Endoscopic Necrosectomy

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KEYWORDS

• Direct endoscopy necrosectomy • Pancreatic necrosis • Pancreatitis • Endoscopy

KEY POINTS

- Direct endoscopic necrosectomy (DEN) is best performed by endoscopists in a tertiary center.
- A combination of chemical and mechanical debridement can be used to perform DEN.
- Paracolic gutter extension often portends the need for percutaneous access.
- The use of plastic stents across lumen apposing metal stents, between DEN sessions, can reduce adverse event rates.
- A variety of devices, some emerging and some familiar, are available for DEN and will be discussed.

Video content accompanies this article at http://www.giendo.theclinics.com.

INTRODUCTION

Endoscopic drainage of pancreatic necrosis was first described in 1996, 27 years ago, with subsequent direct endoscopic necrosectomy (DEN) first described in 2000.[1,2] Since then both have undergone significant advances. Treatment of pancreatic necrosis was once exclusively surgical but has transitioned to a multimodal approach with endoscopy as the backbone.[3–7] Initial transmural treatment of walled-off necrosis (WON) involved only endoscopic identification of extrinsic compression with transmural drainage using plastic stent placement, now uniformly performed with endoscopic ultrasound (EUS) guidance and lumen apposing metal stents (LAMS).[8–10] Creation of access points into WON is discussed elsewhere in this issue. This article focuses on management of WON after access has been obtained but has been shown to be insufficient in leading to resolution.

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Gastrointest Endoscopy Clin N Am 33 (2023) 709–724
https://doi.org/10.1016/j.giec.2023.04.010
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NATURE OF THE PROBLEM

Endoscopic treatment of WON involves numerous nuances and flavors. There is no clear-cut optimal workflow with guidelines focusing on platitudes of treatment, opening the door for further study and customization of DEN to the endoscopist's experience and the patient's response.[11,12]

Chemical Debridement

Before physical debridement of DEN became part of routine care, drainage was often augmented by chemical debridement. Discontinuation of gastric acid suppression after drainage allows gastric acid to breakdown solid debris. In one retrospective multicenter study, no proton pump inhibitor (PPI) use was found to be associated with less DEN sessions without a difference in bleeding or infection rates.[13] However, no PPI use was also associated with a higher rate of LAMS stent occlusion, suggesting that gastric acid dissolves and mobilizes necrosis. This risk may be mitigated by concurrent use of plastic stents across LAMS. Therefore, it is recommended to discontinue PPI after transmural drainage assuming there is not an acute indication for its use.

Additional chemical agents have been used variably in the treatment of WON. Aggressive irrigation was initially described using endoscopic placement of a nasocystic tube. This practice has generally fallen out of favor given the unclear additive benefits when LAMS are placed and the relative lack of patient acceptance. Hydrogen peroxide instillation has been used despite uncertain benefits from retrospective studies.[14,15] It has also been used as an irrigant infused through percutaneously placed necrosectomy catheters.[16] Instillation of antibiotics has also been described, also with uncertain clinical benefits.[17,18] Although significant increases in adverse events (AEs) associated with use of either of these have not been reported, the lack of clear benefit combined with the theoretical risk of aspiration (for hydrogen peroxide) precludes our group's routine use of them.

Streptokinase irrigation has also been reported with the aim of dissolution and mobilization of solid debris.[19] Although one study showed that streptokinase use was associated with a lower rate of surgical intervention and mortality, robust data are lacking.

Management of WON is ever evolving and with the introduction of LAMS and DEN we have found limited clinical benefit to chemical debridement. Outside of stopping PPI when able they are not part of our practice.

Mechanical Debridement (Direct Endoscopic Necrosectomy) and Indications

As changes in management shifted toward incorporating physical debridement, an initial question posed was whether endoscopic drainage with irrigation alone was sufficient or if the augmentation of DEN produced clinically meaningful benefits. Although a subset of patients can achieve WON resolution without DEN, it clearly has a role in improving endoscopic outcomes (higher resolution rate with lower need for surgery or percutaneous drains, lower recurrence) yet with similar AEs.[20] In practice, DEN is recommended and often pursued in the presence of substantial solid debris identified either by endosonographic images or after subsequent cross-sectional imaging reveals a large amount of solid necrosis or the collection has failed to resolve, even when only small volume.[11,12]

Pre-drainage imaging studies can predict treatment response, which can be important in managing both patient and health care providers' expectations. The composition of a collection and its percentage of solid versus liquid content can influence

outcome since mostly liquid collections often resolve with LAMS placement alone.[21] Similarly, pre-drainage CT characteristics including size of the collection, its location, the presence of hemorrhage, and concern for pancreatic duct disconnection can allow one to predict the number of DEN sessions needed for resolution.[22] However, difficulty with prediction of degree of underlying solid composition prior to evacuation of the liquid component limits the utility of CT.[23–25] Similarly, EUS is limited by poor interobserver agreement for percentage solid component, though good agreement for procedural planning.[26] MRI can provide reasonable estimates of composition though sacrifices spatial resolution, which may be beneficial for procedural planning.[24] Most patients undergo initial drainage followed by repeat CT imaging to assess remaining solid material and, if present, proceed with DEN as clinically indicated.

In one recent retrospective study, this so-called "step-up therapy" was required in slightly >50% of patients who underwent drainage with LAMS placement, demonstrating that DEN plays a frequent role in management.[27] Step-up therapy is utilized for both endoscopic and surgical approaches. Endoscopic step-up begins with endoscopic transmural drainage and proceeds to DEN if there is a lack of clinical improvement/resolution by imaging. Surgical step-up begins with percutaneous drainage and proceeds to minimally invasive debridement (typically video-assisted retroperitoneal debridement [VARD]) as needed. Endoscopic step-up appears to have similar complication rates and mortality compared to surgical step-up with the advantage of a decrease in rate of external fistulae and shorter hospital stays, leading to its prioritization when available.[28] In our practice, we have found that most patients do not progress past percutaneous drainage in the surgical step-up pathway, but this is contingent on the use of aggressive DEN.

Severity of illness of patients with WON can be compelling and the pressure to act is high. These patients are best managed through multidisciplinary collaboration involving experienced gastroenterology, diagnostic and interventional radiology, critical care, and surgical teams.[11,12] One recent study found that an annual volume of 15 EUS-guided drainages of pancreatic fluid collections was associated with the lowest risk of AEs.[29]

ANATOMY

Paracolic Extension

The variety of shapes and distribution of WON underlines the need to tailor approaches to an individual patient while remaining within the experience and ability of the endoscopist. This especially holds true when progress on resolution of WON with DEN alone stalls, as is frequently the case in the presence of paracolic gutter extension and greatly increases the need to incorporate surgical step-up, beginning with percutaneous drainage.[30]

Although some patients will have a single ovoid central pancreatic collection, multilobulated or multiple discrete collections with thin communications are frequently encountered and often found with paracolic extension. A transgastric approach targeting the most anterior and superior aspect of WON establishes a gradient that can be problematic for large collections. Even with the most aggressive multi-gate drainage and DEN, the deepest depths of these pockets have an uphill battle against gravity to pass contents into the stomach or duodenum.

To combat this, our group has explored aggressive reduction in resistance to flow within the cavity to lower the pressure gradient needed to yield egress of debris as close to the stomach or duodenum as possible. Overcoming the barrier to passage from the deep recesses of the cavity can facilitate resolution. To this end we have

used fully covered self-expandable metal stents (FC-SEMS) deployed entirely within the WON cavity, particularly at the site of thin communications between larger collections. Figs. 1–5 illustrate a case where this technique successfully augmented drainage of a deep paracolic extension. A less aggressive, yet similar in theory, method has been the use of very long double pigtail plastic stents (DPPS) (Figs. 6 and 7). Cutting a nasobiliary drain to create a custom length single pigtail plastic stent may also be possible for very deep paracolic extension. Transcolonic drainage could potentially serve a similar role.

Surgical step-up enters the algorithm when the above approaches fail, and necrotic debris cannot be cleared from the paracolic gutters. In the spirit of ownership of WON as a gastroenterological problem, some centers have explored percutaneous necrosectomy as an endoscopic procedure. Similar to transluminal drainage, FC-SEMS can be placed across percutaneous drain tracts to allow endoscopic entry into WON followed by DEN as is done transluminally.[31–33] The principle is the same as when comparing simple EUS transluminal drainage to DEN–solid debris needs large conduits and mechanical removal, and often limited bore plastic catheters are not sufficient. One concern with augmenting percutaneous tracts is the creation of an eventual pancreaticocutaneous fistula, the risk of which is unknown with percutaneous FC-SEMS. This may be mitigated by a stepwise removal of entry sites into WON, with transluminal being the last.

EQUIPMENT AND MATERIALS

As with esophageal food impactions, a variety of devices are available to assist with DEN, often a lengthy and arduous procedure. Our most commonly used item is the "spiral" snare (SnareMaster, Olympus America, Center Valley, PA, USA). Its unique wire properties allow for more secure entrapment of debris while preventing inadvertent cutting, though an experienced endoscopy tech is still essential. By anchoring the

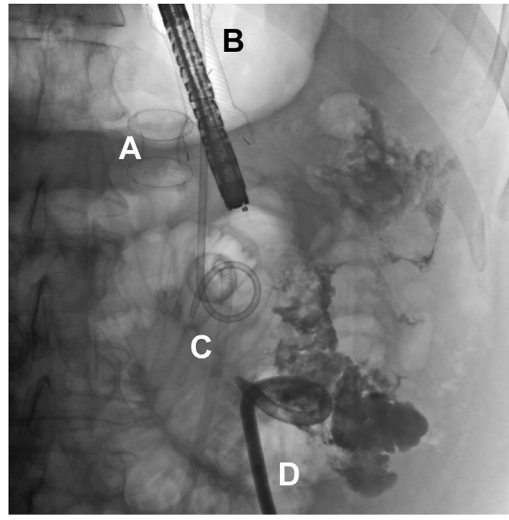

Fig. 1. Paracolic gutter collection with contrast injection via percutaneous drain to delineate dimensions. (*A*) LAMS at site of gastroenterostomy. (*B*) FC-SEMS and DPPS at cystgastrostomy. (*C*) Percutaneous jejunostomy tube. (*D*) Percutaneous drain into paracolic portion of collection.

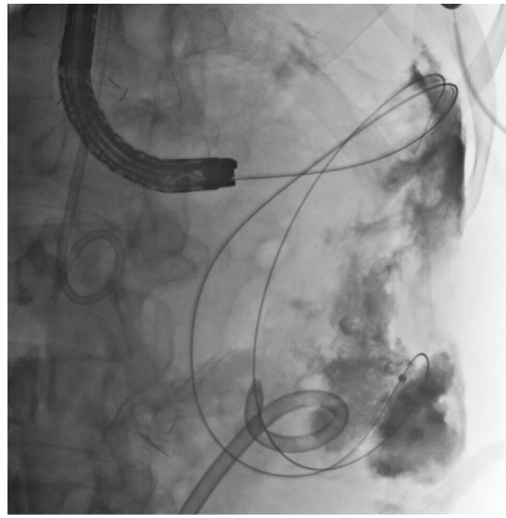

Fig. 2. Passage of catheter and wire into deep recesses of collection, adjacent to percutaneous drain.

tip against the wall of the cavity and laying the snare down, as though preparing for polypectomy, large pieces can be securely grasped and pulled through an LAMS, even when liquid obscures direct visualization of solid material (Videos 1–3). Some groups have also described using cautery to create grooves in solid debris to further enhance grip.[34]

Numerous other devices can also be used, with options only limited by creativity and availability. Common through-the-scope devices also include the Rescue Grasper and RescueNet (Boston Scientific, Marlborough, MA, USA) and Talon Grasper (Steris

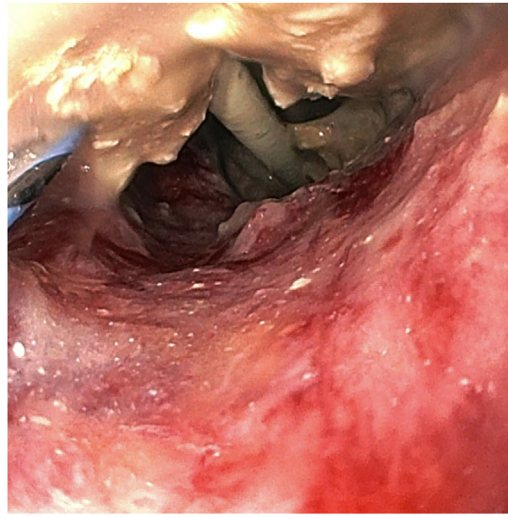

Fig. 3. Traversal of the endoscope using the "finder" catheter deep into the collection, with direct visualization of the percutaneous drain.

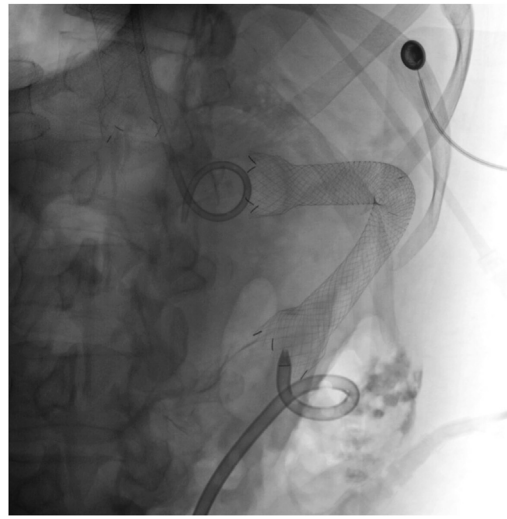

Fig. 4. Placement of FC-SEMS fully within the cavity bridging between transgastric and percutaneous entry points.

Healthcare, Mentor, OH, USA) (Video 4). Their use can also be combined with a distal attachment cap that can improve the efficacy of "grasping" with suction without clogging the working channel.[35] Novel over-the-scope graspers have also been developed to allow safe and efficient DEN (Xcavator, Ovesco Endoscopy AG, Tübingen, Germany).[36] An intriguing high pressure water jet device similar to a pressure washer has also undergone preclinical testing and was effective and rapidly reducing the size of solid debris.[37]

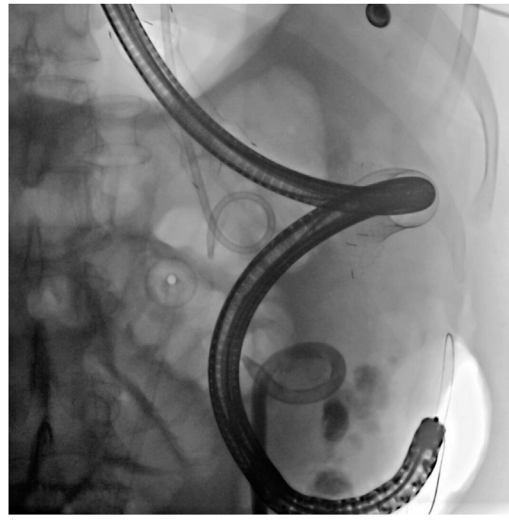

Fig. 5. On a subsequent procedure a significant portion of debris had cleared through the 2 FC-SEMS to the stomach. The endoscope was able to traverse deeply within to complete DEN in this portion.

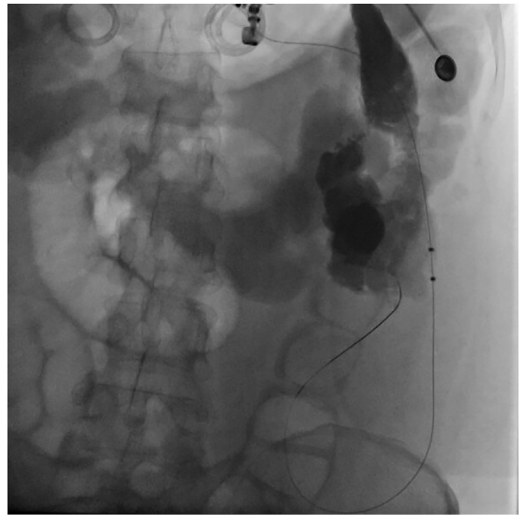

Fig. 6. Catheter and wire delineating deep recesses of paracolic gutter extension.

Even endoscopic submucosal dissection (ESD) techniques and tools have made their way into DEN. One group described tunnel creation through tracing a plastic stent placed solely with fluoroscopic visualization, followed by balloon dilation along the course of the stent to improve visualization and tissue evacuation.[38] ESD knives can also provide fine-tuned, rotatable grasping.[39] Necessity is the mother of invention, and the laborious nature of DEN has and will continue to spawn creative solutions.

Endoscopic morcellators have gained recent attention (EndoRotor, Interscope, Inc, Northbridge, MA, USA).[40] A through-the-scope catheter with a controllable rotating cutting edge, when combined with suction, can potentially lead to rapid clearance

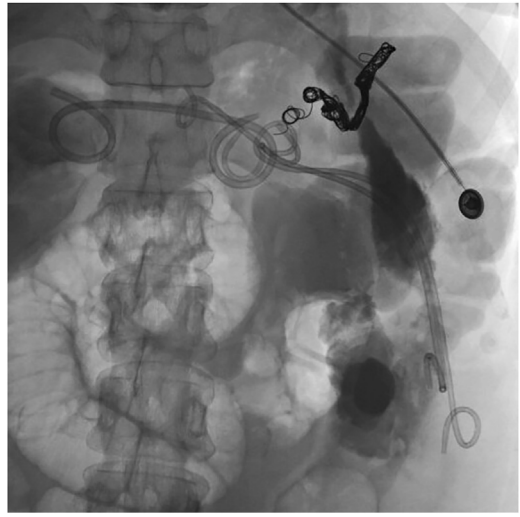

Fig. 7. Long DPPS placed into the collection to facilitate transgastric drainage.

of debris. Concerns about a rotating knife within a cavity and risk of damaging major vasculature have been partially alleviated by the lack of device-related AEs in a recent prospective multicenter trial of 30 patients.[41] Gastrointestinal bleeding occurred in 2 patients, believed to be procedure and not device related. In this study, patients only required a median of 1.5 DEN sessions but with a mean procedure time of 117 minutes and mean device time of 71 minutes. These durations do not seem to be shorter than typical DEN sessions, so the time benefit is unclear. One group highlighted the controlled nature and improved visualization that may lead to less inadvertent injury to major vessels.[42] The device has also been used via percutaneous tracks, further blurring the lines between surgical (VARD) and endoscopic management.[43]

Although morcellators and other devices show the promise for use during DEN, more data are needed regarding their safety and improvement of outcomes. The ongoing lack of Current Procedural Terminology (CPT) codes for DEN is also an impediment to introduction and adaptation of devices that require capital purchases.

ADVERSE EVENTS

AEs following DEN offer a few additional risks to those incurred with initial EUS drainage of WON. Principle concerns are perforation (in the form of dislodgement/disconnection of the FC-SEMS or LAMS maintaining access to the WON as well as perforation of the wall not in contact with the transmural site), intracavitary bleeding, infection, stent occlusion, pneumoperitoneum, fistula formation, and fatal air embolism.[11,44–47] Most high-quality externally validated data regarding AE rates focus on EUS drainage rather than DEN itself.

The potential for severe bleeding underlines the recommendation of pursuing DEN in centers with interventional radiology and surgical backup. One study reported a bleeding rate of 5.2% per procedure or 11.9% per patient which was similar to previous reports.[48] In this study, direct endoscopic visualization of a vessel, cirrhosis, and thrombocytopenia conferred a significantly increased risk of bleeding. Given the multiple major vessels that can course nearby, severe bleeding can result from DEN as from arterial pseudoaneurysms. Often endoscopic management of intraprocedural bleeding can be limited by visualization and obscurement of the source. Traditional endoscopic hemostasis devices can be used, including clips, cautery (grasper or probe based), epinephrine, and even argon plasma coagulation.[49] Spray-based hemostatic powders (Hemospray, Cook Medical, Bloomington, IN, USA) may be helpful as a rescue device. Its use would be contingent on a relatively dry cavity with an identifiable bleeding source, which may not be possible within WON cavities.

Double Pigtail Plastic Stent Use

DPPS placement through an LAMS has often been suggested as a means of reducing AE rates. The WON cavity is dynamic and changes between the time of LAMS placement and removal. As the cavity decreases in size, the back wall or an egressing piece of solid necrosis may lead to occlusion of the LAMS lumen. The flanges of the stent may also abrade the back wall leading to bleeding–one of the rationales for removal of LAMS prior to 60 days (as the cavity significantly collapses down). The role of DPPS then is to serve as a tent pole for the stent.

This theoretical benefit of DPPS has been variably observed. One retrospective study of 46 patients who underwent LAMS placement for pseudocyst drainage found a non-significant trend toward decreased infection with placement of DPPS.[50] A separate retrospective study of 41 patients found DPPS use significantly lowered global AE rate, despite the higher patient ASA score; bleeding was the most frequently occurring

event (though not statistically significantly different).[51] A recent, randomized controlled trial included 67 patients and found DPPS resulted in significantly lower global AE rate and stent occlusion, but did not significantly alter bleeding.[52] Infection rates after LAMS placement (with or without DPPS) were not reported.

Given the lack of clear and convincing evidence supporting the advantages of DPPS with LAMS, their use is not mandatory. Although no studies have shown an increase in risk in their use, the need to remove and replace them with each DEN session will certainly add time and cost for an already lengthy procedure without a dedicated CPT code. However, more convincing data may become available as more patients have them utilized–each of the above studies may not be powered to detect differences in outcomes. A yet explored potential benefit may also be the mitigation of risks of LAMS which dwell for longer than the dwell time based upon LAMS manufacturer labeling (eg, 60 days for WON using the AXIOS device). Our group routinely uses DPPS with all LAMS for WON.

PREPROCEDURE PLANNING

- Prior to initiating drainage of WON with potential future DEN, consider transfer of the patient to a facility with interventional radiology and surgical backup, if none are available locally.
- Personally review all available pertinent cross-sectional imaging.
- Obtain contrast-enhanced CT if not recently done. Repeat imaging after initial drainage but before considering DEN.
- If the WON has not responded to drainage (symptoms with any remaining size or large amount of remaining cavity size/contents), consider DEN.
- Prior to initiating DEN, personally commit to the likely need for multiple repeated sessions.
  - Given the theoretical need for LAMS removal at 60 days, it is advised to make significant headways against WON volume reduction prior to this time.
- Informed consent and discussion with the patient with emphasis on multiple sessions and potential for slow resolution/recovery.
- Ensure there are no barriers to completing another DEN session prior to starting:
  - Adequate time slot–we suggest at least 1 hour for each DEN session.
  - Preferred equipment available–some of the devices routinely used in DEN are not otherwise used. Low or no stock of an item may not be discovered until after it is requested during the procedure. This can be particularly critical for hemostasis devices.
- Consider stopping PPI if there are no strong indications for continuing, as discussed under *Chemical Debridement.*

PREP AND PATIENT POSITIONING

- Endoscope choice
  - A gastroscope with a therapeutic channel should be used, at minimum. The lessened likelihood of clogging of the channel can lead to a smoother and more efficient experience. This will be required if 10 French DPPS are intended to be used at the end of the DEN session, or if a dislodged LAMS needs replacement.
  - For WON that might respond to suction and lavage alone, consider a gastroscope with an extra-large working channel, such as the GIF-XTQ160 (Olympus America, Center Valley, PA, USA). If the solid pieces are small enough, or made small enough during the procedure, this endoscope can facilitate a quick DEN.
  - Significant disadvantages are the reduced agility and large outer diameter which can make WON entry impossible depending on the position of the LAMS.

- Strongly consider intubation:
  - Although not mandatory for procedural completion, there are a number of potential aspiration risks from DEN including the removal of solid debris through the mouth rather than depositing in the gastric antrum, presence of fluid within the cavity, and use of irrigation during the procedure, especially when using hydrogen peroxide as mentioned above in *Chemical Debridement*.
  - Potential disadvantages:
    - Procedural duration (though as above it can be crucial to success to ensure ample time is available).
    - Inability to extubate (critically ill but not currently intubated patients may be difficult to extubate postprocedure).
- Consider fluoroscopy:
  - Particularly if the WON cavity is large or contains percutaneous drain. Although not essential, fluoroscopy can aid navigation into deep recesses of the collection. This can be particularly helpful when attempting to augment paracolic drainage toward the stomach. Its use becomes more important if entry into the WON is maintained without LAMS, as the cystgastrostomy tract can become quite narrow even after only short periods of time.
  - Potential disadvantages:
    - Higher (though not definite) need for intubation.
    - Not needed for DPPS placement post-DEN if LAMS is present.
    - Physical burden on endoscopy team (protective lead use can make an already lengthy procedure seem much longer).
- Use of CO_2 insufflation rather than air *is essential* to reduce the risk of fatal air embolization.

PROCEDURAL APPROACH

- Predetermine goals for the session:
  - Because most patients often require more than one DEN session, it can be helpful to set goals/stopping points for each session. We typically assign a loose time constraint of one hour. This often can coincide with specific milestones: clearance of the entryway, clearance of the main cavity, access to distant subcavities (such as in paracolic gutter extension), and clearance of those cavities. Although an individual patient may have each of the above steps take more or less time, they can all easily take an hour. Having a goal in mind can reduce the burden of performing this cumbersome procedure.
- Access to the cavity depends on initial drainage modality
  - LAMS:
    - Remove any indwelling plastic stents
    - Although reusing the same plastic stents after DEN may be possible, this could risk dislodgment of the LAMS. It can also be helpful to use progressively longer DPPS that mirror your progress through clearance to facilitate egress of deeper portions of the cavity (**Fig. 8**).
    - We place DPPS across the LAMS at the end of every DEN session, as discussed above under section “Adverse events.”
  - DPPS:
    - Remove stents either before or after wire cannulation.
    - Balloon dilate the cystgastrostomy tract to 20 mm.
    - Place new stents across the tract at the end of the DEN session.

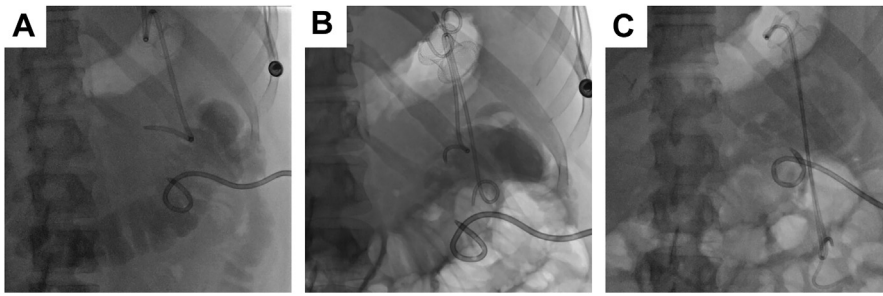

Fig. 8. Progressively longer DPPS (*A–C*) tracking the progress of DEN and facilitating egress between procedures.

- Clearance of the entryway
  - During the first DEN session, we often encounter necrotic debris impacted within and occluding LAMS. Clearance can be challenging given the frequent acute angulation required to enter the stent. Short throw devices can be helpful here (such as grasping forceps), though care needs to be taken to not grasp the LAMS. Suction can also be helpful though may lead to frequent endoscope clogging.
- Clearance of the main cavity
  - We almost exclusively use the spiral snare at this stage. Achieving efficiency with it can prove to be an unexpectedly steep learning curve. Anchoring the snare tip against the cavity wall followed by directing the sheath to the opposite wall to "lay down" the snare perpendicular to the axis of the endoscope can maximize debris entrapment, even with poor visualization (see Videos 1–3). This is a similar maneuver to colonic polypectomy when the target is straight in front and cannot be rotated to 6 o'clock.
  - Care should be taken to avoid injury to vessels within the cavity. Pink walls with oozing blood upon irritation are to be expected and should resolve spontaneously without intervention (Video 5).
  - If significant bleeding occurs and is not responsive to traditional hemostatic techniques, discussed above in AEs, there should be a low threshold for escalation of care and involvement of interventional radiology for embolization. Bleeding in these scenarios can become massive and fatal if not promptly identified and remedied.
- Access to distant subcavities
  - Fluoroscopy and recent cross-sectional imaging can be particularly helpful in this phase. If a percutaneous drain has been placed, a "finder" wire can be passed to probe a route toward it. If needed, balloon dilation can then facilitate endoscope entry into these subcavities, which are often connected to the main cavity through thin passageways.
  - Placement of stents from the gastric lumen all the way down to subcavities at this stage can augment egress toward the stomach and maintain progress achieved in this stage. We often use DPPS, though have used fully intracavitary FC-SEMS in the past (see **Figs. 1–5**).
- Clearance of subcavities
  - This is the final stage of DEN. Robust access into these areas achieved previously can lead to a trail of breadcrumbs of egressing debris. If access cannot be achieved percutaneous debridement may be beneficial, as discussed in section "*Paracolic extension".*

- Attempt to complete DEN sessions prior to 60 days so that LAMS can be removed within this time.
  - Current FDA indications for use labeling states that LAMS are intended for implantation of up to 60 days. However, in common clinical practice an informal goal of 4 weeks of implantation time is often targeted.
  - As above there is a theoretical risk of increased AEs, particularly bleeding, if LAMS remain in place for longer periods. We expect this risk to be mitigated by concurrent DPPS use though this has not been scientifically confirmed.
  - If additional DEN sessions are needed, it would be reasonable to keep LAMS in place slightly longer than 2 months or to convert access into the WON cavity via DPPS alone, as was done prior to LAMS availability.
- When possible, we delay removal of transgastric or transduodenal access until after all percutaneous access has been removed. This is done to reduce the rate of pancreaticocutaneous fistula formation.

MANAGEMENT, OUTCOMES, AND RECOVERY

- It is reasonable to perform DEN as an outpatient procedure. The need for additional DEN sessions should not be a factor preventing discharge of a patient.
- Each patient may have some pain after each session, which is normal. This should resolve within 1 day and be replaced with a better tolerance of oral intake with less nausea and vomiting.
- Expectation setting for patients can be critical. We often advise that it can take months to a year or more for a patient to fully recover from necrotizing pancreatitis that requires DEN.
- These patients may develop new-onset (or worsening) pancreatic insufficiency, both exocrine and endocrine. Monitoring for this, starting pancreatic enzyme replacement therapy, and ensuring a patient has a primary care physician can improve outcomes in this recovery phase. For these reasons, it is advised to have clinic follow-up with patients for at least one visit after completion of DEN.
- Monitoring WON response to treatment with cross-sectional imaging is crucial. We obtain contrast-enhanced CT prior to the first and suspected last DEN sessions. After LAMS removal, we repeat imaging again to ensure a fluid collection (pseudocyst) has not developed. If this occurs, consider if there is disconnected pancreatic duct, discussed elsewhere in this issue.
- Consider internal monitoring of success and AE rates for quality control.

SUMMARY

The management of WON has evolved substantially over the past 23 years since it was first described. In this article, we reviewed its history and the evidence supporting modern practice, which is still subject to heterogeneity across centers and based on many factors, including endoscopist experience. This allows for creativity and customization of what can be an endoscopic marathon. Our typical practice was discussed with image and video guides aimed at improving procedure success.

CLINICS CARE POINTS

- DEN is best performed at centers with experience in the techniques involved and with both interventional radiology and surgical backup.

- Some patients may respond to drainage alone. A lack of improvement in symptoms and a large residual cavity after drainage are indications for DEN. This process has been coined "endoscopic step-up".
- A combination of chemical and mechanical debridement can be used. Stopping PPI use can be effective and safe. Hydrogen peroxide use is under ongoing investigation and appears to be safe but with questionable benefit.
- Paracolic gutter extension often portends the need for percutaneous access and introduction of "surgical step-up". There have been recent forays into endoscopic approaches, but involvement of teams outside of gastroenterology is critical in this scenario.
- The use of plastic stents across LAMS, between DEN sessions, can reduce AE rates.
- A variety of devices, some emerging and some familiar, are discussed. Some of these may play an integral role in DEN of the future as additional evidence becomes available.

DISCLOSURE

A.J. Gilman has nothing to disclose. T. H. Baron is a consultant and speaker for Ambu, Boston Scientific, Cook Endoscopy, Medtronic, Olympus America, and W.L. Gore.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.giec.2023.04.010.

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