Percutaneous Endoscopic Necrosectomy

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KEYWORDS

• Necrotizing pancreatitis • PEN • Necrosectomy • Sinus tract endoscopy

KEY POINTS

- Patients with infected necrotizing pancreatitis not responding to antibiotics require drainage and subsequent necrosectomy (Step-up approach).
- Percutaneous Endoscopic Necrosectomy (PEN) has evolved as a minimally invasive approach for necrosectomy through the percutaneous catheter route using a flexible endoscope and can be done under conscious sedation.
- It is best suited for predominantly laterally placed collections and also can be performed at the bedside for sick patients admitted to an ICU.
- PEN has a clinical success rate of 80% with minimal adverse events.

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

INTRODUCTION

Acute pancreatitis (AP) is an acute inflammatory condition of the pancreas that can result in both local and systemic complications. AP is mild in the majority of patients but 20% to 30% of patients develop acute necrotizing pancreatitis leading to a more severe course of the disease.[1,2] Patients with significant pancreatic necrosis are prone to develop marked systemic inflammation which may even lead to organ failure. The mortality in this subgroup of patients with severe disease and organ failure may reach up to 40%.[3–5] Patients with acute necrotizing pancreatitis are susceptible to develop secondary infection of the necrotic tissue and fluid collections termed as infected necrotizing pancreatitis.

Infected necrotizing pancreatitis (INP) is a dreaded complication of AP. INP leads to significant morbidity and a mortality ranging from 23% to 39%.[3,4] Infection of the necrotic fluid collections occurs in up to 40% of patients with acute necrotizing pancreatitis and usually sets in after 2 to 3 weeks of the onset of illness. INP is suspected when a patient with acute necrotizing pancreatitis manifests with new onset

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or persistent fever beyond the first week of illness, elevated leukocyte count, and deterioration or lack of improvement in his/her clinical condition without any other identifiable source of infection. The infection can be confirmed on the culture of the necrotic fluid. The presence of air foci in the necrotic (peri)pancreatic collection on a CT scan is also suggestive of INP.[6,7] Initial management of patients with INP involves the institution of broad-spectrum antibiotics, adequate nutrition, and supportive therapy. Subsequently, drainage of the infected collection is required if there is no response to antibiotics, and necrosectomy in case of nonresponse to drainage, the so-called "Step-up Approach."[5,8,9]

Over the past 2 decades, the management paradigm of INP has shifted from an open surgical debridement to the step-up approach.[8,10] Interventional treatment for INP is generally performed when the necrotic fluid collections are walled off, termed as 'Walled Off Necrosis (WON). In a randomized controlled trial, the primary composite outcome of major complications or death was 69% in the open surgical arm and 40% in the step-up approach ($P = .006$).[10] In the step-up approach, the initial management involves drainage of (peri)pancreatic fluid collection by either per-oral endoscopic transenteral drainage or percutaneous catheter drainage (PCD) preferably via the retroperitoneal route followed by necrosectomy if sepsis is not controlled. The step-up approach can avoid necrosectomy in 35% to 64% of patients.[10,11] If required, necrosectomy can be performed through the initial drainage tract that is, transenteral route by per-oral direct endoscopic necrosectomy (DEN) or a percutaneous approach through the PCD tract. This can be achieved by either video-assisted retroperitoneal debridement (VARD), which involves a 5 cm skin incision or minimal access retroperitoneal pancreatic necrosectomy (MARPN) via 2 to 3 ports using a nephroscope/laparoscope without the incision. Per-oral DEN has similar adverse events rate as compared to minimally invasive surgical necrosectomy but with lesser hospital stay and fistula rate as shown in two randomized trials.[12,13] Hence, per-oral transenteric drainage with DEN is preferred for walled-off necrosis (WON) located predominantly in the lesser sac. However, the majority of (peri)pancreatic fluid collections are not amenable for per-oral transenteral drainage either because their wall is not well-formed or they are located distant from the stomach or duodenum.[12,13]

Percutaneous Endoscopic Necrosectomy (PEN) is an important addition to our armamentarium of other modes of necrosectomy. It is an alternative to VARD and MARPN as necrosectomy is performed through the tract of percutaneous catheter that is, sinus tract using a flexible endoscope. Collections distant from the stomach and duodenum are most suitable for PEN as a minimally invasive endoscopic approach though it can be used in all types of collections which are drained by percutaneous catheter. In this article, we will review the indications, technique, and outcomes of PEN.

GENESIS AND EVOLUTION OF PERCUTANEOUS ENDOSCOPIC NECROSECTOMY

Pancreas being a retroperitoneal organ, the (peri)pancreatic necrotic fluid collections are predominantly retroperitoneal in location that is, deep seated in the pancreatic bed extending to paracolic gutters. Percutaneous catheter drainage (PCD) is considered the preferred modality of drainage in the majority of patients because of the following reasons: (a) distance between the collection and stomach/duodenum $\geq$ 3 to 4 cm (b) ongoing organ failure or general conditions making a patient unfit for general anesthesia which is required for per-oral DEN while PCD can be performed at the bedside in sicker patients under local anesthesia (c) multiple collections and/or deep extension of the collections requiring drainage, and (d) immature wall of the WON which is a relative contraindication for the per-oral endoscopic drainage.[14]

PCD tract acts as a guide to the deep-seated collections via the retroperitoneal route for minimally invasive necrosectomy thus avoiding the transperitoneal approach and collateral damage to the bowel. MARPN and VARD are done using this approach. However, these approaches involve the use of a rigid nephroscope or laparoscope which have limited maneuverability and require at least 2 ports, one for visualization and the other for necrosectomy. Following the success of per-oral DEN, endoscopists have developed a modality of necrosectomy using the percutaneous tract (also known as sinus tract) and this method of percutaneous endoscopic necrosectomy (PEN) is gaining popularity over the past several years.

The first description of "sinus tract endoscopy" was by Carter and colleagues[15] in 2000. In a series of 14 patients with INP, initial 4 patients underwent open necrosectomy followed by sinus tract endoscopy and through the tract necrosectomy for residual necrotic debris, and avoided additional surgery. In the next 10 patients, sinus tract endoscopy and necrosectomy were performed as the primary modality via the percutaneous tract using either a double-channel endoscope or a nephroscope. Incidentally, Seifert and colleagues[16] reported for the first time transgastric per-oral direct endoscopic debridement in the same year. Castellanos and colleagues[17] also described sinus tract necrosectomy in a prospective series of 11 patients in 2005. Over the next 10 years, this technique was not utilized much perhaps due to the development of VARD.[18] In 2015, Dhingra and colleagues[19] first described the usefulness of this procedure in a prospective series of patients with INP many of whom had ongoing organ failure and required ICU care, as a technique which could be done in the regular endoscopy suite and also at the patient's bedside under conscious sedation and local anesthesia. The authors coined the term "percutaneous endoscopic necrosectomy" (PEN). Subsequently, the feasibility and safety of the procedure as a step-up approach for necrosectomy as an alternative to VARD was demonstrated by Jain and colleagues in a prospective cohort of 177 patients with INP, 53 of whom underwent PEN as a step-up treatment protocol.[20] More recent case series have also shown its usefulness and successful outcome of patients treated with PEN.[21–24]

INDICATIONS OF PERCUTANEOUS ENDOSCOPIC NECROSECTOMY

The main indication of PEN is infected necrotic collections which are predominantly laterally placed (**Fig. 1**) and non-responding to conservative therapy including supportive treatment, antibiotics, and percutaneous drainage. An important caveat is

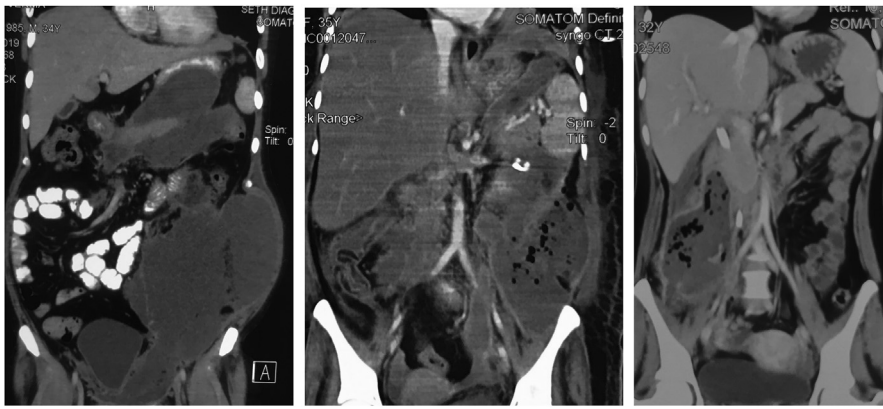

Fig. 1. Predominantly laterally placed necrotic fluid collections suitable for PEN.

that the PCD catheter should be upsized adequately before considering non-response. There is no definite guidance about the optimum size of the PCD catheter but in general 16 to 20 F size catheter is required to drain thick pus and bits of necrotic debris (the initial catheter size is usually 12 F).[25] First drainage with a large bore catheter (>20 Fr) is not preferred in view of higher risk of pancreatic bed hemorrhage.[26] The size of the catheter also depends on the size of the necrotic collection and the relative amount of necrotic debris. The judgment about upsizing the catheter is ideally made by the interventional radiologist based on the clinical response to the initial drainage. A few additional indications are summarized in **Box 1**.

TECHNIQUE OF PERCUTANEOUS ENDOSCOPIC NECROSECTOMY

Classification of Pancreatic Fluid Collections (PFCs)

For uniformity and ease of description, we propose the following classification system for pancreatic walled-off necrosis which requires intervention.

WON can be classified on the basis of location and amount of necrotic debris inside (**Fig. 2**).

On the basis of location.

1. Lesser sac only with or without subhepatic extension (L)
2. Paracolic gutter (G) only
   a. Right paracolic gutter (G_R)
   b. Left paracolic gutter (G_L)
3. Pelvis only (P)
4. A combination: such as lesser sac and left paracolic (L + G_L)
5. Others – perigastric, perihepatic, perisplenic, omentum, mesentery, mesocolon (O)
6. Extensive (E)

Quantification of Necrotic Debris

The amount of necrotic debris within the collection should be assessed before the drainage procedure either on abdominal USG or MRI scan and should be quantified as less than 30%, 30% to 50% or greater than 50%. In collections with predominantly solid debris and little fluid, PCD and subsequent minimally invasive procedure may not be the ideal approach and direct surgery may be a better option.

Box 1
Indications of PEN

Absolute Indications
1. Predominantly laterally placed necrotic fluid collections not amenable for transenteral drainage and no improvement/worsening sepsis after PCD
2. Ongoing organ failure or worsening organ failure (as a bedside technique in ICU)
3. Extensive gas in the collection resulting in poor visualization of the cavity on EUS

Relative Indications
1. Presence of multidrug resistant or extreme drug resistant bacteria in the first culture of the drained fluid
2. Poor nutritional status and general condition making patient unfit for general anesthesia

Contraindications
1. Large vessels coursing through the cavity
2. Suspected colonic fistula
3. Pancreatic bed hemorrhage (relative contraindication as PEN can be performed if a pseudoaneurysm is identified and embolized by radiologic intervention)
4. Extensive (peri)pancreatic necrosis

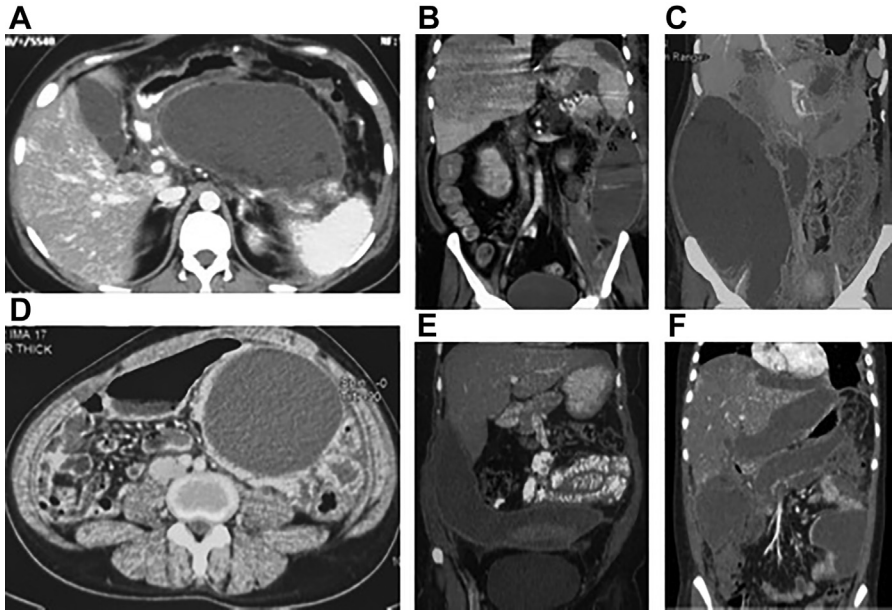

Fig. 2. (*A*) Lesser sac collection (L). (*B*) Left paracolic gutter collection (G_L). (*C*) Right paracolic gutter collection (G_R). (*D*) Collection in the omentum (O). (*E*) Right paracolic gutter and pelvic collection (G_R + P). (*F*) Extensive collection in lesser sac with sub-hepatic extension and both paracolic gutter extension (*E*).

Prerequisites for Percutaneous Endoscopic Necrosectomy

Appropriate patient selection, prior PCD of the infected collection preferably through the retroperitoneal access, and adequate size of the percutaneous tract after gradual tract upsizing are important pre-requisites for PEN.

DRAINAGE OF THE COLLECTION

Percutaneous drainage should be performed for collections other than predominantly lesser sac collections, which may be better drained endoscopically by the per-oral route. Retroperitoneal access should be preferred for percutaneous drainage whenever feasible as it avoids peritoneal contamination, reduces the risk of bowel injury and facilitates the step-up approach. A minimum PCD catheter size of 16 F is required to start the PEN procedure.

Tract Size Upgradation and Endoscopic Lavage:

The authors prefer to do the procedure in the regular endoscopy theater under local anesthesia and conscious sedation but it can also be done under general anesthesia (GA) (**Fig. 3** and Video 1). First, the previously placed PCD is removed under strict aseptic precaution. An ultrathin flexible endoscope (outer diameter 4.9–5.5 mm) is introduced into the cavity. The prerequisite for the introduction of the ultrathin endoscope is a minimum 16 Fr PCD tract size. Pre-procedure, the endoscope should be thoroughly disinfected with glutaraldehyde for 30 minutes followed by additional cleaning of the biopsy channel with alcohol and betadine. The tract is entered under visual guidance by the instillation of normal saline and minimal CO_2 insufflation at a

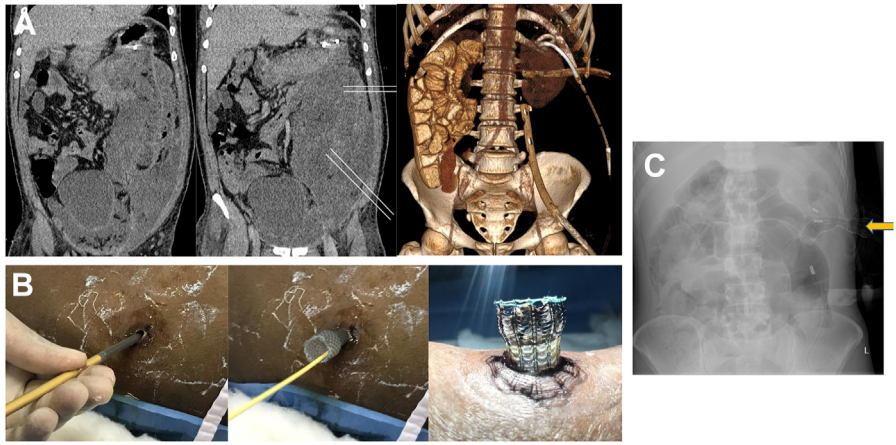

Fig. 3. (*A*) Large collection in the lesser sac extending to left paracolic gutter (L + G_L). The collection is distant from the stomach and wall is not well formed. Initial PCD was done through the retroperitoneal approach one in lesser sac and one in the left paracolic gutter. (*B*) Dilatation of the tract using covered self-expanding metal stent (16 mm). (*C*) X-ray abdomen showing the expanded SEMS (yellow *arrow*).

rate of 1.5 to 2.0 L/min. The WON cavity is inspected to determine the size, necrotic debris, and pus content. Liquid pus is washed with saline irrigation and sucked out till it clears off. Repeated gentle suctioning and endoscope withdrawal from the cavity is done so that the pressure in the collection doesn't increase. The cavity size and quantity of the necrotic debris determine whether the patient will need necrosectomy. After adequate lavage, a larger bore (2–4 Fr more than the previous catheter) straight PCD catheter (similar to a chest drainage tube) is placed using a Seldinger technique over a guidewire. In case of difficulty, the tract can be dilated with a CRE balloon. Tract dilatation with the upgradation of the PCD catheter and lavage of the cavity are done every alternate/third day till it reaches 30 Fr. The larger catheter can be inserted by back mounting it over the ultrathin endoscope which is used as a guide for proper placement. If tract dilatation to 30 Fr size is difficult to achieve for example, in the intercostal region, or if early necrosectomy is required due to sepsis, a fully covered self-expandable esophageal metal stent (16 mm diameter, length 8–12 cm) is placed.

ENDOSCOPIC NECROSECTOMY

After 48 hours of either a 30 Fr catheter or SEMS placement, necrosectomy is performed through the sinus tract/SEMS (**Fig. 4**). The procedure is performed under local anesthesia and conscious sedation with the monitoring of vital parameters. A regular upper gastrointestinal tract endoscope (diameter ~9 mm) is used for this procedure. The procedure can be performed at the patient's bedside if the patient is too sick to be moved to the endoscopy/operation theater. After inspecting the cavity, loose necrosum is removed using a snare and/or Roth-net basket as described previously by our group.[19,27] The cavity is irrigated well with saline. In addition, diluted hydrogen peroxide or povidone iodine may also be used for lavage. The duration of the procedure is guided by the patient's general condition and tolerance, and the amount of necrotic debris as judged by the endoscopist. The authors prefer to restrict the procedure time by not trying to remove all the necrotic debris in one go if the patient is sick. The duration of the procedure usually varies from 30 to 90 minutes.

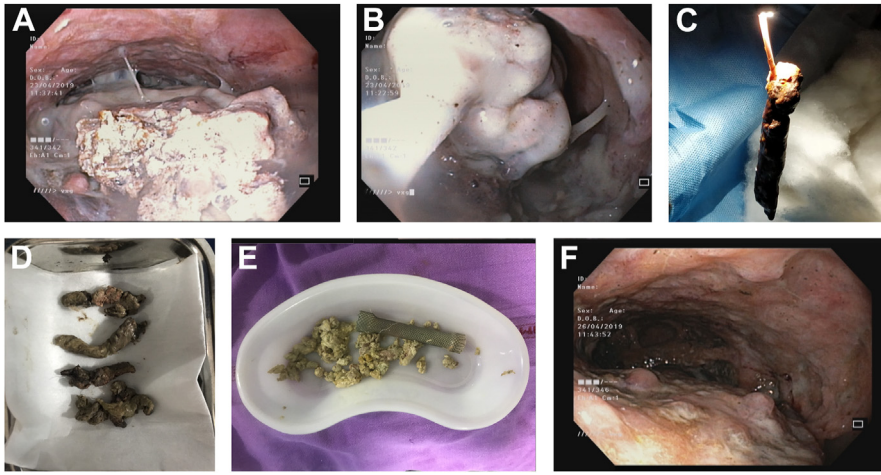

Fig. 4. (*A*) Inspection of the cavity shows extensive necrotic debris. (*B*) Debris removed with snare and Roth net during PEN. (*C*) Removed debris. (*D*) and (*E*) Debris with removed stent. (*F*) Residual clean cavity with granulation tissue.

Repeat Procedure

In case the cavity is not completely cleared off the debris, the next session of endoscopic debridement is undertaken after 2 to 3 days till complete clearance of the necrosum is achieved. Adherent debris should not be forcefully removed. After each session of necrosectomy, a 30-32 Fr drain tube is replaced into the cavity and the tract is lavaged twice daily with 500 mL normal saline through the percutaneous drain.

Downsizing the Tract

When the cavity is cleared off the debris and looks clean, the large bore tube is replaced with a smaller catheter of size 18 Fr (the authors prefer a nasogastric tube). When the draining fluid is clear after a few days, the catheter length is shortened and the collecting bag is replaced by an ostomy bag to prevent gravity-assisted drainage. These measures help prevent pancreatic fistula. The catheter is removed when the output decreases to less than 10 to 20 mL/d.

Based on the description above, there could be 2 approaches of PEN.

i. Endoscopic lavage and gradual upgradation of the PCD tract for necrosectomy: This approach is considered in relatively stable patients. First endoscopic lavage is done to remove the thick liquid pus and then gradual tract upgradation is done for subsequent necrosectomy in a phased manner depending upon the clinical course.
ii. Rapid tract dilatation and upfront necrosectomy: This approach is usually considered in patients with sepsis and persistent organ failure. If the patient doesn't improve after initial endoscopic lavage, rapid tract upgradation is done (usually using a SEMS) and upfront necrosectomy is performed.

OUTCOMES

Technical success is defined as successful clearance of the cavity by PEN. Clinical success is defined as the resolution of sepsis. The success rate and adverse events as reported in different series are summarized in **Table 1**.

Table 1
Summary of the results of major studies using PEN

Author, year	N	Technique	Success Rate	Adverse Events	Need for surgery and Mortality	Comments
Carter CR et al,[15] 2000	14	Rigid nephroscope alongside grasping forceps or a flexible endoscope was used along the percutaneous tract after dilatation	86%	Bleeding: 1 Prolonged ileus: 1 Recurrent collection: 2	Open surgery: 1 Mortality:2	Procedure done under GA over a median of 2 sessions
Castellanos et al,[17] 2005	11	Two large bore catheters placed in the collection through retroperitoneal route. Using a flexible endoscope, irrigation and suction were used to remove necrotic debris without insufflation.	73%	Not mentioned	Open surgery: 0 Mortality: 3	Procedure was completed under GA over a mean of 5 sessions (3–10)
Mui LM et al,[24] 2005	9	Initial 8.5 Fr percutaneous catheter was gradually upsized to 18 Fr Catheter. Choledochoscope (5 mm) was used for necrosectomy.	77%	Colonic Fistulization: 2 PCD related complication: 2	Open Surgery: 2 Mortality: 1	6 patients needed additional ERCP for CBD stone or pancreatic communication. It is not clear how necrosectomy was done using a choledochoscope which has a small working channel
Dhingra R et al,[19] 2015	15	After initial PCD was upsized gradually to 18 Fr catheter, an ultrathin endoscope was used for lavage and suction of liquid pus. Gradually, the catheter was upsized to 28–30Fr and necrosectomy was done using an adult gastroscope	93%	Bleeding: 1 Pancreatico-cutaneous fistula: 1	Open surgery: 1 Mortality: 1	Procedure done under conscious sedation without endotracheal intubation

Mathers B et al,[30] 2016	10	After tract upsizing to 24–28 Fr, adult gastroscope was used for necrosectomy.	100%	Pancreatico-cutaneous fistula: 1	Open surgery: 0 Mortality: 0	Median time to resolution after intervention was 57 (10–210) days
Thorsen A et al,[22] 2018	5	Initial 7Fr catheter was upsized to 20 mm and a covered SEMS was placed. Debridement was done using a gastroscope through the SEMS.	80%	Severe abdominal pain: 5 Pancreatico-cutaneous fistula: 2	Open surgery: 0 Mortality: 1	Two patients underwent endoscopic transmural drainage and debridement prior to PEN. All patients had severe pain which might be attributable to rapid tract upgradation from 7Fr Catheter to 20 mm SEMS.
Tringali A et al,[31] 2018	3	SEMS placed through percutaneous tract and necrosectomy done using an adult gastroscope	100%	None	None	
Saumoy M et al,[21] 2018	9	Percutaneous catheter tract was dilated with 15 mm and 18 mm bougie dilator and a 18 mm covered SEMS was placed. Endoscopic necrosectomy was done through a SEMS using an adult gastroscope.	89%	None	Mortality: 1	Plastic stent placed through SEMS. Done under GA.
Goenka et al,[32] 2018	10	After initial percutaneous catheter placement, it was replaced with 32 Fr tube by blunt skin dissection. PEN was done using an adult gastroscope through the tract after 10 d.	90%	Pneumoperitoneum: 2	Surgery: 1	Two patients underwent transenteral LAMS placement in addition to PEN.

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Table 1
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Author, year	N	Technique	Success Rate	Adverse Events	Need for surgery and Mortality	Comments
Ke Lu et al,[23] 2019	23	Endoscopic necrosectomy was done through a SEMS	65%	Major bleed: 10 Spontaneous enteric fistula: 5 Pancreatic fistula: 2	Mortality: 7 Surgery: 7	Transperitoneal approach was also used. Higher complication rate.
Jain et al,.[20] 2020	53	After Initial PCD was upsized gradually to 18 Fr catheter, an ultrathin endoscope was used for lavage. Gradually, the catheter was upsized to 28–30Fr and necrosectomy was done using an adult gastroscope.	79%	Aspiration Pneumonia: 2 Peritonitis: 2 Paralytic Ileus: 1 Bleeding: 1 Subcutaneous emphysema: 1	Surgery: 8 Mortality: 11	Consecutive patients were included to avoid selection bias. A PEN centered step-up protocol was established. Independent predictors of mortality: Early OF and extensive necrosis

Abbreviations: Fr, French; GA, general anesthesia; OF, organ failure; PCD, percutaneous catheter; SEMS, self-expandable metal stent.

In the first series by Carter and colleagues[15] 10 of 14 patients with IPN were treated with necrosectomy through the sinus tract as a primary modality. A rigid nephroscope or flexible endoscope was used for necrosectomy by removing small bits of necrotic pieces with the help of grasping forceps. The procedure could be successfully performed in all the patients. Eight patients improved, 2 died due to worsening sepsis and one needed open surgery (gastrojejunostomy).

In a series of 11 patients by Castellanos and colleagues,[17] PEN was performed using a flexible endoscope. Two large bore catheters were placed into the cavity by retroperitoneal approach and loose bits of necrotic debris were removed by irrigation and suction using a flexible endoscope over a mean of 5 sessions (range 3–10 sessions). No formal necrosectomy was done. Eight patients improved and 3 died of worsening organ failure.

Dhingra and colleagues[19] described the procedure in detail and also used it as a bedside tool in patients with worsening sepsis. The authors used a regular flexible endoscope with a 2.8. mm channel which allowed the use of standard endoscopic accessories for formal necrosectomy. They showed that PEN could be done under local anesthesia and conscious sedation. The authors demonstrated improvement in sepsis and organ failure once the liquid pus was removed by endoscopic lavage. The procedure could be done successfully in all patients but one patient died of worsening sepsis and organ failure.

In a prospective series of 9 patients, Saumoy and colleagues[21] described PEN through a metal stent placed through the percutaneous tract. After a median of 3 endoscopic sessions, 8 patients had successful removal of all PCD catheters and resolution of sepsis. One patient died of multi-organ failure. Thorsen and colleagues[22] also described a similar technique in 5 patients with successful outcome in 4 of them. In a series of 23 patients with INP, Ke and colleagues[23] described PEN through the SEMS. Clinical success rate was 70% with 48% major complications or death. Jürgensen and colleagues[28] also described a series of 14 patients with INP who underwent PEN with success in 13 patients. In their series, 6 patients had also undergone endoscopic transenteral drainage and debridement.

The largest prospective series was published by Jain and colleagues who described a “PEN centered step-up protocol.”[20] Of a total of 177 patients with IPN, 53 patients underwent PEN as a part of the step-up therapy. Of these, 42 (79.2%) patients could be treated successfully and 11 patients died. Independent predictors of mortality after PEN were greater than 50% necrosis and organ failure.

In a recently published systemic review and meta-analysis of PEN in 282 patients from 16 observational studies, the clinical success rate of PEN was 82% (95% CI 77%–87%) with a periprocedural morbidity rate of 10% and no procedure-related mortality. Based on the findings, the authors concluded PEN to be a safe and effective modality with a high success rate.[29]

ADVERSE EVENTS OF PERCUTANEOUS ENDOSCOPIC NECROSECTOMY

Adverse events following PEN are summarized in **Table 2**. Periprocedural major adverse events include bleeding, peritonitis, pneumoperitoneum, paralytic ileus and aspiration pneumonia. Long-term complications include the development of pancreatic fistula and recurrence of collections.

Bleeding during the procedure can be minor and self-limiting due to ooze from the granulation tissue or major due to injury to a vessel traversing through the cavity or a pseudo-aneurysm rupture. Major bleeding warrants radiologic or surgical intervention.

Table 2
Adverse events

Periprocedural Adverse Events	
Periprocedural bleeding	2%–3%
Peritonitis	1%–5%
Pneumoperitoneum	1%–3%
Aspiration pneumonia	1%–3%
Paralytic ileus	1%
Subcutaneous emphysema	1%
Colonic perforation	1%
Drain dislodgement	1%
Long term adverse events	
Pancreatic fistula	7%–13%
Recurrence of collection	1%–4%

Peritonitis may develop following leakage of the infected fluid into the peritoneal cavity during the procedure due to increased intra-cavitatary pressure. Usually, it is self-limiting but may require laparotomy. Excessive insufflation should therefore be avoided during the procedure.

SUMMARY

Over the past 20 years, PEN has emerged as a promising minimally invasive tool for necrosectomy in predominantly laterally placed infected WON with a very good success rate similar to other modalities of debridement that is, DEN and VARD. In comparison to DEN or VARD, it has the following added advantages: (a) It can be performed under conscious sedation as compared to the need for GA for VARD and DEN (b) Ability to maneuver through deeper pockets of the collection with the help of a flexibile endoscope as compared to rigid and non-flexible instruments used in VARD (c) Ease of using it as a bedside tool in very sick patients with ongoing organ failure in ICU and (d) Better patient tolerability and hence it can be repeated easily as compared to VARD. PEN may also be used as an adjunct to DEN for large extensive collections.

FUTURE PROSPECTS

Step-up intervention is the preferred modality for the management of INP. PEN has evolved as an effective minimally invasive approach as an alternative to VARD/MARPN with a good safety profile. Better tolerability by the patients and ease of performing the procedure multiple times under conscious sedation make it a preferred approach for patients with ongoing organ failure who are high risk for GA. Randomized trials comparing PEN with other minimally invasive techniques might provide further robust data in the future.

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CLINICS CARE POINTS

- Laterally placed infected necrotic fluid collections not responding to antibiotics and drainage are best suited for percutaneous endoscopic necrosectomy (PEN).
- Removal of thick liquid pus during endoscopic lavage helps in the improvement of sepsis and can be done bedside in sicker patient admitted in ICU prior to PEN.
- Rapid tract upgradation can be done with the balloon dilatation of tract or placement of fully covered metal stent.
- Procedure can be repeated as it can be done in an endoscopic theater under conscious sedation and is tolerated well.
- Post procedure patient should be monitored for signs of peritonitis and bleeding for 24 to 48 hours.

CONFLICT OF INTEREST

None.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.giec.2023.04.011.

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