EUS 2008 Working Group document: evaluation of EUS-guided drainage of pancreatic-fluid collections (with video)

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In recent years, EUS-guided transmural drainage of symptomatic pancreatic-fluid collections has increasingly been performed. Before the introduction of linear EUS in the 1990s and the subsequent development of EUS-guided drainage procedures, the options available included surgical drainage, percutaneous drainage by using radiologic guidance, and non–EUS-guided endoscopic transmural drainage. This section of the EUS 2008 Working Group Proceeding evaluates the current status of EUS in the management of pancreatic-fluid collections and provides recommendations for future research and technology development.

CURRENT APPROACHES AND LIMITATIONS

The current approaches and limitations are shown in Table 1.

Surgical drainage

Traditionally, open surgery has been considered the standard treatment for drainage of symptomatic pancreatic-fluid collections. However, surgery requires general anesthesia and is more invasive when compared with percutaneous and endoscopic options. The clinical outcome, as well as the morbidity and mortality rates, also differs depending on the nature of the fluid collections.

Pseudocysts. Surgical drainage of pancreatic pseudocysts involves creating a cystogastrostomy or cystojejunostomy. Although surgical drainage has high success rates, morbidity rates of 10% to 30% and mortality rates of 1% to 5% were reported.[1]

Abscess and necrosis. Surgery for abscesses and infected necrosis involves options, such as debridement with closed packing and external drainage; debridement with immediate lesser-sac lavage; and debridement followed by open packing, planned reexploration, and secondary closure. The morbidity is higher than surgical drainage of pseudocysts, and postoperative complications were reported in 78%[2] of cases, with mortality rates that ranged from 11%[3] to 27%.[2,4] For patients who underwent surgical debridement with closed packing, a need for repeated operations was reported in 12.6%[3] to 51%[2] of cases. Despite these high morbidity and mortality rates, surgery has the distinct advantage over endoscopic drainage in the sense that it can be performed at both an early stage, when there is only solid necrotic debris, or at a later stage, when liquefaction has occurred. Surgery can also be performed whether or not the necrotic collection is walled off. At present, the consensus is that surgery, if required, should be deferred to the 3rd or 4th week to allow proper demarcation of pancreatic and peripancreatic necrosis to occur, thus optimizing the conditions for necrosectomy.[5]

The use of open surgical drainage has declined as less-invasive procedures emerged. However, it remains the only feasible approach in some situations, and several important issues must be considered when weighing the decision about the treatment options: (1) although endoscopic therapy appeared less invasive, with similar outcomes, when compared with surgery, it must be remembered that, to date, there are no prospective randomized controlled studies that compared endoscopic therapy against surgery; (2) endoscopic drainage can only be performed if there is a mature, walled-off pancreatic-fluid collection that is adjacent to the gastric-duodenal wall; fluid collections that extend to more distant locations, eg, the paracolic gutter, cannot be accessed by endoscopy at all; if intervention is required for infected necrosis that remains solid, then surgical debridement is the only feasible approach; (3) when considering the choice between surgical and endoscopic options, one must consider the underlying anatomic predisposition, such as the pancreatic-duct anatomy, ie, whether there is a coexisting pancreatic-duct disruption, stricture, or fistula, and whether it can be managed endoscopically in the long term or whether surgery would be more definitive. In these cases with pancreatic-duct abnormalities, the endoscopic option is pancreatic-duct stenting and fistula sealing, whereas surgical options are pancreatic resection and pancreaticojejunostomy; (4) even if surgery were to be ultimately indicated because of an anatomical predisposition to recurrence of fluid collection, endoscopic drainage of fluid collections, such as abscesses and infected necrotic collections, before surgery may help to control ongoing sepsis, thereby optimizing the clinical status before surgery; and (5) surgery remains an important salvage therapy in the treatment of complications that arise from endoscopic or percutaneous drainage,[6] but, conversely, an endoscopic or percutaneous approach is considered the preferable approach in the management of postoperative pancreatic-fluid collections.

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TABLE 1. Comparison of surgical, percutaneous, and endoscopic approaches

	Strengths	Disadvantages
Surgical therapy (cystogastrostomy, cystojejunostomy, pancreatic resection, surgical or laparoscopic necrosectomy, open and closed packing, and placement of drainages)	(1) Effective drainage therapy, (2) able to perform more extensive necrosectomy in any place, (3) able to address anatomical consequences of primary underlying disease, such as pancreatic-duct stricture, disconnected-duct syndrome, fistula, and (4) important role as salvage therapy in unsuccessful percutaneous or endoscopic drainage	(1) Invasive, (2) high morbidity and mortality, and (3) longer hospital stay, longer intensive care unit stay
Percutaneous therapy (percutaneous drainage placement)	(1) Less-invasive primary approach and less-invasive alternative in patients with postoperative pancreatic-fluid collections, (2) important adjunct to endoscopic drainage when the fluid collection is inaccessible by endoscopy, (3) may be performed in patients too unstable to undergo endoscopic drainage	(1) Potential local complications, such as bleeding, injury of viscera, and cutaneous infections, (2) inadequate in presence of necrotic debris
Endoscopic therapy (endoluminal drainage placement, endoscopic necrosectomy, pancreatic-duct stenting, and fistula sealing)	(1) Less-invasive primary alternative to surgical drainage, with comparable results, (2) less-invasive alternative in patients with postoperative pancreatic-fluid collections, (3) able to effectively treat necrotic collections with endoscopic necrosectomy, and (4) completely organ preserving compared with surgery	(1) Only possible if the pancreatic-fluid collection is encapsulated and adjacent to the gastric or duodenal wall, (2) multiple endoscopic sessions required, and (3) may only be a temporary measure if the underlying anatomical predisposition needs surgical correction.
(A) Non–EUS-guided endoscopic drainage		(1) Unable to drain collections in the absence of endoscopic bulging, (2) unable to exclude interposed vessels before drainage, with potential risk for bleeding, and (3) potential for misdiagnosing cystic tumor and pancreatic-fluid collection.
(B) EUS-guided endoscopic drainage	(1) Able to characterize the type of pancreatic-fluid collection and more accurately distinguish between cystic tumor and pseudocyst before drainage, (2) facilitate drainage in absence of endoscopic bulging, and (3) avoids interposed blood vessels through Doppler US	(1) Limited available equipment and accessories

Percutaneous drainage

Percutaneous drainage under radiologic guidance is much less invasive compared with surgery. However, percutaneous drainage necessitates an external indwelling drainage catheter and has the major drawback of not being able to clear solid debris, with reported surgical rescue rates of 53% to 62%.[7] In addition, complications, such as bleeding, inadvertent puncture of adjacent viscera, and secondary infection, may occur. A prolonged period of external drainage may be needed, and a pancreaticocutaneous fistula could occur.[8] Nonetheless, percutaneous drainage remains an important adjunctive therapy, such as in the context of fluid collections that have extended to the paracolic gutters, which cannot be accessed by endoscopy, and also in the drainage of collections without a mature wall, and, therefore, cannot be drained by endoscopy. In this situation, a van Sonnenberg catheter can be inserted for drainage. It must be remembered that adjunctive percutaneous drainage may also be required after surgery; this was reported at 30% in one series.[3]

Non–EUS-guided endoscopic transmural drainage

Before the introduction of EUS, once a walled-off pancreatic-fluid collection was detected by CT, the collection would be punctured at the site of maximum endoscopic bulging by using a duodenoscope. Because it is a blind procedure, when attempting to achieve initial endoscopic access, the presence of endoscopic bulging is a prerequisite. In addition, there is a potential risk of hemorrhage from puncture of interposed vessels during the process of transmural drainage. There is also a potential concern of misdiagnosing a necrotic collection, which is associated with the presence of solid debris, as a simple fluid collection, based on CT appearance, such that the collection is undertreated by placement of transmural stents only, without performing aggressive endoscopic necrosectomy.[9,10]

EUS-guided drainage of pancreatic-fluid collections

Advantages of EUS-guided drainage. The main advantage of EUS-guided drainage is that, in the absence of endoscopic bulging, endoscopic transmural drainage may still be performed. One may potentially decrease the bleeding rate by avoiding interposed blood vessels through the use of Doppler US. By using a transmural approach, the problems of cutaneous infection and external fistulas can be avoided, because there is no need for an external drainage catheter. EUS can also differentiate a pseudocyst from a cystic tumor and can ascertain the presence of a drainable collection. The importance of EUS was highlighted in a case series in which EUS was used to evaluate pseudocysts before attempting endoscopic drainage, and it was shown that EUS provided essential information that led to a change in management strategy in 37.5% of cases.[11] Another case series showed that EUS could be used to guide pseudocyst drainage in the context of patients with portal hypertension, thereby reducing the bleeding risk.[12]

Technique of EUS-guided drainage. By using the traditional single guidewire approach, a linear echoendoscope is used to visualize the pancreatic-fluid collection; the collection is then punctured with a needle under Doppler US guidance (Video 1, available online at www.giejournal.org). Several types of needles can be used and include a 19-gauge FNA needle,[13,14] specific puncture kits,[15,16] and the cystotome[17,18] (Fig. 1A). A guidewire is then inserted through the needle into the fluid collection under fluoroscope guidance (Fig. 1B), the puncture site is dilated by a balloon catheter to 6 to 8 mm (Fig. 2), and a double-pigtail transmural stent is then inserted for drainage. When multiple stents or an additional nasocystic catheter are required, the pseudocyst is recannulated by using a catheter and guidewire, followed by insertion of the second transmural stent or nasocystic catheter.

To circumvent the problem of having to recannulate the pseudocyst after gaining initial transmural access and catheter or transmural stent placement, the concept of a ‘‘double-wire’’ approach, in which 2 guidewires are inserted through the same catheter before stent placement, has been advocated. Three approaches have been described. The initial

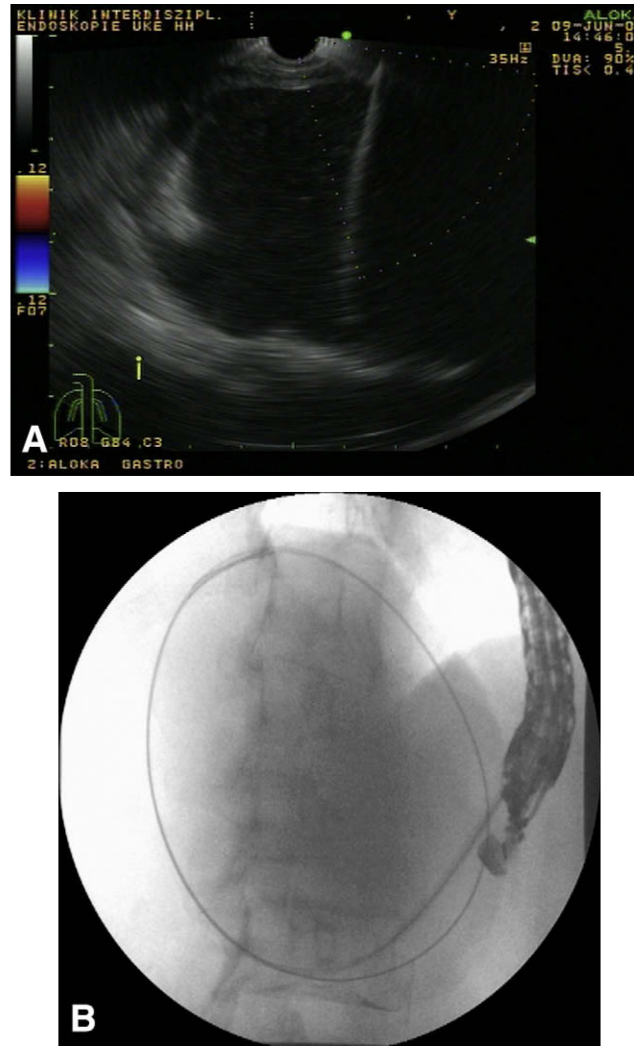

Figure 1. A, EUS-guided puncture of pancreatic pseudocyst. **B**, Fluoroscopy, showing guidewire inside the pseudocyst cavity.

publication of the procedure used a prototype 3-layer puncture kit that allowed the simultaneous insertion of 2 guidewires at the initial puncture. This puncture kit consisted of a 6F inner Teflon (DuPont, Wilmington, Del) catheter inserted through an outer 8.5F Teflon catheter and a 22-gauge FNA needle, which was inserted through the inner catheter. The 6F inner catheter reduces step formation and facilitates the insertion of the assembled kit into the pseudocyst cavity after needle puncture. By using the assembled kit with the needle protruding out at the distal end of the catheter, the pseudocyst is punctured under EUS-guidance by using electrocautery. The assembled inner and outer catheters are then pushed into the cavity. Once entry into the pseudocyst is confirmed by EUS and by aspiration of fluid, the needle and the 5F inner catheter are withdrawn, which leaves behind the 8.5F outer catheter. Two 0.035-inch guidewires are simultaneously inserted into the pseudocyst cavity

Figure 2. Balloon dilation of the cavity stoma under direct endoscopic view.

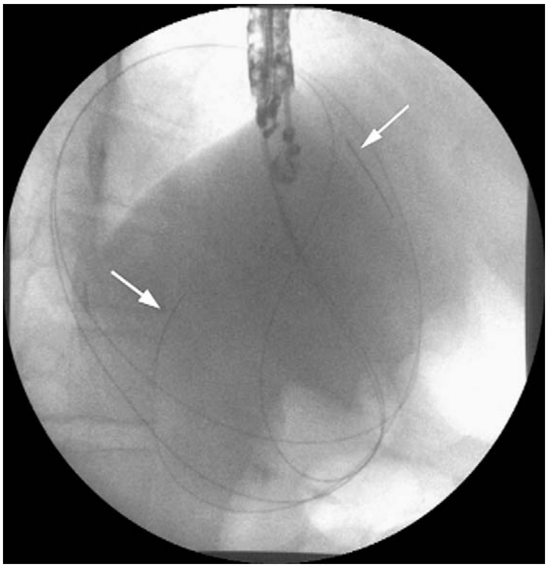

Figure 3. Fluoroscopy, illustrating 2 guidewires (*arrows*) simultaneously inserted by using the double-wire approach.

(Fig. 3) and a 8.5F double-pigtail stent and a 7F nasocystic catheter or another stent can be sequentially placed.[19] Other investigators reported inserting either the 10F outer catheter of a cystotome,[20] or a 10F Soehendra biliary dilator,[21] into the pseudocyst cavity through the single guidewire inserted at the initial EUS-guided puncture, followed by insertion of a second guidewire through these catheters. Sequential transmural stent and drainage catheter placement can then be performed without a loss of access to the pseudocyst cavity and obviates the need for recannulation, which may be difficult because of a tangential axis of puncture or from poor visibility caused by the fluids flowing from the pseudocyst.

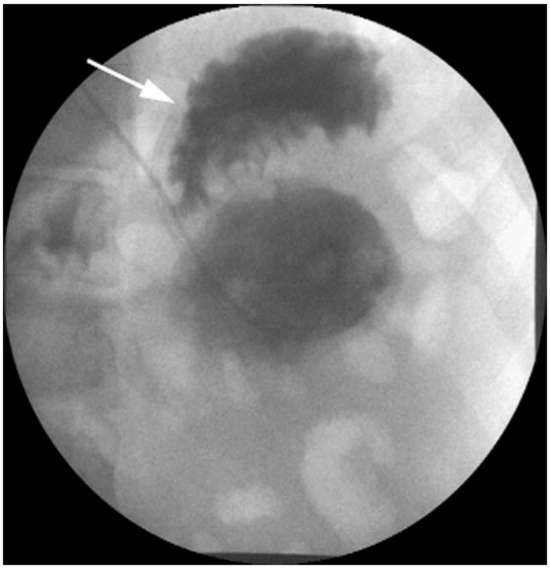

Figure 4. Functioning irrigation system. Contrast medium enters the pseudocyst cavity through the nasocystic drainage and is flushed out through the double-pigtail stent (*arrow*) into the stomach.

After placement of transmural stents and drainage catheters, further adjunctive measures may be necessary. These adjunctive steps are the same, whether or not EUS guidance was used to achieve the initial endoscopic transmural drainage. In the context of an infected pancreatic-fluid collection, continuous saline solution irrigation and drainage with a nasocystic catheter is important until sepsis has resolved (Fig. 4). In the presence of infected pancreatic necrosis, adjunctive endoscopic transmural necrosectomy (Fig. 5A and B) is essential to improve the treatment success rates.[22–28] When considering the outcome of endoscopic treatment, one needs to distinguish between immediate technical success and successful endoscopic treatment with resolution of the fluid collection.

RESULTS OF EUS-GUIDED DRAINAGE OF PANCREATIC-FLUID COLLECTIONS

Results of EUS-guided drainage of pancreatic-fluid collections are shown in Table 2. The success rate of pseudocyst drainage is higher compared with drainage of infected necrosis, which requires additional endoscopic necrosectomy to remove necrotic and devitalized tissue. When assessing outcomes, one also needs to distinguish between technical success and resolution of the fluid collection. The former refers to successfully achieving access and drainage of the fluid collection, whereas the latter pertains to complete resolution and recovery. This concept is important, because, technically, one can be successful in terms of placing transmural stents for an infected walled-off necrosis, but this will not lead to

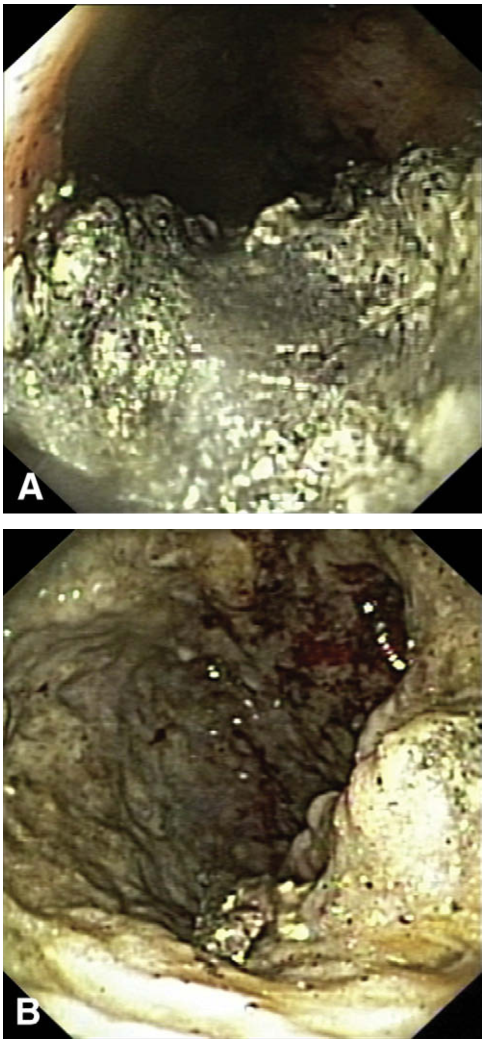

Figure 5. A, Endoscopic view inside the pseudocyst cavity after sequential balloon dilation, showing necrotic material. **B**, Endoscopic view inside the pseudocyst cavity after successful endoscopic necrosectomy.

resolution of the collection, because additional steps, such as endoscopic debridement and necrosectomy, are needed. Another point to note is that, when one considers and compares EUS-guided versus non–EUS-guided drainage, the difference exists only at the initial stage of attempting to puncture and access the fluid collection. All subsequent steps are similar with both approaches.

Pseudocysts

For pseudocysts, several case series reported very high success rates for EUS-guided drainage. Even the lowest success rates were in the range of 82%[18] to 84%.[29] Usually success rates exceeded 91%[30-32] and even reached 100%.[33]

Pancreatic abscesses

The data on abscess drainage are more limited than pseudocyst drainage. Nonetheless, high success rates that ranged from 80%[33] to 90% and more[25,30] were reported.

Infected walled-off pancreatic necrosis

The results of endoscopic drainage of infected walled-off necrosis are generally poorer than pseudocyst drainage, because of the need to remove the necrotic solid debris. Baron et al[23] showed that the success rate of pseudocyst drainage was 92%, compared with 72% in patients with necrosis. Although this study used non-EUS-guided endoscopic drainage, it illustrated the principle that the outcome of endoscopic drainage for pseudocysts was superior to infected necrosis. In fact, in another study, the success rate was only 25%.[30] Nonetheless, if an aggressive endoscopic approach that uses endoscopic necrosectomy is adopted, success rates that range from 73%[28] to 81%[26] and even up to 92%[27] can be achieved. Adjunctive surgical and percutaneous drainage may be needed.[27]

COMPARISON OF EUS-GUIDED DRAINAGE WITH ALTERNATIVE DRAINAGE TECHNIQUES

Surgical versus percutaneous and endoscopic drainage

Vosoghi et al[34] compared the results of cases series of surgical, percutaneous, and endoscopic drainage of symptomatic pseudocysts in a recent review. The success rates of surgical, percutaneous, non–EUS-guided, and EUS-guided transmural drainage were 100%, 84%, 90%, and 94%, respectively. Complication rates were higher for surgical (28%–34%, with 1%–8.5% mortality) and percutaneous drainage (18%, with 2% mortality), compared with non–EUS-guided (15%, with 0% mortality) and EUS-guided transmural (1.5%, with 0% mortality) drainage.

EUS-guided cystogastrostomy versus surgical cystogastrostomy

A recent study compared the clinical outcomes of EUS-guided cystogastrostomy with surgical cystogastrostomy for the management of patients with uncomplicated pancreatic pseudocysts and performed a cost analysis of each treatment modality.[35] It was shown that EUS-guided drainage was similar to surgery in terms of rates of treatment success (100% vs 95%) but had advantages in terms of a shorter hospital stay (mean length of stay 2.7 vs 6.5 days) and lower costs.

EUS-guided versus non–EUS-guided endoscopic drainage

A direct comparison of EUS and non–EUS-guided endoscopic drainage was made. Non–EUS-guided transmural drainage was compared with EUS-guided drainage in a study in which pseudocysts with bulging and no obvious portal hypertension underwent conventional transmural drainage, whereas all remaining patients underwent EUS-guided drainage. There were no significant differences between the groups in terms of efficacy or safety. Indirectly, this study supported the concept that

TABLE 2. Results of EUS-guided drainage from large series

Study, y	No. of patients	Type of fluid collection (no. of cases)	% Technical success	% Treatment success	Complication rates
Pfaffenbach et al,[41] 1998	11	Pseudocyst	91	82	0%
Giovannini et al,[33] 2001	35	Pseudocyst (15)	100	100	3% (pneumoperitoneum 1)
		Abscess (20)	90	80	
Seewald et al,[16] 2005	13	Abscess (8), necrosis (5)	100	85	31% (minor bleeding 4)
Kahaleh et al,[29] 2006	46	Pseudocyst	100	Short term 93, long term 84	20% (bleeding 2, stent migration 1, infection 4, pneumoperitoneum, 2)
Hookey et al,[30] 2006	51/116	Pseudocyst 94, abscess 9, necrosis 8, acute fluid collection 5	96	93	Without EUS 11.7%, with EUS 10.8%; total 11.2% (bleeding 6, pneumoperitoneum 4, systemic infection 1, post-ERCP pancreatitis 1, duodenal/surgical drain communication 1)
Antillon et al,[13] 2006	33	Pseudocyst	94	Complete resolution 82, partial resolution 12	Major 6% (perforation 1, major bleeding 1), minor 9% (minor bleeding 2, asymptomatic pneumoperitoneum 1)
Azar et al,[14] 2006	23	Pseudocyst	91	82	4% (pneumoperitoneum 1)
Kruger et al,[42] 2006	35	Pseudocyst 30, abscess 5	94	88	Immediate complications 0%, delayed infection 31%, (stent occlusion 4, ineffective drainage 3, secondary infection 4)
Ahlawat et al,[18] 2006	11	Pseudocyst	100	82	18% (stent migration 2)
Charnley et al,[27] 2006	13	Necrosis	100	92	0% (note: 2 unrelated mortalities after successful treatment and resolution)
Lopes et al,[25] 2007	51	Pseudocyst 36, abscess 26 (51 patients with 62 collections)	100	94	Immediate 3% (pneumoperitoneum 1, stent migration 1), delayed 18% (stent occlusion 3, stent migration 8)
Voermans et al,[43] 2007	25	Necrosis	100	93	Severe 7% (perforation 1, major bleeding 1), minor 30% (minor bleeding 8)
Seifert et al,[28] 2007	60	Necrosis	100	73	13% (perforation 2, bleeding 5, pneumoperitoneum 1, with 1 mortality)
Varadarajulu et al,[44] 2008	60	Pseudocyst 36, abscess 15, necrosis 9	95	93	0%

EUS-guided drainage is superior, because it can be used to drain pseudocysts not amenable to conventional transmural drainage, without any increased risks.[29] In another study, the rate of technical success between EUS-guided and non–EUS-guided transmural drainage of pancreatic pseudocysts was directly compared prospectively. All the patients randomized to EUS (n = 14) underwent successful drainage, whereas the procedure was technically successful in only 33% randomized to non–EUS-guided drainage (n = 15). Reasons for technical failure were absence of luminal compression in 9 patients and severe bleeding after attempted puncture of the pseudocyst in one. All these 10 patients subsequently underwent successful drainage of the pseudocyst under EUS guidance.[36] In another similar study, the technical success rate of pseudocyst drainage was higher in patients undergoing EUS-guided drainage compared with those without EUS guidance (96.3% vs 66.7%).[37] An often raised argument for the use of non–EUS-guided drainage rather than EUS-guided drainage is that it takes a longer time to perform EUS-guided drainage. This argument is no longer valid, with the introduction of therapeutic linear echoendoscopes with a 3.7-mm to 3.8-mm working channel, because there is no need for additional steps, eg, changing to a duodenoscope after performing EUS. By using a double-wire technique, from our experience, it is possible to complete the drainage procedure with placement of 2 transmural stents within 30 minutes.

Limitations to EUS-guided endoscopic drainage

It is clear that EUS-guided drainage offers several advantages over traditional drainage techniques, but there are limitations because of the echoendoscope design, which result in technical difficulties during endoscopic drainage. An important limitation is that the size of the working channel of a therapeutic linear echoendoscope is 3.7 or 3.8 mm, smaller than that of a therapeutic duodenoscope (4.2 mm). This limits the suction ability, which is important when there is a large amount of fluid coming out of the pseudocyst cavity after the initial puncture. In addition, although placing a 10F stent is not an issue with a linear echoendoscope, one may need to place multiple stents or an additional nasocystic catheter for irrigation. In these situations, it may be faster and easier to use a double-wire technique. However, the smaller working channels of echoendoscopes limit the utilization of ''double-wire'' techniques, in the sense that the size of the first transmural stent that is inserted has to be 8.5F or smaller, because of excessive resistance within a 3.7-mm working channel with 2 guidewires in place. The first stent that is placed cannot be the preferred larger 10F size.

Another limitation is the oblique view of current echoendoscopes. This limits the endoscopic view and results in a tangential puncture axis. Puncturing at an angle may hamper successful completion of the procedure, because the force that is applied when introducing accessories through the working channel cannot be fully directed toward the puncture site. The tangential axis also makes subsequent cannulation of the pseudocyst cavity difficult, unless there is prior balloon dilation of the puncture site or if a double-wire technique was used.

A prototype forward-viewing therapeutic echoendoscope developed by Olympus Optical Co Ltd (Tokyo, Japan) allows a forward axis of needle puncture and insertion of accessories, parallel to the scanning axis. The use of a forward-viewing echoendoscope facilitates forward transmission of force when inserting accessories, stents, and catheters. In a pilot study, all pseudocysts were successfully drained without complications, and there were cases that could only be punctured by using the forward-viewing echoendoscope.[38] Based on our early experience, the forward-viewing linear echoendoscope can be used with a one-step simultaneous double-wire technique.[39] The new forward-viewing echoendoscope is a breakthrough but remains limited by a 3.7-mm working channel, a lack of elevator, and an US view of only 90°.

A prototype device, the ''transluminal balloon accessotome,'' which combines a needle-knife and a dilating balloon, was shown to be useful for pseudocyst drainage; it could puncture the pseudocyst and dilate the puncture site in a single step, simplifying the procedure by reducing the need to exchange accessories. In the study, a duodenoscope was used, but it can be adapted for EUS-guided drainage.[40] Currently available sets are not ideal, and innovations, eg, the double-wire puncture kit, are not commercially available.[19] Developments will depend on the availability of a larger working channel that can create more space for new puncture devices.

Endoscopic drainage is feasible only for pancreatic-fluid collections located around the stomach and the duodenum. If these collections involved more distal locations, such as the paracolic regions, then these collections are not accessible by endoscopy and other adjunctive measures, such as percutaneous or surgical drainage, need to be considered.

WORKING GROUP RECOMMENDATIONS

Clinical research

a. Prospective studies that compare the linear-array and the prototype forward-viewing echoendoscopes are required to identify the advantages and limitations of each echoendoscope for performing pancreatic pseudocyst drainage.
b. Also, trials that compare EUS and surgery (the current criterion standard) for drainage of uncomplicated pancreatic pseudocysts are required to evaluate end points, such as the long-term response to therapy, patient quality of life, and cost-effectiveness.

Device development

To facilitate and simplify the process of EUS-guided pseudocyst drainage, further research and development is needed for both echoendoscope and dedicated drainage accessories:

a. With regard to improvement in the echoendoscope design, the presence of an elevator and a larger working channel should make the procedure technically easier. If these refinements can be added to the prototype forward-viewing echoendoscope without compromising the echoendoscope diameter, then therapeutic interventions could possibly be undertaken with relative ease.
b. The development of dedicated EUS-drainage kits that minimize the need to exchange accessories and to facilitate the placement of multiple transmural stents and/or a nasocystic catheter for drainage is important. To enable endosonographers without much experience in therapeutic ERCP to perform these procedures with relative ease, development of EUS specific drainage kits are essential.

From current evidence, it is clear that EUS establishes an alternative diagnosis or provides important information such as the presence of intervening vasculature in patients who present for endoscopic drainage of pancreatic-fluid collections. When available, EUS should be performed before endoscopic drainage in all patients or the drainage procedure should be performed under EUS guidance. The working group sets a high priority for prospective studies that compare the prototype forward-viewing and linear-array echoendoscopes for performing pseudocyst drainages. Also, studies that compare EUS and surgery for performing cystogastrostomy are required for evaluating long-term outcomes, such as rates of pseudocyst recurrence, cost-effectiveness, and quality of life. Given the practical limitations, the working group sets the priority at low for such a trial. Because pancreatic-fluid collections are increasingly being drained under EUS guidance, the working group sets the priority at high for echoendoscope and device development in this area.

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