *but are without full encapsulation.* Chronic collections include (1) pancreatic pseudocysts, which usually develop adjacent to the pancreas, are homogeneous, and are fluid filled without significant solid debris and (2) WON, which develops in the context of pancreatic or peripancreatic necrosis, are heterogeneous,

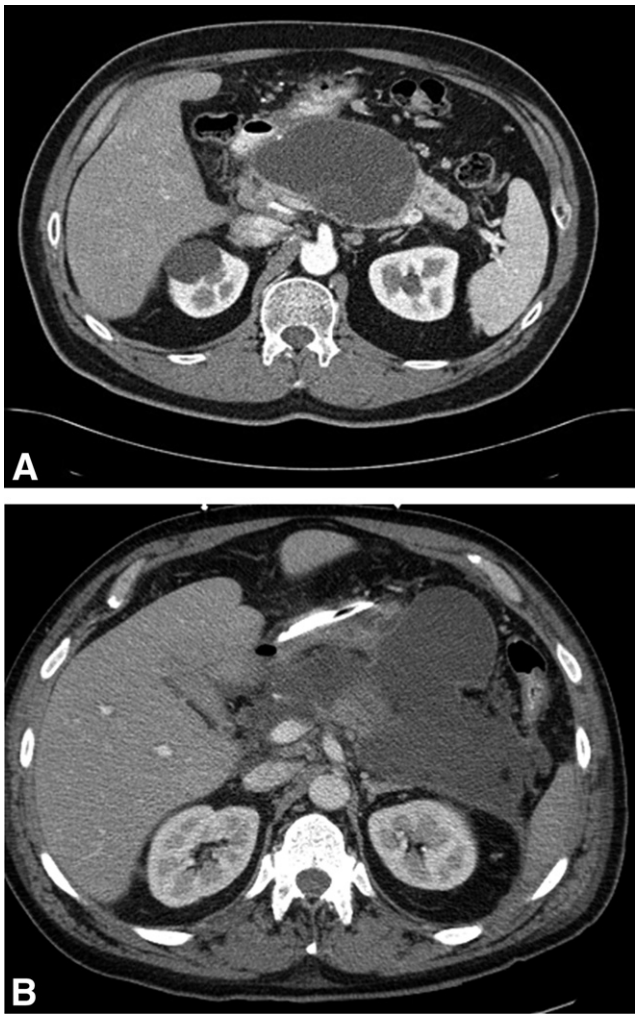

Figure 1. Representative example of well-demarcated walled-off necrosis (**A**) that was successfully treated with endoscopic necrosectomy in an ambulatory patient with gastric outlet obstruction with extensive peripancreatic necrosis extending into the gutters (**B**) in an unstable hospitalized patient with sepsis syndrome that required a step-up approach of percutaneous drainage followed by percutaneous laparoscopic débridement.

contain solid material with varying amounts of fluid, and *have an encapsulating wall.* All of these collections can be sterile or infected, and all are believed to have different management strategies because they represent unique clinical entities (Fig. 1).

It is also important to recognize that there is often considerable overlap between these entities and in some cases, the distinction can be very difficult to make. For example, how much solid debris needs to be present for a collection to be termed WON and not a pseudocyst? Thus, although the revised Atlanta Classification does make progress with regard to defining these collections, certain classification controversies will remain intrinsic to this schema until a universal nomenclature is achieved. For the purposes of this review, WON is subsequently defined per the revised Atlanta Classification (Table 1).

INDICATION AND TIMING OF INTERVENTION

Before considering endoscopic drainage, it is imperative to recognize that interventional methods for the management of necrotizing pancreatitis are often complementary, not competitive, and maximizing medical management is a prerequisite for successful interventions. Optimal management of patients with WON requires a multidisciplinary team including specialized expertise in critical care and in multiple and continuously evolving interventional methods.

Clearly, the most important indication for treating necrotizing pancreatitis is the presence, or suspected presence, of infection in a patient with systemic clinical deterioration despite maximal medical support. This remains the case despite recent literature suggesting that infected necrosis can be managed effectively with aggressive antibiotics and supportive care.[22] Although the need to drain sterile necrosis is less common, occasionally other indications such as luminal or biliary obstruction from external compression, undiagnosed sepsis syndrome, persistent pain requiring narcotics, or recurrent acute pancreatitis drive the need for débridement.[14]

The issue of timing is critical for successful endoscopic drainage. Interventions within the first few weeks for necrotizing pancreatitis, especially single-modality endoscopic techniques, are generally associated with poor outcomes and should be reserved for infected necrosis in a severely ill patient with clinical deterioration. Poorly organized or liquefaction necrosis is more difficult to manage by any method compared with necrosis containing a well-encapsulated rim. Therefore, the guiding principle for timing of débridement is to delay, if at all possible, any intervention until the collection has become encapsulated. Although encapsulation can occur in some patients as early as 1 week after the onset of acute pancreatitis, this is unusual, and typically encapsulation does not occur until at least 4 weeks after the initial injury.[23]

One must also consider that the goals of treating necrotizing pancreatitis differ for each clinical situation. For example, in the acute setting of infected necrosis causing a sepsis picture in the hospitalized patient without a well-encapsulated collection, the goal of therapy is to control the source of infection rather than remove all of the infected necrotic tissue; percutaneous catheter drainage is likely acceptable in this situation. However, in the ambulatory patient with a walled-off collection having symptomatic gastric outlet obstruction, the goal of therapy would be complete tissue removal. Therefore, it is critical to define the goals of therapy pertinent to the individualized situation before choosing the interventional approach. Not only will goals of care influence the type of intervention, they will also determine the aggressiveness of débridement.

TABLE 1. Revised Atlanta Classification for fluid collections in acute pancreatitis*

Entity	Type of pancreatitis	Time course, wk	Solid debris present	Encapsulated wall
Acute fluid collection	Interstitial	<4	No	No
Acute necrotic collection	Necrotic	<4	Yes	No
Pseudocyst	Interstitial	>4	No	Yes
Walled-off necrosis	Necrotic	>4	Yes	Yes

*This classification provides general guidelines; some collections may be difficult to categorize.

In addition, the presence of extension into the pelvis, ie, along the colonic gutters, needs to be considered. In some centers, extension deep into the pelvis is a relative contraindication to a strictly endoscopic approach.[14] In these cases, a multimodality approach, including VARD or retroperitoneal sinus tract endoscopy, may be a more appropriate option.

One of the challenges of evaluating the successes and failures of endoscopic therapies has been the wide discrepancy in reported time to treatment.[22,23] This is such an important issue because the timing of intervention not only alludes to the rationale behind the therapy, but ultimately can guide its success rate.[24] In a large multicenter U.S. series of endoscopic necrosectomy for WON with a 95% successful resolution rate, the median number of days from acute pancreatitis to first endoscopic intervention was 46 days.[25] Clearly waiting for encapsulation or "walling off" is critical to the success of primary endoscopic therapy, and the success of necrosectomy often directly correlates with the degree to which the collection is encapsulated.[26-30]

CHOICE OF THERAPIES

The past 3 decades have heralded a revolution in the options available to treat WON. Whereas open and subsequently laparoscopic surgery were the dominant means of treating necrotizing pancreatitis through the 1970s, percutaneous drainage of liquefied necrosis became increasingly used with the widespread use of CT.[31,32] Further advancement by using retroperitonoscopic techniques subsequently became popularized as a means of débriding sterile, and even infected, necrosis.[33-37] VARD, for example, is 1 technique for performing percutaneous débridement by using a retroperitoneal approach in which both laparoscopes and endoscopes have been used. These interventions were thought to be generally as safe as surgery, simpler, and as efficacious; however, issues with selection bias and a lack of randomized, controlled trials limited their generalizability.[36]

In the early 1980s, with the advent of radial echoendoscopic technology, the ability to clearly visualize the pancreatic parenchyma and duct from the stomach and proximal duodenum was realized. Beginning in the mid-1980s and early 1990s, transmural endoscopic therapy for pancreatic pseudocysts was developed with the advent of the linear echoendoscope, and endoscopically placed nasocystic tubes were even used to drain WON.[15,38-41] Subsequently, in 2000, Seifert et al,[11] from Germany, reported the first direct endoscopic necrosectomy, with successful direct endoscopic cavitary débridement in 3 patients by using a variety of accessories.

Increasingly, a combined approach to therapy, in which 2 or more strategies for treating necrotizing pancreatitis are used, has been advocated. The principle behind this approach, the so-called step-up approach to therapy, is to use the least invasive approach possible to achieve the desired outcome. Thus, the intervention may start with endoscopic or percutaneous sinus tract drainage of WON. If this intervention is not successful, repeating the intervention or proceeding with an adjunctive alternative technique could then be attempted.[42-47] Using a combined technique, for example, sinus tract endoscopy combined with endoscopic necrosectomy, may have further advantages such as decreased rates of percutaneous fistula formation.[45]

The decision to proceed with a certain type of therapy should be guided by (1) local or regional expertise, (2) the goals of therapy (ie, control of infection vs eradication of the cavity), (3) resource use, and (4) preservation of organ function (pancreas and spleen). The overriding principle of all interventions for necrotizing pancreatitis is that no single approach is optimal for all patients, and the best treatment must involve a multimodal and adaptable approach. Multidisciplinary management of these patients by various specialists with specific expertise in treating necrotizing pancreatitis is essential to achieving the best outcomes. In addition, patients with WON are best served at specialized centers with a team that is dedicated to management of this disorder (Fig. 2).

ENDOSCOPIC NECROSECTOMY TECHNIQUE

Preprocedural considerations

Conscientiously addressing several issues before proceeding will undoubtedly yield dividends in a more suc-

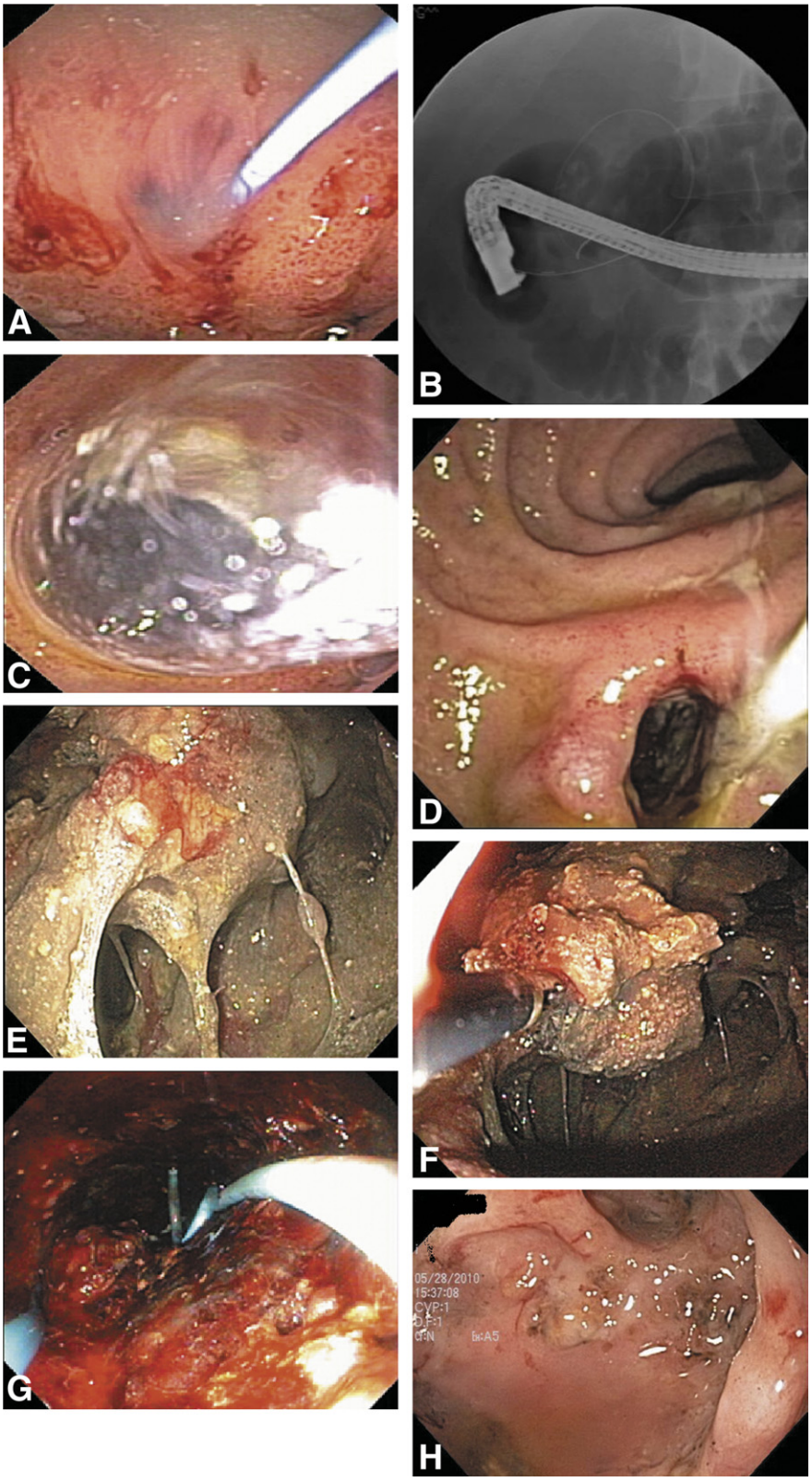

Figure 2. Representative images of the technique for draining pancreatic pseudocysts and necrosis. **A,** Puncture of the cavity by using the sheath of an EUS needle. **B,** Validation of the guidewire within the cavity by using fluoroscopic guidance. **C,** Dilation of the fistula tract by using a through-the-scope balloon. **D,** The cystduodenostomy after balloon deflation. **E,** The initial appearance of the cavity on initial entry. **F,** Débridement of the cavity by using a snare. **G,** Stent placement after cavitary débridement. **H,** The cavity on completion of the necrosectomy demonstrating completely débrided walls.

cessful outcome.[2,3] Before proceeding, it is imperative for the endoscopist to recognize that endoscopic necrosectomy should only be attempted by those who have specific training in this technique.

1. Make sure that the goal of therapy is well defined (ie, is the procedure just to control infection or completely eradicate necrotic tissue?) and that a multimodality approach has been considered.
2. Make absolutely sure that the collection is WON and not a cystic neoplasm such as an intraductal papillary mucinous neoplasm or mucinous cystic neoplasm. If in doubt, make sure that a biopsy is performed on the lesion and a sample obtained before attempting endoscopic drainage.
3. Make sure that the anesthesia plan is commensurate with the needs of the patient. In general, it is best to use general anesthesia for the first débridement session because there is potential for extensive reflux and subsequent aspiration of fluid after initial cavity puncture.
4. Positioning should be selected based on the patient and the nature of the WON, ie, in unstable patients, the supine position is generally safer, although the prone position may allow for better gravitational drainage from posteriorly located collections.
5. Make sure that there is adequate surgical, interventional radiology, and blood bank backup immediately available should a massive hemorrhage arise.
6. Make sure that the endoscopy staff is familiarized with the technique and the tools being used during the procedure.
7. Make sure that the endoscopist is readily available in the hours and days after the initial intervention in case repeat procedures are necessary.
8. Make sure that adequate time is spent on the informed consent process, including providing other treatment options and their associated success and risks if possible.

Periprocedural technique

Although performing endoscopic necrosectomy follows a fairly standardized technique, there are several variations at each stage of the procedure. Practitioners should consider which variation is most appropriate for themselves or their center.

Initial endoscopy is performed by using a therapeutic, side-viewing video duodenoscope, gastroscope, or echoendoscope by using moderate sedation or monitored or general anesthesia. If possible, CO_2 insufflation can be used to help minimize the theoretical risk of air embolism, although the use of CO_2 routinely has not been proved to prevent this complication.[14] Routine antibiotic use is recommended for those not already receiving broad-spectrum antibiotics for presumed or documented infection. Localization of the most appropriate access site from within the gastric or duodenal lumen should be performed under EUS guidance because there is considerable evidence suggesting that, at least in PFCs, EUS allows for fewer complications and higher success rates, especially for nonbulging collections, collections in the tail, and those patients with varices.[1] The most appropriate site of transmural puncture should be through a wall less than 10 mm in thickness. In those who do not use EUS, external compression of the gastric or duodenal wall is determined endoscopically while referencing the most recent cross-sectional imaging.[48] Integrity of the pancreatic duct can be assessed by CT, MRCP, EUS, or ERCP. Whether to perform direct pancreatography by using ERCP at the time of initial drainage is subject to varying opinions, but does require a subsequent endoscopy if the duct is later found to have a persistent leak. In general, however, in ill patients with infected necrosis, ERCP should be avoided before containing the infection.

When the appropriate site is identified, the posterior gastric or medial duodenal walls are targeted and punctured. Here it should be noted that in certain situations, multiple fistula tracts may be appropriate.[49] The choice of instrument to puncture is at the discretion of the endoscopist: needle-knife electrocautery, cystotome, and needle aspiration all have been used. In patients undergoing EUS, transmural puncture is performed under direct EUS guidance, with use of color-flow to avoid disruption of mural blood vessels at the time of wall puncture.[14] Many endoscopists use a 19-gauge FNA needle for puncture and subsequently the needle sheath for initial dilation. Aspiration of cavity contents and/or demonstration of contrast injection into the cavity under fluoroscopic guidance confirms cavity access.

Once the collection is accessed, any standard-sized guidewire (as small as 0.018 inch) is advanced into the collection under fluoroscopic guidance. Care should be used with a 0.035-inch guidewire because these are fairly tight in a 19-gauge needle and can easily shear. The fistula tract is then created; again, a variety of accessories can be used for initial dilation including low-profile dilating balloons, 4-5-6 tapered biliary dilating catheters, or the Soehendra stent extractor for resistant fibrous capsules. Next, the tract is dilated to at least 10 mm in size by using sequentially larger hydrostatic balloons. As long as there is no contraindication (eg, bleeding, disrupted fistula tract, patient instability), generally the goal is to fully dilate the fistula tract to 20 mm at the time of the first endoscopy.

With the fistula tract created and bleeding controlled, liquid can be aspirated until dry and sent for Gram stain and culture. Next, débridement of the intracavitary solid debris commences by driving a forward-viewing gastroscope across the gastric or duodenal wall into the necrotic cavity. The fluid contents within the necrotic cavity are then aspirated through the endoscope until dry, and devitalized necrotic tissue is then removed. The devitalized

pancreatic tissue can be removed via a combination of several accessories including balloons, snares, waterjets, and baskets. Hydrogen peroxide has also been used as a means of "loosening" the debris, although its safety has not been rigorously tested (Georgios Papachristou, personal communication, May 9, 2011). As much of the visualized devitalized tissue that can be débrided is removed at each session and deposited into the stomach or duodenum. The degree of necrosectomy performed at each session is at the discretion of the therapeutic endoscopist with the goal being to eventually uncover pink granulation tissue lining the wall of the collection.

At the conclusion of each session, stents must be left in place to allow the fistula tract to remain patent and not necessarily act as a conduit for drainage. Current stenting practices vary, but the standard use of 2 parallel double pig-tail stents allows the fistula tract to drain even if the stents become occluded because of the space between the round catheters. Placement of 1 stent is fraught with occlusion and increases the risk of treatment failure. Uncovered enteral stents can also be used and can subsequently be removed by an inversion technique.[50] It is important, however, that the fistula tract be kept patent so that fluid can escape from the collection, pus can be released into the lumen, and the collection be allowed to collapse. This allows for débridement by gastric and bile acids for several weeks to months; the stent is subsequently removed or, in the case of plastic stents, allowed to spontaneously migrate once the collection has resolved (Fig. 3).

Recently, a single-step system called the NAVIX system (Xlumena, Mountain View, Calif) has been U.S. Food and Drug Administration approved for PFC drainage. A fully integrated transluminal access device that creates and dilates an access tract, then facilitates placement of 2 guidewires, it is the first device specifically approved for PFC drainage.

Postprocedural care

After an initial uncomplicated drainage procedure, serial cross-sectional imaging is performed to evaluate the status of the WON until resolution in each patient. Often, 1 intervention is necessary, especially if the amount of initial necrosis is limited. Routine endoscopic removal of stents and/or repeat drainage or necrosectomy is performed at various intervals if necrosis and/or persistent sepsis remains. It is also important to consider additional complementary techniques, such as retroperitoneal sinus tract débridement, in this clinical situation.

Additionally, if the collection fails to resolve or reaccumulates, disconnected pancreatic duct syndrome should be considered. Although many possible interventions to treat the disconnection or leak are available (transpapillary stenting across or into the cavity, percutaneous drainage), surgical resection is sometimes necessary for persistent unresolving collections.

EFFECTIVENESS

With few exceptions, available data do not allow for the specific comparison of outcomes of minimally invasive approaches because of variability of patient selection, definitions, and reporting. Effectiveness data for endoscopic therapy is limited almost exclusively to single and multicenter case series with a few exceptions; comparative effectiveness data are sorely lacking.

One of the first case series, from Seewald et al,[51] described successful resolution of necrotizing pancreatitis in 13 patients by using EUS-guided direct necrosectomy. Subsequent series have documented similar success rates, with the largest series to date including 104 patients from 6 American centers with symptomatic WON.[25] Successful resolution was achieved in 91%, and the mean number of procedures was 3.7 with 2.5 débridements. Published case series of endoscopic necrosectomy are listed in Table 2.

The only randomized, prospective study comparing minimally invasive techniques with open necrosectomy is a landmark study of 88 hospitalized patients from the Dutch Acute Pancreatitis Study Group.[46] In this multicenter study, 88 patients with pancreatic necrosis with suspected or confirmed infection were randomized to open necrosectomy or a step-up approach of percutaneous drainage followed by, if necessary, minimally invasive retroperitoneal necrosectomy. The authors found that in patients treated with the step-up approach, 35 were treated with percutaneous drainage only, new-onset multisystem organ failure occurred less often, and major complications and death were significantly lower (40% vs 69%, $P = .006$) compared with the open necrosectomy group.

Although the first Dutch Acute Pancreatitis Study Group study moved the treatment paradigm forward for a specific type of patient with necrotizing pancreatitis, it did not include a role for endoscopy. However, the group subsequently published the PENGUIN trial, a prospective, randomized trial of 22 patients hospitalized with infected pancreatic necrosis.[52] Patients were randomized to endoscopic transgastric or surgical necrosectomy. Endoscopic necrosectomy consisted of transgastric puncture, balloon dilation, retroperitoneal drainage, and necrosectomy. Surgical necrosectomy consisted of VARD or, if not feasible, laparotomy. The authors found that endoscopic necrosectomy reduced the postprocedural proinflammatory response as measured by serum interleukin 6 levels and a predefined composite endpoint of major complications (new-onset multiple organ failure, intra-abdominal bleeding, enterocutaneous fistula, or pancreatic fistula) or death compared with the surgical group. The group is currently enrolling patients in a larger multicenter study to validate these findings.

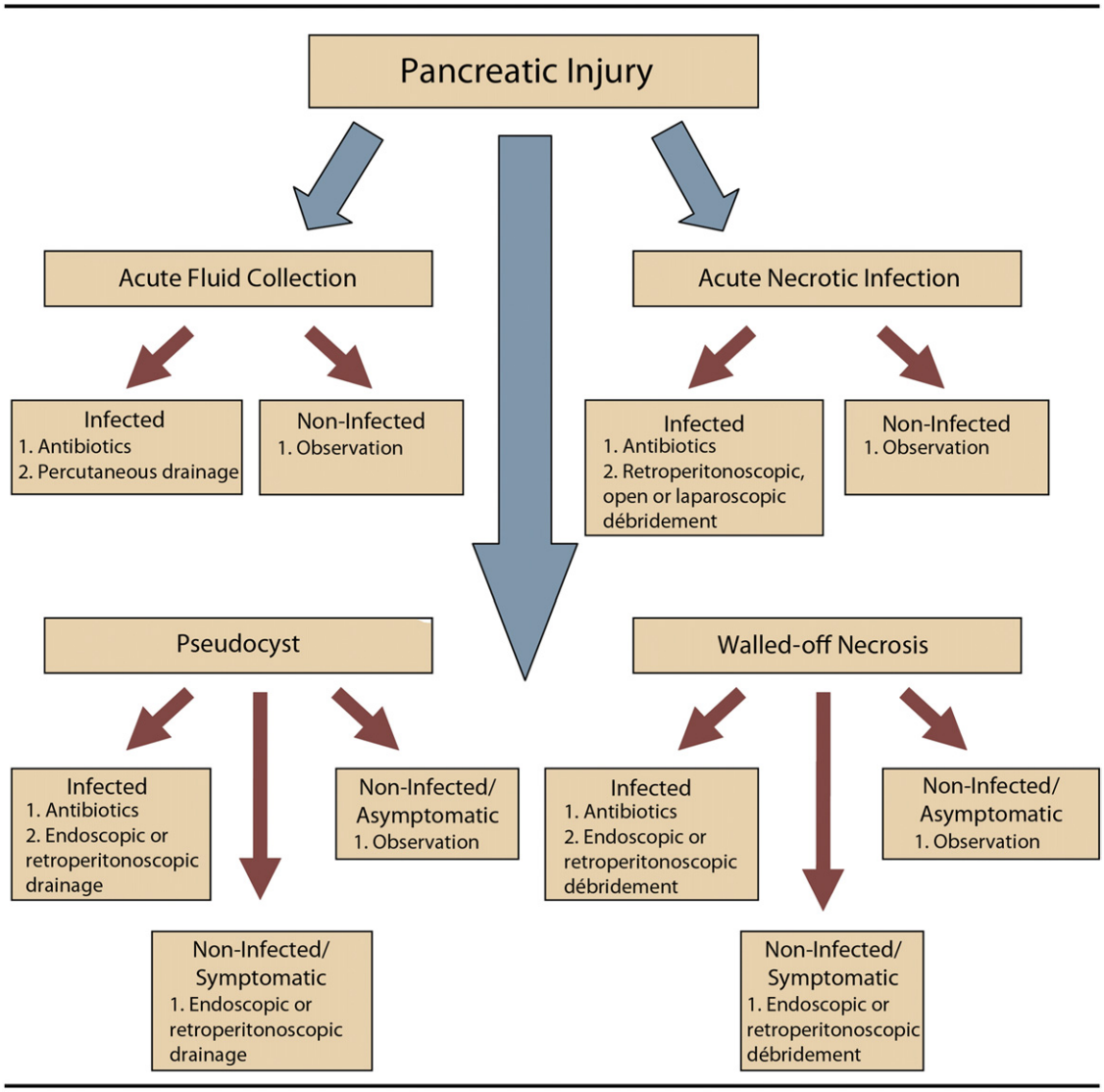

Figure 3. Optimal treatment modality based on indication and type of injury. This figure is based on expert opinion only. Combination procedures can also be successfully used in many clinical circumstances.

COMPLICATIONS

As with any intervention, complications are an inherent risk, and endoscopic necrosectomy techniques pose their own unique set of potential complications. In the largest series of single-modality therapy for WON, the rate of major complications was 13%.[25] Pneumoperitoneum/perforation developed in 5 patients; however, all were managed nonoperatively. Bleeding developed in 19 patients (18%), requiring endoscopic intervention (epinephrine injection/hemostatic clips) and 2 of these patients had bleeding that could not be controlled endoscopically. One death was reported periprocedurally; although an autopsy was not granted, it was believed that that the patient had an air embolus.

Similar complication rates were found in the GEPARD study in which there were 13 cases (14%) of bleeding (including 1 case resulting in death), 5 (6%) perforations, and 2 cases of air embolism, 1 of which resulted in death.[53] Similar rates of bleeding have been reported in other series.[12,51] Other reported complications include infection (especially in undrained necrosis), pancreatitis, aspiration, stent migration/occlusion, pancreatic duct damage, and complications of sedation.[54,55] It is generally accepted, therefore, that the overall complication rate of transmural drainage, in expert hands, is between 15% and 25%.

It is critical therefore that the endoscopist must recognize the frequency of severe, life-threatening complications and that a discussion and documentation of these risks should occur before each attempt at endoscopic débridement. Mak-

TABLE 2. Published case series of endoscopic necrosectomy

Study	Modality	No. of patients	Results
Baron et al, 1996[15]	Endoscopic cystenterostomy with nasocystic drainage	11	Complete resolution achieved nonoperatively in 9 patients. Complications occurred in 5 including bleeding that precluded entry into 1 collection
Seifert et al, 2000[11]	Endoscopic cystenterostomy with direct endoscopic necrosectomy	3	First series of direct endoscopic necrosectomy; 3 patients treated successfully
Seewald et al, 2005[51]	Endoscopic cystenterostomy with direct endoscopic necrosectomy	13	Successful drainage in 13 patients; surgery avoided in 9 patients; complication of minor bleeding in 4 patients
Charnley et al, 2006[26]	Endoscopic cystenterostomy with direct endoscopic necrosectomy	13	Successful in 12 patients, requiring a mean of 4 endoscopic interventions; 1 required open surgery, 2 underwent additional percutaneous necrosectomy, and 1 required laparoscopic drainage
Voermans et al, 2007[12]	Endoscopic cystenterostomy with direct endoscopic necrosectomy	25	93% successful resolution at 16 mo; severe complications in 2 patients (hemorrhage and perforation)
Papachristou et al, 2007[10]	Endoscopic cystenterostomy with direct endoscopic necrosectomy and percutaneous drainage	53	21 (40%) required concurrent radiology-guided catheter drainage; 12 required open surgical intervention
Escourrou et al, 2008[27]	Endoscopic cystenterostomy with direct endoscopic necrosectomy	13	2 with percutaneous drains; successful resolution in all patients
Hocke et al, 2008[55]	Endoscopic cystenterostomy with direct endoscopic necrosectomy	30	This series combined patients with WON pseudocysts; combined technical success of 97%
Seifert et al, 2009,[53]	Endoscopic cystenterostomy with direct endoscopic necrosectomy	93	Initial success in 80% of patients with a 26% complication rate and a 7.5% mortality rate at 30 d
Ross et al, 2010[45]	Endoscopic cystenterostomy with direct endoscopic necrosectomy and retroperitonoscopic drainage	15	All procedures successful; fever and hypotension in 2 patients immediately
Gardner et al, 2011[25]	Endoscopic cystenterostomy with direct endoscopic necrosectomy	104	91% successful resolution; mean time from necrosectomy to resolution 4.1 mo; complications in 14%

ing a substantial attempt to mitigate complications is essential when performing these procedures. Endoscopists should be experienced with advanced therapeutic techniques and have appropriate backup available (interventional radiology, surgery, blood bank) should a major complication arise. Procedures should generally not be performed if the proceduralist will be going out of town soon thereafter. Many centers have now changed completely to CO_2 insufflations to theoretically lessen the chance of air embolism. Broad-spectrum antibiotics are generally given periprocedurally. Bleeding or potentially bleeding pseudoaneurysms should be managed by intravascular embolization of the splenic artery before any endoscopic or surgical intervention.

Finally, it cannot be emphasized enough that, before undertaking any definitive drainage of WON, the diagnosis be firmly established as an inflammatory collection.

AREAS OF UNCERTAINTY

Although endoscopic drainage of PFCs is now firmly entrenched in the therapeutic armamentarium of many endoscopists, there are several questions, limitations, and

controversies involving the endoscopic management of WON, including:

1. The necessity of using EUS for every drainage procedure versus using endoscopes or duodenoscopes for initial cavity puncture and fistula formation
2. The optimal tools for performing cavity débridement
3. The type of stents to be left across the fistula tract including whether removable metal stents are efficacious and safe
4. The extent of technical mastery needed before performing necrosectomy independently
5. The role of pancreatic duct evaluation/stenting in treating WON
6. The optimal size of the fistula tract
7. The limits in size, amount of necrosis, and extension into the abdomen, which preclude an attempt at endoscopic débridement

Probably the most important area of uncertainty, however, is the comparative effectiveness of single-modality endoscopic techniques and retroperitonoscopic/laparosopic/operative/combined therapies. Not only should technical success be evaluated, but also patient preferences, quality of life, complication rate, and cost.

CONCLUSIONS

Since the last published ASGE guideline in 2005, the endoscopic management of necrotizing pancreatitis has continued to expand as a technique for addressing this often complex clinical condition. Great progress has been made in standardizing the classification of necrosis, thereby allowing more accurate patient selection. As more case series are published and prospective studies are conducted, it appears that the endoscopic drainage/débridement of necrosis has technical outcomes perhaps better than surgical drainage in expert hands. Increasingly, other therapeutic options such as combined retroperitonoscopic/endoscopic débridement have also been described, and the step-up approach for infected necrotizing pancreatitis has changed the way in which hospitalized patients are being treated. What remains unknown, however, is how these modalities compare with regard to important outcomes such as patient preference, complication rate, and cost. Until further comparative effectiveness trials are completed, the selection of modality will be largely driven by local expertise and tradition. In the next decade, therefore, it is incumbent on the therapeutic endoscopy community to conduct randomized, multicenter trials in an effort to provide clarity on these important questions.

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