EUS followed by endoscopic pancreatic pseudocyst drainage or all-in-one procedure: a review of basic techniques (with video)

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The 3 main objectives of this review are to (a) evaluate the role of EUS when performed before conventional transmural drainage of pancreatic pseudocysts, (b) evaluate the technical aspects of EUS when applied as a 1-step procedure for pancreatic pseudocyst drainage, and (c) evaluate the requisite technical proficiency for performing EUS-guided drainage of pancreatic pseudocysts.

Endoscopy is a minimally invasive and well-proven alternative to surgery for drainage of symptomatic pancreatic pseudocysts. However, a luminal compression must be present at endoscopy for successful drainage, and only 50% of pseudocysts cause a luminal compression.[1,2] Also, the relatively ''blind'' approach of the technique causes perforation or bleeding in about 2% to 6% of patients.[3-6] EUS by virtue of its ability to visualize outside the lumen of the GI tract enables drainage of pancreatic pseudocysts that do not cause a luminal compression. The technical success rate of EUS for performing pancreatic pseudocyst drainages has been reported to be greater than 90%, with a complication rate of less than 5%.[1,7-9] Apart from issues related to access and safety, performing a routine EUS before endoscopic drainage leads to a change in management in 5% to 37% of cases.[1,10,11] This is because EUS establishes an alternate diagnosis of cyst neoplasm in 3% to 5% of cases originally misclassified as a pseudocyst by CT.[1,10,12] From a treatment point of view, the differentiation of a walled-off pancreatic necrosis from a pseudocyst is very important, and EUS is much more sensitive than CT in making this distinction. Also, if a CT has not been performed recently, then EUS can assess suitability for drainage, because pseudocysts tend to resolve or become smaller over time.[1,10,11]

At some institutions, endoscopists first perform EUS to confirm the diagnosis and to identify a site for subsequent conventional transmural drainage (CTD) by EGD. At other institutions, pseudocyst drainage is performed under EUS guidance as a 1-step procedure. This variation in practice pattern may be because of the following factors:

1. The endosonographer may not be proficient in performing therapeutic interventions. In such cases, after confirmation of a diagnosis and identifying an appropriate site, CTD is subsequently undertaken by the therapeutic endoscopist.
2. In most centers, although the ERCP suite has access to fluoroscopy, the EUS suite does not have fluoroscopy. This requires the manual transport of a patient to the ERCP suite, after EUS, because maneuvers such as guidewire exchange and stent deployment require fluoroscopic guidance. Also, if a dedicated MRCP had not been undertaken to assess the pancreatic-duct anatomy, then most endoscopists perform a pancreatogram before pseudocyst drainage.
3. Because most therapeutic interventions involve deployment of 7F or 10F transmural stents, a therapeutic echoendoscope with a large biopsy channel ($\geq$ 3.7 mm) is required for performing pseudocyst drainage. At centers that do not have access to the therapeutic echoendoscope, drainage procedures are undertaken by using a side-viewing duodenoscope or the double-channel gastroscope.

EUS FOLLOWED BY CONVENTIONAL TRANSMURAL DRAINAGE OF PANCREATIC PSEUDOCYSTS

In all patients subjected to pseudocyst drainage, when available, it is preferable to perform EUS examinations by using a curvilinear echoendoscope. This enables aspiration of cyst fluid for analysis and performing EUS-guided drainage or marking a site for subsequent drainage by endoscopy. Marking of a site can be performed by tattooing or by any other convenient technique. The pseudocyst is first evaluated by EUS for confirmation of diagnosis, assessment of size and cyst-wall maturity, and to exclude the presence of any intervening vasculature. If required, a sample of the cyst aspirate is sent for tumor marker studies (carcinoembryonic antigen) and amylase and lipase levels. In patients with suspected infection, the aspirate may be sent for Gram staining and culture. Antibiotics are administered before the procedure for all patients.

This section will be categorized based on the following 3 presentations at endoscopy:

1. Presence of a definitive luminal compression
2. Presence of submucosal prominence but without a definitive luminal compression
3. Absence of luminal compression

Presence of definitive luminal compression

In a majority of patients (>90%) with a definitive luminal compression, after EUS, CTD of the pseudocyst can be

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successfully undertaken by EGD.[1,2] Only in patients with portal hypertension and gastric or duodenal varices will a safe site need to be identified and marked at EUS for subsequent drainage.[13]

Presence of a submucosal prominence but without a definitive luminal compression

In patients with multiple pancreatic pseudocysts, more than one luminal compression may be evident at endoscopy, and it is only the largest pseudocyst or the one that is infected that will require drainage. Also, extramural organs, eg, a distended gallbladder or spleen, can cause luminal compression and mimic a pseudocyst. In patients with severe hypoalbuminemia, the diffuse edema in the gastric mucosal layer can mask the luminal compression caused by a pseudocyst. In these patients, the area of the GI tract that is apposed to the wall of the pseudocyst is identified at EUS and marked. It is important that, after marking the site, CTD is undertaken with the patient in the same position as when he or she underwent the EUS examination. This is particularly relevant in transgastric drainage, because the site identified for puncture at EUS may not be apposed to the pseudocyst because of variation in patient positioning.[14] This is encountered when the size of the pseudocyst is intermediate (4-6 cm) or when the window of contact between the pseudocyst and the gastric wall is small. Patient positioning is not a major factor for transduodenal drainage, because the luminal compression is more obvious. Placement of a guidewire within the pseudocyst at EUS can circumvent this problem with patient positioning.

Absence of luminal compression

In patients in whom no luminal compression is evident at endoscopy, the pseudocyst is best drained under EUS guidance or by alternate treatment modalities. A luminal compression may not be evident when (a) the pseudocyst is small, (b) the pseudocyst is located in the tail of the pancreas, or (c) when the pseudocyst is situated in an atypical location, such as the right upper quadrant.[1] In these patients, marking a site at EUS may still not guarantee access to the pseudocyst. In such cases, a 0.035-inch guidewire is coiled into the pseudocyst at the time of EUS so as to guarantee definitive access for CTD. In general, the distance between the pseudocyst and the EUS transducer should be no greater than 1.5 cm. A distance greater than 1.5 cm is considered a relative contraindication because of concerns of perforation and leak.

Advantages

As stated earlier, EUS can establish an alternate diagnosis and thereby impact patient management in a subset of patients. If an endosonographer is not trained to perform therapeutic procedures, then a safe site can be identified at EUS so that CTD can be undertaken by a different endoscopist. Next, deploying 10F stents by using the curvilinear echoendoscope can sometimes be technically challenging given the small diameter of the biopsy channel (3.7 mm). In these patients, placing a guidewire at EUS will enable easier deployment of 10F stents by using a duodenoscope or a double-channel gastroscope. If the fluid collection is necrotic, then placing a guidewire at EUS will enable subsequent access for debridement when using a double-channel gastroscope. Also, because the quality of an MRCP is institution dependent, most endoscopists still prefer ERCP to assess the integrity of the main pancreatic duct before performing pseudocyst drainage. In such instances, both ERCP and CTD can be undertaken in the same setting after assessment of the pseudocyst at EUS.

Disadvantages

The need to exchange the echoendoscope for a duodenoscope or a double-channel gastroscope prolongs the procedural duration and increases patient discomfort and the need for more sedation. Also, if a guidewire had been placed at EUS for subsequent access at CTD, then there remains a potential for accidental dislodgement of the guidewire during scope exchange. In a minority of patients with intermediate-size pseudocysts (4-6 cm) in whom a luminal compression is not definitive, despite identification of a site at EUS, transgastric access to the pseudocyst may be unsuccessful at EGD if there is any variation in patient positioning.

EUS-GUIDED PSEUDOCYST DRAINAGE AS A 1-STEP PROCEDURE

When a therapeutic echoendoscope and access to fluoroscopy is available, pancreatic pseudocyst drainage can be performed as a 1-step procedure under EUS guidance. The technique is relatively straightforward but requires expertise with therapeutic maneuvers such as guidewire exchange and stent deployment. This section will review the basic techniques and keys to success for EUS-guided pseudocyst drainage. Requisite accessories for the procedure include

- An echoendoscope with a biopsy channel $\geq$ 3.7 mm
- A 19-gauge FNA needle (a lumen of 22-gauge needle does not permit 0.035-inch guidewire)
- A 0.035-inch guidewire
- 4.5F or 5F ERCP cannula or a over-the-wire needle-knife catheter
- Over-the-wire biliary-balloon dilator
- 7F or 10 F double-pigtail plastic stents

Graded dilation technique for EUS-guided drainage of pancreatic pseudocyst

The graded dilation technique for EUS-guided drainage of a pancreatic pseudocyst is shown in Video 1 (available online at www.giejournal.org). After excluding the presence of vasculature in the path of the needle by using

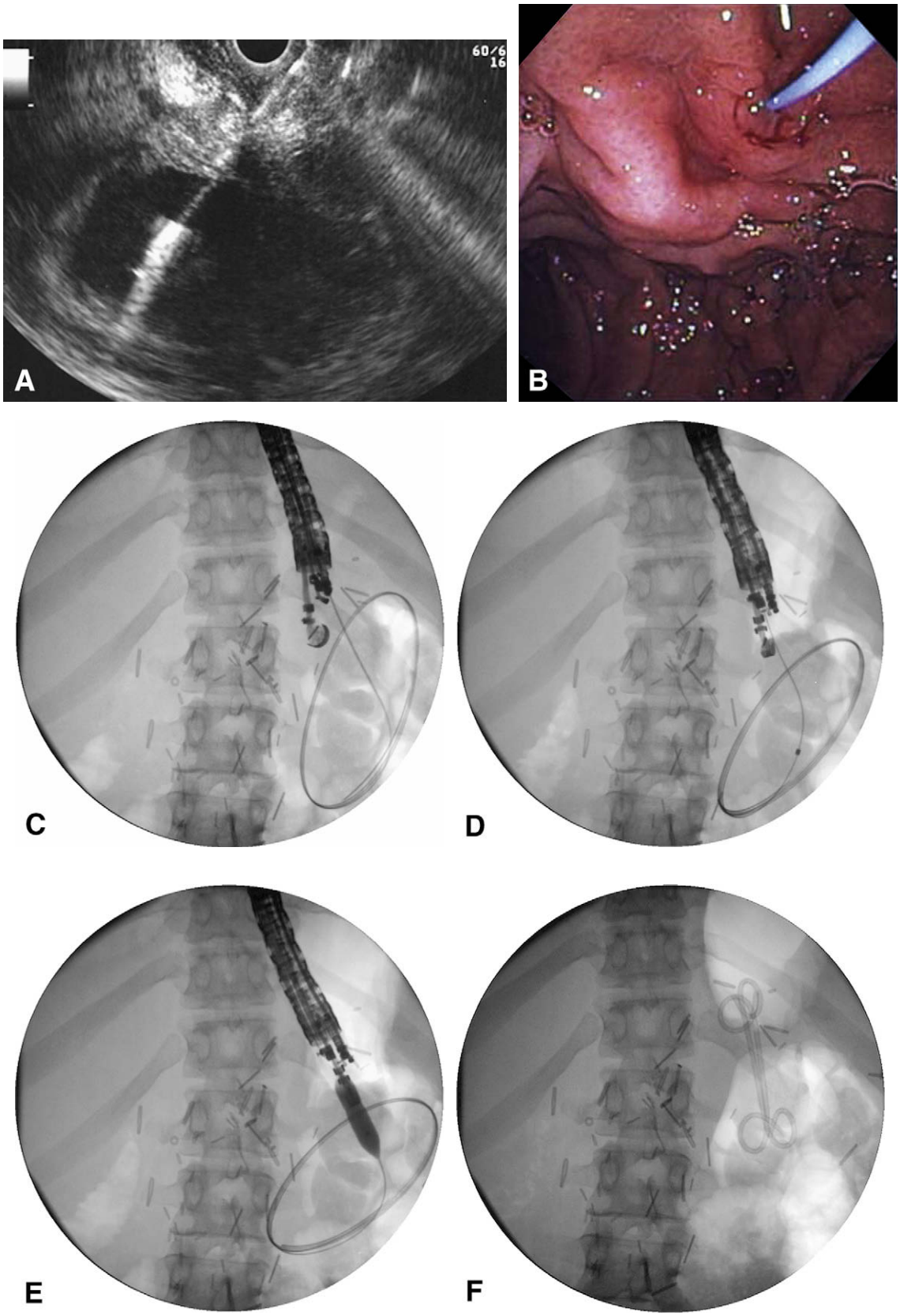

Figure 1. A, Pseudocyst accessed with a 19-gauge FNA needle. **B,** Passage of 0.035-inch guidewire into the pseudocyst; note the edematous gastric mucosa in severe hypoalbuminemia. **C,** Passage of a 0.035-inch guidewire under fluoroscopy. **D,** Passage of a 5F ERCP catheter to dilate the transmural tract. **E,** Dilation of the transmural tract with an 8-mm balloon. **F,** Placement of 2 transmural stents.

color-Doppler US, a 19-gauge FNA needle is used to puncture the pseudocyst under EUS guidance (Fig. 1A). A 0.035-inch guidewire is then introduced through the needle and coiled within the pseudocyst under fluoroscopic guidance (Fig. 1B). The tract is then sequentially dilated under fluoroscopic guidance (Fig. 1C) by first passing a 4.5F or 5F ERCP cannula over the guidewire (Fig. 1D). Further dilation is then undertaken by using a 6-mm or 8-mm over-the-wire biliary balloon dilator (Fig. 1E). After dilation, two 7F or 10F double-pigtail stents are deployed within the pseudocyst under fluoroscopic guidance (Fig. 1F). Additional stents and a 7F or 10F nasocystic drainage catheter have to be deployed in all patients with pancreatic abscess or necrosis for periodic flushing and evacuation of the cyst contents.

Technical tips

A major advantage of the graded-dilation technique is that electrocautery is not used during any step of the procedure. In the largest series reported to date on EUS-guided drainage of peripancreatic fluid collections (PFC) by using the above technique, no major complication, eg, bleeding or perforation, was encountered in any patient.[15] In patients with a thick pseudocyst wall, the ERCP cannula may ''bounce off'' if not aligned properly. It is important that the cannula be in line with the guidewire when it exits the echoendoscope so as to perpendicularly penetrate the pseudocyst (Fig. 1C and D). Once within the pseudocyst, the cannula should be withdrawn into the echoendoscope, and multiple reentry of the pseudocyst should be attempted to further dilate the transmural tract.

NEEDLE-KNIFE TECHNIQUE FOR PSEUDOCYST DRAINAGE

After coiling a guidewire within the pseudocyst by using a 19-gauge FNA needle, the transmural tract can be dilated by using electrocautery administered via an over-the-wire needle-knife catheter (rather than dilating the tract with an ERCP cannula). After access to the pseudocyst, dilation and stenting is performed as outlined above.

Technical tips

An advantage of the needle-knife technique is that it penetrates the pseudocyst wall with relative ease. The main disadvantage of the technique is that perforation has been reported as a complication in several series.[2,9,16-18] Generally, EUS is performed for pseudocyst drainage in patients without a luminal compression. Pseudocysts that do not cause a luminal compression are usually located in the pancreatic-tail region or in atypical locations, such as the right upper quadrant.[1] The location of these pseudocysts is such that they are accessed from the gastric cardia or the fundus of the stomach. When a catheter is deployed at these locations, because of the acute angulation of the echoendoscope, the needle-knife, when deployed, points tangentially, which leads to an undesirable incision. Maintaining a degree of tension over the guidewire keeps the needle-knife catheter in the plane with the guidewire as it exits the echoendoscope and can possibly minimize the risk of perforation.

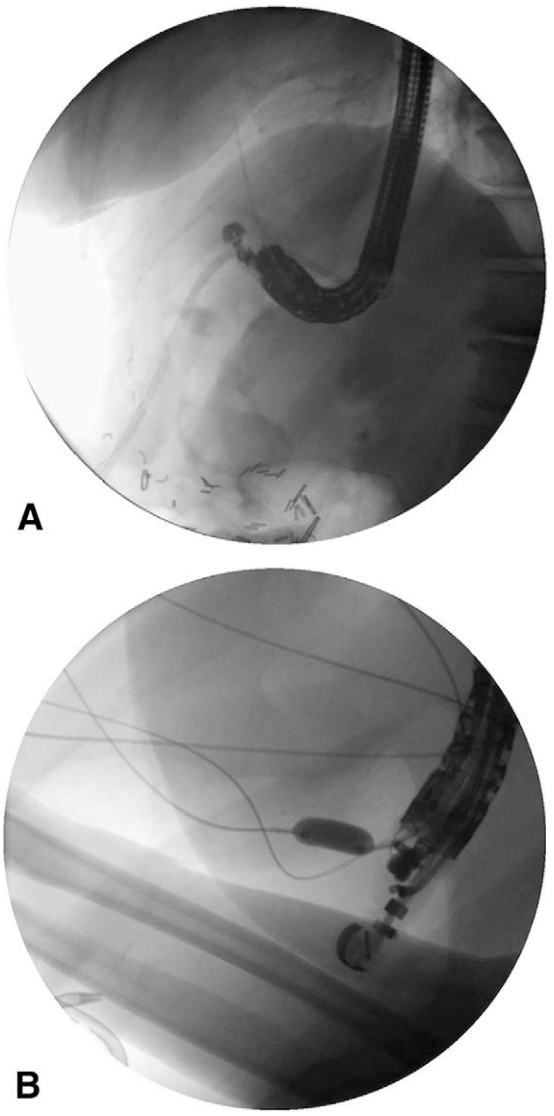

Figure 2. A, Acute angulation of the echoendoscope at drainage via the gastric fundus. A transpapillary pancreatic stent is seen in background. **B,** After guidewire passage, the tip of the echoendoscope is straightened for undertaking further endotherapy.

Keys to technical success and other considerations

Stent deployment. When performing pseudocyst drainages via the cardia or the fundus of the stomach and the duodenum, the tip of the echoendoscope is acutely angulated. Deployment of 10F transmural stents at these sites can be technically challenging, unless the

tip of the echoendoscope can be kept straightened by using fluoroscopy (Fig. 2A and B). This limitation can also be overcome by placement of multiple 7F double-pigtail stents. However, 10F stents should be preferentially deployed if a pseudocyst is infected. Unlike the duodenoscope, which has a 4.2-mm biopsy channel, the biopsy channel of most therapeutic echoendoscopes is only 3.7 mm. When deploying 10F stents, it is important not to have another 0.035-inch guidewire in the biopsy channel, because it increases the friction and makes stent deployment very difficult. Once a stent is deployed, it may be better to recannulate the pseudocyst for placement of additional stents.

Use of the small-channel curvilinear echoendoscope for pseudocyst drainage. When a therapeutic echoendoscope is not available, pseudocyst drainage can still be undertaken by using a small-channel curvilinear echoendoscope by passing a 0.035-inch guidewire into the pseudocyst via a 19-gauge FNA needle. The echoendoscope is then exchanged over the guidewire for a double-channel gastroscope or duodenoscope, and the pseudocyst drainage can be successfully completed.

Bedside EUS for pseudocyst drainage. For patients in the intensive care unit who are unstable and deemed to be too sick to be safely transported to the endoscopy unit, drainage of a PFC can be undertaken at the patient's bedside if a portable fluoroscopy machine is available. This concept was demonstrated in a recent study of 6 patients who underwent bedside EUS in the intensive care unit.[19] A pancreatic pseudocyst and mediastinal abscess were successfully drained in 2 of these 6 patients. From a convenience point of view, these procedures are easier to perform if the EUS processor is small and can be placed on the endoscopy cart.

Multiple pancreatic pseudocysts. Approximately 10% of patients have pseudocysts at multiple locations, and their management poses a clinical dilemma.[15] These patients are generally managed by surgery or percutaneous drainage. In a recent study, 6 of 60 patients with PFC had multiple fluid collections ($\geq$ 6 cm), and pancreatogram revealed a complete duct disruption in all 6 cases.[15] With EUS, 15 individual PFCs were successfully drained in these 6 patients, with a successful clinical outcome in all 3 patients with pancreatic pseudocysts. Three pseudocysts were drained at 3 different sites in each of these 3 patients. Generally, the largest pseudocyst is drained at the index procedure. A repeated procedure is warranted for drainage of other pseudocysts if a patient has persistent symptoms with noncommunicative fluid collection on follow-up imaging.

Patients with altered anatomy. In patients with postsurgical anatomy, identification of focal pathology at EUS can be technically challenging. However, EUS-guided drainage of pancreatic pseudocysts may still be technically feasible, because symptomatic pseudocysts usually tend to be large and frequently communicate or extend to other areas in the lesser sac. Reviewing a CT before the procedure will provide important information on the landmarks and the best site from which the pseudocyst can be accessed. Caution must be exercised while navigating the echoendoscope via different limbs, because the presence of adhesions can increase the risk for perforation. In a recent study that evaluated the clinical outcomes of patients undergoing EUS-guided drainage of PFCs, we were able to safely drain a pseudocyst via the Roux-en-Y limb in one patient.[15]

Management of small symptomatic pseudocysts. It is technically not feasible to place transmural stents in patients with a pseudocyst that is 4 cm or smaller in size. Therefore, symptomatic pseudocysts $\leq$4 cm in size that communicate with the main pancreatic duct are managed by transpapillary pancreatic stenting. In these patients, after pancreatic stenting, we completely aspirate the pseudocyst by EUS-guided FNA. Despite the lack of published data, it is my observation that these patients experience quick and better symptom relief.

Advantages

When the requisite accessories and technical expertise are available, EUS enables 1-step drainage of pancreatic pseudocysts, irrespective of the presence or absence of a luminal compression. Being a 1-step procedure, drainage can be undertaken in a timely manner, with minimal discomfort to the patient and less need for additional sedation. Both confirmation of diagnosis and therapy can be undertaken in the same setting. The ability to drain the pseudocyst in real time under US guidance minimizes the risk of complications. Intracystic hemorrhage is a rare but serious complication encountered during FNA of cyst lesions of the pancreas. At EUS, the bleeding manifests as a hyperechoic foci within the pseudocyst.[20] Early identification of bleeding at EUS will enable timely intervention and thereby minimize the risk for serious adverse events. At CTD, if a guidewire is accidentally dislodged after balloon dilation of the transmural tract, then it may be difficult to access the pseudocyst again, because the luminal compression may have disappeared. This is not a major problem with EUS-guided drainage, because the pseudocyst is well visualized at all times and reentry to the pseudocyst can be easily accomplished.

Disadvantages

There really is no major disadvantage to the EUS-guided pseudocyst-drainage approach. Deployment of 10F stents can sometimes be technically challenging when the tip of the echoendoscope is acutely angulated. This can be overcome by straightening the tip of the echoendoscope with the aid of fluoroscopy or by deployment of 7F stents.

TECHNICAL PROFICIENCY

Although EUS-guided pseudocyst drainages are increasingly performed, there is a need for more studies to assess

the learning curve for performing the procedure. In a recent study that evaluate 60 consecutive EUS-guided PFC drainages undertaken by one investigator, the median procedural duration decreased significantly after performing the first 25 procedures.[15] After performing 25 cases, the procedural duration was more likely to be less than 30 minutes, even after adjusting for variables such as patient age, serum albumin level, type and location of the PFC, size of the PFC, EUS access site in the GI tract, and the type of drainage modality (stent or stent plus drainage catheter placement). This improvement in technical proficiency (measured in terms of procedural duration) may be because of the following factors: (a) increased familiarity with technical maneuvers, eg, correct orientation of the echoendoscope with respect to the position of the PFC, (b) identifying an appropriate plane, ie, in line with the guidewire, for passing ERCP accessories into the PFC for graded dilation of the transmural tract, (c) the ability to choose stents of the correct caliber based on the location of the PFC, ie, 7F stents are easier to deploy (vs a 10F stent) when the scope is angulated, such as in the gastric fundus, (d) improved familiarity with the use of accessories, eg, nasocystic drainage catheters, and (e) increased experience of endoscopy personnel assisting with the procedure. A major limitation of the study was that the endoscopist had expertise in performing both EUS and ERCP, and, therefore, the findings may not be applicable to a beginner or an endosonographer without experience in therapeutic endoscopy. Nevertheless, the study demonstrates that technical proficiency improves with experience.

CONCLUSIONS

Mounting evidence suggests that EUS is the endoscopic modality of choice for transmural drainage of pancreatic pseudocysts. The procedure is technically successful in a majority of patients in whom it is attempted, and the safety profile appears excellent. Ideally, EUS-guided pseudocyst drainage should be practiced as a 1-step procedure. Preliminary data suggest that the technical proficiency improves significantly after performing 25 cases.

Abbreviations: CTD, conventional transmural drainage; PFC, peripancreatic fluid collection.

REFERENCES

1. Varadarajulu S, Wilcox CM, Tamhane A, et al. Role of EUS in drainage of peripancreatic fkuid collections not amenable for endoscopic transmural drainage. Gastrointest Endosc 2007;66:1107-19.
2. Kahaleh M, Shami VM, Conaway MR, et al. Endoscopic ultrasound drainage of pancreatic pseudocyst: a prospective comparison with conventional endoscopic drainage. Endoscopy 2006;38:355-9.
3. Monkemuller KE, Baron TH, Morgan DE. Transmural drainage of pancreatic fluid collections without electrocautery using the Seldinger technique. Gastrointest Endosc 1998;48:195-200.
4. Bejanin H, Liguory C, Ink O, et al. Endoscopic drainage of pseudocysts of the pancreas. Study of 26 cases. Gastroenterol Clin Biol 1993;17:804-10.
5. Smits ME, Rauws EA, Tytgat GN, et al. The efficacy of endoscopic treatment of pancreatic pseudocysts. Gastrointest Endosc 1995;42:202-7.
6. Sharma SS, Bhargawa N, Govil A. Endoscopic management of pancreatic pseudocyst: a long-term follow-up. Endoscopy 2002;34:203-7.
7. Kruger M, Schneider AS, Manns MP, et al. Endoscopic management of pancreatic pseudocysts or abscesses after an EUS-guided 1-step procedure for initial access. Gastrointest Endosc 2006;63:409-16.
8. Lopes CV, Pesenti C, Bories E, et al. Endoscopic-ultrasound-guided endoscopic transmural drainage of pancreatic pseudocysts and abscesses. Scand J Gastroenterol 2007;42:524-9.
9. Antillon MR, Shah RJ, Stiegmann G, et al. Single-step EUS-guided transmural drainage of simple and complicated pancreatic pseudocysts. Gastrointest Endosc 2006;63:797-803.
10. Fockens P, Johnson TG, van Dullemen HM, et al. Endosonographic imaging of pancreatic pseudocysts before endoscopic transmural drainage. Gastrointest Endosc 1997;46:412-6.
11. Norton ID, Clain JE, Wiersema MJ, et al. Utility of endoscopic ultrasonography in endoscopic drainage of pancreatic pseudocysts in selected patients. Mayo Clin Proc 2001;76:794-8.
12. Varadarajulu S, Christein JD, Tamhane A, et al. Prospective randomized trial comparing EUS and EGD for transmural drainage of pancreatic pseudocysts. Gastrointest Endosc 2008;68:1102-11.
13. Sriram PV, Kaffes AJ, Rao GV, et al. Endoscopic ultrasound-guided drainage of pancreatic pseudocysts complicated by portal hypertension or by intervening vessels. Endoscopy 2005;37:231-5.
14. Bhasin DK, Rana SS, Nagi B, et al. Movement of the pancreas associated with change of posture. JOP 2007;8:458-9.
15. Varadarajulu S, Tamhane A, Blakely J. Graded dilation technique for EUS-guided drainage of peripancreatic fluid collections: an assessment of outcomes and complications and technical proficiency (with video). Gastrointest Endosc 2008;68:656-66.
16. Azar RR, Oh YS, Janec EM, et al. Wire-guided pancreatic pseudocyst drainage by using a modified needle knife and therapeutic echoendoscope. Gastrointest Endosc 2006;63:688-92.
17. Will U, Wegener C, Graf KI, et al. Differential treatment and early outcome in the interventional endoscopic management of pancreatic pseudocysts in 27 patients. World J Gastroenterol 2006;12:4175-8.
18. Giovannini M, Pesenti CH, Rolland AL, et al. Endoscopic ultrasound guided drainage of pancreatic pseudo-cyst and pancreatic abscess using a therapeutic echoendoscope. Endoscopy 2001;33:473-7.
19. Varadarajulu S, Eloubeidi MA, Wilcox CM. The concept of bedside EUS. Gastrointest Endosc 2008;67:1180-4.
20. Varadarajulu S, Eloubeidi MA. Frequency and significance of acute intracystic hemorrhage during EUS-FNA of cystic lesions of the pancreas. Gastrointest Endosc 2004;60:631-5.

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