

Review

Endoscopic Ultrasound-guided Bilio-pancreatic Drainage

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Abstract:

The echoendoscopic biliary drainage is an option to treat obstructive jaundices when endoscopic retrograde cholangiopancreatography (ERCP) drainage fails. These procedures compose alternative methods to the side of surgery and percutaneous transhepatic biliary drainage, and it was only possible by the continuous development and improvement of echoendoscopes and accessories. The development of linear sectorial array echoendoscopes in early 1990 brought a new approach to diagnostic and therapeutic dimension on echoendoscopy capabilities, opening the possibility to perform puncture over direct ultrasonographic view. Despite of the high success rate and low morbidity of biliary drainage obtained by ERCP, difficulty could be found at the presence of stent tumor ingrown, tumor gut compression, periampullary diverticula and anatomic variation. The echoendoscopic technique starts performing puncture and contrast of the left biliary tree. When performed from gastric wall, the access is made through hepatic segment III. From duodenum, direct common bile duct puncture. Diathermic dilatation of the puncturing tract is required using a 6-Fr cystostome and a plastic or metal stent is introduced. The technical success of hepaticogastrostomy is near 98%, and complications are present in 20%: pneumoperitoneum, choleperitoneum, infection and stent disfunction. To prevent bile leakage, we have used the 2-stent techniques. The first stent introduced was a long uncovered metal stent (8 or 10 cm) and inside this first stent a second fully covered stent of 6 cm was delivered to bridge the bile duct and the stomach. Choledochoduodenostomy overall success rate is 92%, and described complications include, in frequency order, pneumoperitoneum and focal bile peritonitis, present in 14%. By the last 10 years, the technique was especially performed in reference centers, by ERCP experienced groups, and this seems to be a general guideline to safer procedure execution. The ideal approach for pancreatic pseudo-cyst (PPC) puncture combines endoscopy with real time endosonography using an interventional echoendoscope. Several authors have described the use of endoscopic ultrasound (EUS) longitudinal scanners for guidance of transmural puncture and drainage procedures. The same technique could be used to access a dilated pancreatic duct in cases in which the duct cannot be drained by conventional ERCP because of complete obstruction.

Keywords: endoscopic ultrasound; biliary drainage

ENDOSCOPIC ULTRASOUND-GUIDED BILIARY DRAINAGE

Introduction

Endoscopic biliary stenting is the most common method to treat obstructive jaundice. In 3%-12% of cases selective cannulation of the major papilla failed and surgery or percutaneous biliary drainage are required. Percutaneous drainage needed dilated intrahepatic biliary ducts and the rate of complications reached 25%-30% of cases including peritoneal bleeding. A new technique of biliary drainage using endoscopic ultrasound (EUS) and EUS-guided

puncture of the bile duct (common bile duct or left hepatic duct) is now possible.

Using EUS guidance and dedicated accessories is now possible to create bilio-digestive anastomosis. The aim of this paper is to (1) describe the material needed for such procedures, (2) describe the technique of biliary drainage under EUS guidance, and (3) describe the place of these techniques today in comparison with endoscopic retrograde cholangiopancreatography (ERCP).

Material

Interventional echoendoscopes

Around 1990, the Pentax-Corporation developed an electronic convex curved linear array echoendoscope (FG32UA) with an imaging plane in the long axis of the device that overlaps with the instrumentation plane. This echoendoscope, equipped with a 2.0-mm working channel,

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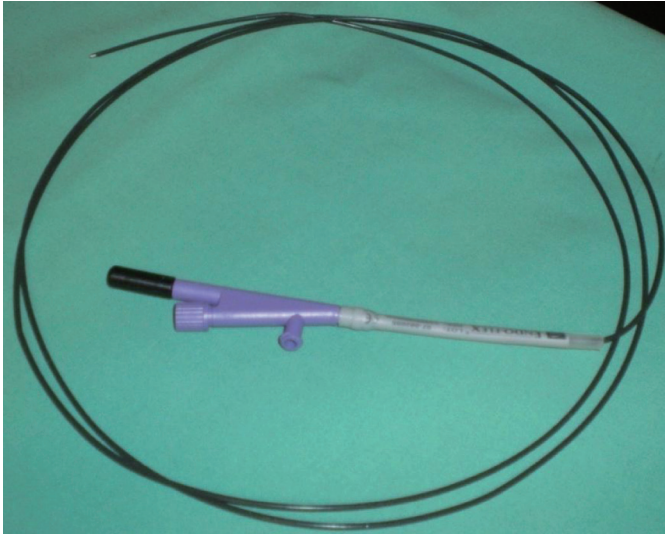


Figure 1. 6-Fr cystostome (Endoflex company).

enabled fine-needle biopsy under EUS guidance. However, the relatively small working channel of the FG32UA was a drawback for pseudocyst drainage since it necessitated the exchange of the echoendoscope for a therapeutic duodenoscope to insert either a stent or nasocystic drain. To enable stent placement using an echoendoscope, the EUS interventional echoendoscopes were developed by different companies which allows the insertion of a 10-Fr stent^{1,2}.

Needles and accessories for drainage

Some authors have used needle knife catheters, but the needle can be difficult to visualize endosonographically. The “Zimmon” needle-knife has a large gauge needle that is easier to visualize. Diathermy is usually required to penetrate the cyst³⁻⁵ (Fig. 1).

In standard endosonography fine needle aspiration (FNA), the needle is well visualized sonographically and can be used for pseudocyst puncture. The drawback of this needle is the small caliber (22 or 23-G) that will accept only a 0.018-inch guide wire. Using a 19-G FNA needle, a 0.035-inch guide wire can be inserted through the needle into the dilated bile duct. Wilson Cook Corporation has recently developed a “new access needle”; However, one of the main problems during these new techniques of hepatico-gastrostomy, is the difficulty manipulating the wire guide through the 19-G EUS needle. The main trouble was the “stripping” of the coating of the wire, which in turn created a risk of leaving a part of the wire coating in the patient and also the impossibility to continue the procedure and to insert the stent.¹

To solve this problem, we worked with Cook Medical to design a special needle called the EchoTip[®] Access Needle*. This needle is original because the stylet is sharp and it is relatively easy to insert the needle into the bile duct or the pancreatic duct or a pseudocyst. When the stylet is withdrawn, the needle left in place is smooth and the

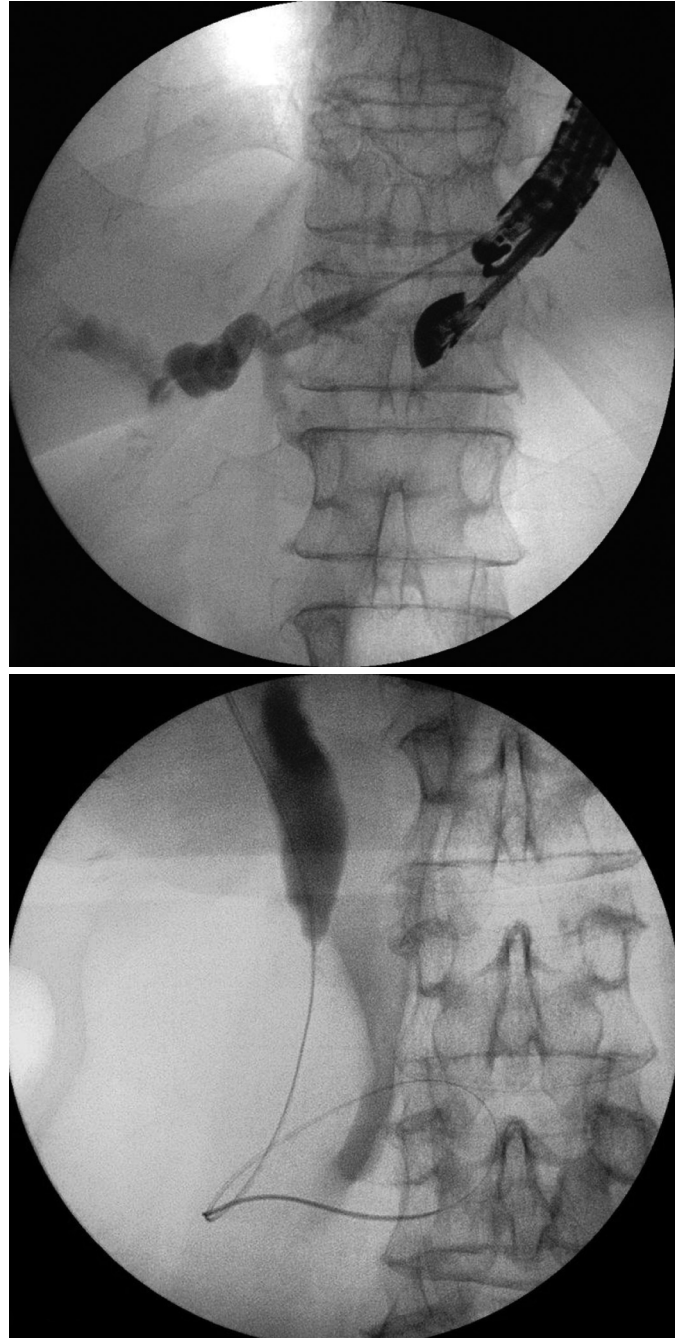


Figure 2. Rendez-vous technique using endoscopic ultrasound-guidance.

manipulation of the wire guide is easy and the device is designed to decrease the possibility of the wire stripping.

EUS-guided rendez-vous technique (Fig. 2)

After puncture of the left hepatic biliary system (see above) using a 19-G needle allowing using contrast-medium to obtain a cholangiogram, a 0.035-inch hydrophilic guide wire was inserted into the biliary duct and then rolled up inside the duodenum. Then, echoendoscope was gently withdrawn

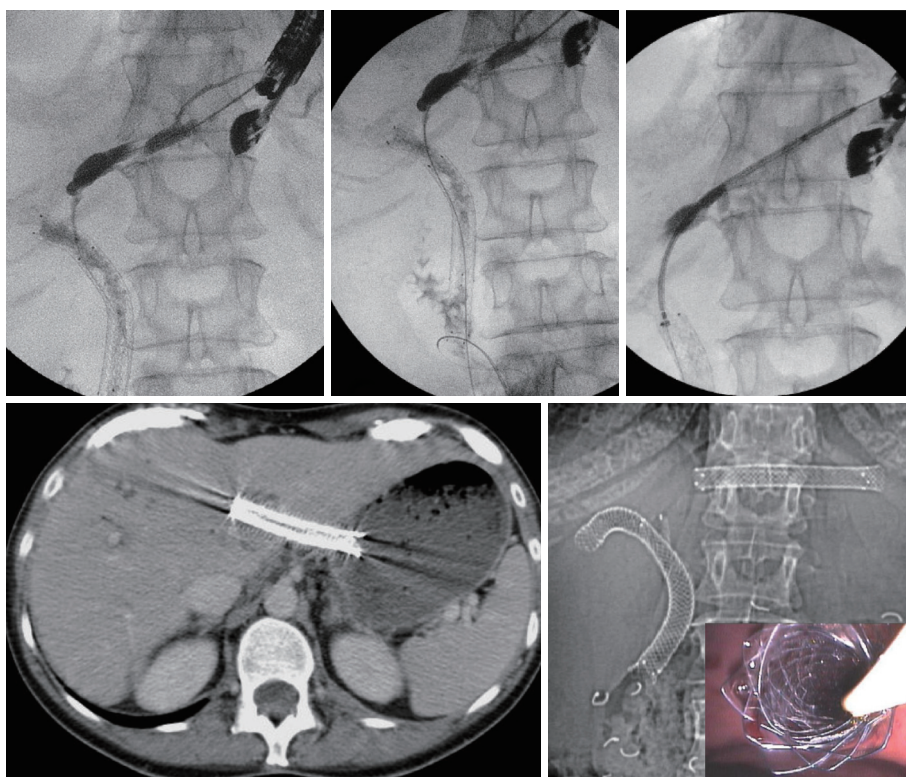


Figure 3. Hepatico-gastrostomy performed after endoscopic retrograde cholangiopancreatography failed to drain the left hepatic lobe in patient with a Klatskin Tumor.

leaving the guidewire in place. Afterwards, a duodenoscope was inserted in parallel of the guidewire and placed in the third duodenum, allowing retrograde approach. Guidewire was then caught with standard snare through the working channel and after over-the-wire biliary sphincteromy, stones removal or stent placement could be achieved as usually.

EUS-choledoco-duodenostomy

A 19-G needle is inserted trans-duodenally into the bile duct under EUS guidance. Bile is aspirated and contrast medium is injected into the bile duct for cholangiography. A 450-cm long, 0.035-inch guide wire is inserted through the 19-G needle into the bile duct. The choledochoduodenal fistula is dilated using a biliary catheter for dilation, or a 6-Fr cystostome. A 7-Fr to 10-Fr biliary plastic stent or a covered self-expandable metal stent (SEMS) is placed through the choledochoduodenostomy site into the extrahepatic bile duct.

Technique of left hepatico-gastrostomy under EUS guidance (HGE) (Fig. 3)

EUS-guided hepatico-gastrostomy was first reported by Burmester *et al.*⁶ in 2003. The technique is also basically similar to EUS-guided drainage of pancreatic pseudocysts. By using an interventional echoendoscope, the dilated left hepatic duct (segment III) was well visualized. HGE was then performed under combined fluoroscopic and ultrasound guidance, with the tip of the echoendoscope positioned such that the inflated balloon was in the middle part of the small curvature of the stomach. A needle (19-G access needle) was inserted transgastrically into the distal part of the left hepatic

duct and contrast medium was injected. Opacification demonstrated a dilated biliary ducts to the complete obstruction. The needle was exchanged over a guidewire for a 6.5-Fr diathermic sheath, which was then used to enlarge the channel between the stomach and the left hepatic duct. The sheath was introduced by using cutting current. After exchange over a guidewire (TFE-coated 0.035-inch), a 8.5-Fr, 8-cm-length hepatico-gastric stent) or a covered metal expandable stent was positioned.⁷⁻⁹ As observed by fluoroscopy, contrast emptied from the stent into the stomach. To prevent bile leakage you can leave through the metal stent a 6- or 7-Fr naso-biliary drain in aspiration during 48 h. More recently we decided to combine an uncovered stent and a covered stent inserted into. To reduce the risk of bile leakage, we have inserted 2 metal stents named stent-in-stent technique. A first uncovered metal stent of 8- or 10-cm length was inserted to prevent migration and the occlusion of side biliary branches and in the second time a fully covered stent of 6-cm length was inserted in the uncovered to prevent the bile leakage. Using this technique, we have reduced dramatically the risk of bile leakage in our experience. Among these, hepatico-gastrostomy was sometimes combined with placement of an additional metal stent bridging the distal stricture.

Place of the bilio-digestive anastomosis guided by EUS in comparison with ERCP

ERCP is the gold standard technique for the drainage of an obstructive jaundice due to a pancreatic cancer. Success rate of biliary stenting using ERCP is around 80%-85%

Table 1. Summary of the published literature on EUS-guided biliary drainage (HGE, CD, and rendez-vous technique)

First author, year	n	Device for puncture	Technical success, n	Clinical success, n	Initial Stent		Early complications (n)
					Fr (pl)	SEMS, mm	
EUS-GUIDED CHOLEDOCHODUODENOSTOMY							
Giovannini, 2001 ⁵	1	NK	1/1	1/1	10	-	None
Burmester, 2003 ⁶	2	19G FT	1/2	1/1	8.5	-	Bile peritonitis (1)
Puspok, 2005 ¹³	5	NK	4/5	4/4	7-10	-	None
Kahaleh, 2006 ⁸	1	19G FN	1/1	1/1		10	Pneumo (1)
Yamao, 2008 ¹⁶	5	NK	5/5	5/5	7-8.5	-	Pneumo (1)
Ang, 2007 ¹⁸	2	NK	2/2	2/2	7	-	Pneumo (1)
Fujita, 2007 ¹⁹	1	19 G FN	1/1	1/1	7	-	None
Tarantino, 2008 ²⁰	4	19G, 22G FN/NK	4/4	4/4	-*	-	None
Itoi, 2008 ²¹	4	NK (2), 19 G FN (2)	4/4	4/4	7, NBD	-	Bile peritonitis (1)
Horaguchi 2009 ²⁰	8	19G	8/8	8/8	7	-	Peritonitis (1)
Hanada, 2009 ²²	4	19G FN	4/4	4/4	6-7	-	None
Park, 2009 ⁹	4	19G FN/NK	4/4	4/4	-	10	None
Brauer, 2009 ¹⁶	3	19G, 22G FN/NK	2/3	2/2	10	-	Pneumo Cardiac failure
Maranki 2009 ¹⁸	4	19G 22G		δ	10	10	δ
Artifon 2010 ²⁶	3	19G	3/3	3/3	-	10	None
Eum, 2010 ¹⁹	2	19G	2/2	2/2	-	10	None
Hara, 2011 ²⁷	18	22G	17/18	17/17	7-8.5	-	Focal peritonitis (2) Hemobilia (1)
Ramírez-Luna, 2011 ²⁸	9	19G	9/9	8/9	7-10	-	Biloma (1)
Park, 2011 ²⁹	24	19G	22/24	20/22	7	10	Pneumo (7), bile peritonitis (2), Bleeding (2). γ
EUS-GUIDED HEPATICOGASTROSTOMY							
Burmester, 2003 ⁶	1	19G FT	1/1	1/1	8.5		None
Kahakeh, 2006 ⁸	2	19G, 22G FN	2/2	2/2	10		None
Artifon, 2007 ²⁴	1	19G FN	1/1	1/1	-	10	None
Bories, 2007 ¹¹	11	19G, 22G FN/CT	10/11	10/10	7	10	Cholangitis (2), ileus (1), biloma (1)
Will, 2007 ¹⁴	4	19G FN	4/4	3/4	-	10	Cholangitis (1)
Chopin-Laly, 2008 ²²	1	-	1/1	1/1	-	-*	None
Park, 2009 ⁹	9	19G FN/NK	9/9	9/9		10	None
Horaguchi, 2009 ²⁰	6	19G	6/6	5/6	7	-	None
Maranki, 2009 ¹⁸	3	19G 22G	3	δ	10	10	δ
Park, 2010 ¹²	5	19G	5/5	5/5	-	10	None
Martins, 2010 ²⁴	1	19G	1/1	0/1	-		Death (1)
Eum, 2010 ¹⁹	1	19G	1/1	1/1	-	10	None
Artifon, 2011 ³⁰	1	19G	1/1	1/1	-	10	None
Ramírez-Luna, 2011 ²⁸	2	19G	2/2	2/2	7	-	Stent migration (1)
Park, 2011 ²⁹	17	19G	17/17	13/17	7	10	Pneumo (4), Bleeding (2)
EUS-GUIDED RENDEZ-VOUS							
Will, 2007 ¹⁷	1	19G FN	-	-	-	-	-
Maranki, 2009 ¹⁸	32	19G 2G	-	δ	10	10	δ

HGE: hepatico-gastrostomy; CD: choledoco-duodenostomy; NK: needle knife; FT: fistulotome; FN: fine needle; SEMS: self expanding metal stent; NBD: nasobiliary drainage; CT: cystotome. *Unspecified; ^δData are presented as a intrahepatic *vs* extrahepatic approach (these included HG, CD, and rendez-vous technique). We cannot obtained the row data.

but sometime ERCP failed to cannulate selectively the papilla or failed to reach the papilla in case of duodenal obstruction. Actually, the percutaneous procedure is the accepted alternative but these new techniques of biliary drainage using EUS guidance could be an alternative. Percutaneous techniques of biliary drainage have a high rate of complication as bleeding, or peritoneal bile leakage (20%-30%) and the morbidity and the mortality of surgery for such palliative procedures are 35%-50% and 10%-15% respectively.

To date, 202 patients with EUS-guided bile duct drainage (EUS-common bile duct drainage = 104; EUS-hepaticogastrostomy = 65, and rendez-vous = 33) have been reported in 26 studies (Tab. 1). A 19- or 22-G fine needle followed by needle knife or cystotome were used for puncturing intrahepatic bile ducts in all of the patients.

Choledoco-duodenal

Patients undergone this technique have a high technical success (98/104 = 94.2%) and clinical success (95/98 = 97%). The rate of complications was 15/104 (14.4%). Any of the patients with complications, according to the obtained data needed invasive treatment.

Hepatico-gastrostomy

Hepatico-gastrostomy was successful in all but one case (98.5%). Various types of stents, including plastic stents, uncovered SEMS, and covered SEMS were used for the drainage. Once the stents were placed, all but five patients (91.6%) had successful resolution of obstructive jaundice. The rate of procedure-related early complications was 20% (13 cases); only 6 patients had complications that need a medical treatment (cholangitis = 4; and bleeding = 2) with one death. Stent migration has been reported as a late complication in two cases.

Kahaleh *et al.* described the advantages of EUS-guided hepaticogastrostomy vs percutaneous transhepatic drainage as: (1) less risk of bleeding by the use of colour doppler to void the puncture of vessels interposed between the gastric wall and the liver, (2) eliminated the presence of small amount of ascitis increasing the risk of bile leakage and choleperitoneum, and (3) difficulty of puncture in case of liver cirrhosis 4-risk of injuring the portal vein.¹⁰

From a clinical standpoint, the most relevant technical choice appears to be the type of stent. It is difficult to draw significant conclusions from the published reports, since no formal comparisons have been made between the different kind of stents. Covered (total or partially) SEMS appears to be a better option for three reasons. Firstly, upon full expansion SEMS effectively seal the puncture/dilation tract, which would in theory prevent leakage. Secondly, their larger diameter provides better long-term patency, which would decrease the need for stent revisions. Finally, if dysfunction by ingrowth or clogging occurs, management is somewhat less challenging than with plastic stents, since a

new stent (plastic or SEMS) can easily be inserted through the occluded SEMS in place. In contrast, exchanging a clogged plastic transmural stent usually requires over-the-wire replacement, because free-hand removal involves the risk of track disruption with subsequent guidewire passage into the peritoneum, hence requiring repeat EUS-guided biliary puncture if drainage is to be re-established.¹⁵ Uncovered SEMS could allow the leak of bile to peritoneum and possible biloma formation. These presumed advantages of covered SEMS must be balanced against the fact that transmural SEMS insertion and deployment are somewhat more demanding than they are at ERCP. In particular, the serious risk of foreshortening and bile peritonitis should be prevented with careful attention to detail.²³⁻²⁵

We reported recently our experience²⁸ on [$F = 3$, mean age 58 (range 20-84) years] prospective cases of EUS-guided cholangio-drainage in patients with end-stage bilio-pancreatic cancer and biliary tract obstruction. Other available drainage methods (ERCP and/or percutaneous biliary drainage) of the biliary tract were attempted without success before the EUS. Technical success was in 10/11 (91%) patients and clinical success in 9/10 (90%) patients; bilirubin decreased more than 50% in 7/11 patients (63.6%); one patient had a complication that needed a re-intervention and one patient was complicated with biloma. No mortality directly related to the procedure was documented.

Conclusion

EUS-guided biliary management is useful in case of failure of ERCP with a high rate of technical success and clinical efficacy. The morbidity rate is high during biliary drainage requiring experienced team. In summary, EUS-guided biliary procedure opens a new way to achieve biliary drainage, complementary to percutaneous approach. The morbidity rate is still elevated and further technical improvement is mandatory to reduce the number of adverse events.

EUS-GUIDED PANCREATIC DRAINAGE

Introduction

The management of pancreatic pseudocysts (PPCs) has traditionally been surgical. Although highly effective, surgery may be associated with a complication rate of 35% and a mortality of 10%. This has encouraged the development of nonsurgical approaches. Percutaneous puncture and aspiration under ultrasonography or computed tomography (CT) guidance has been used, but aspiration alone has been found to be ineffective due to high recurrence rates of up to 71%. Continuous percutaneous drainage with indwelling catheters reduces the relapse rates, but may be associated with a complication rate ranging from 5%-60%. Complications include fistula formation, infection and bleeding.

Endoscopic transmural drainage of PPCs is an alternative nonsurgical approach. Since the first reports by Sahel *et al.*³¹ and Cremer *et al.*³², endoscopic drainage of PPCs has become

established. This entails the creation of a fistulous tract between the PPC and the gastric lumen (cystogastrostomy) or duodenal lumen (cystoduodenostomy). Having established endoscopic access to the PPC, a nasocystic catheter or a stent can be placed for continuous drainage. The obvious limitation of endoscopic transmural drainage of PPCs was its relatively “blind” approach. The risk of perforation is particularly high when endoscopically visible intraluminal bulging was absent. A major risk of endoscopic cystoduodenostomy or cystogastrostomy is haemorrhage (6% of cases).^{31,32} The ideal approach for PPC puncture combines endoscopy with real-time endosonography using an interventional echoendoscope. Several authors have described the use of EUS longitudinal scanners for guidance of transmural puncture³³⁻³⁵ and drainage procedures. The same technique could be used to access a dilated pancreatic duct in cases in which the duct cannot be drained by conventional ERCP because of complete obstruction.

EUS-guided drainage of PPCs

Indications

PPCs are reported to complicate between 10% and 20% of patients with acute and chronic pancreatitis. The majority of these PPCs are asymptomatic and do not require treatment. Spontaneous regression of PPCs is reported to occur in 7%-60%. The indication for PPC drainage will differ depending on whether the cyst develops in the setting of acute or chronic pancreatitis. For PPCs that complicate acute pancreatitis, drainage is indicated when pancreatitis fails to be resolved with conservative measures. PPCs that are not associated with persistent pancreatitis should be observed, as there is a high probability of spontaneous resolution. A 6-week observation period is generally recommended before considering decompression. Spontaneous regression after persistence of more than 6 weeks is considered by some to be unlikely. But actually, this cut-off time of 6 weeks is heavily doubted in the literature now and large pseudocyst (>4 cm of size) should be treated.³¹⁻³³

For PPCs complicating chronic pancreatitis, drainage is indicated to relieve symptoms associated with a space-occupying mass, including neighbouring organ compression. Such patients have chronic cysts that remain unchanged over a period of months. Patients typically complain of a dull and constant pain and may develop symptoms of gastric outlet obstruction or jaundice from bile duct compression.

Multiple or multiloculated PPCs sometimes cannot be adequately treated by an endoscopic approach and warrant surgical resection. It should be remembered that an endoscopic approach contaminates the cyst and risks infection if the contents of the PPCs cannot be completely drained.

Is EUS necessary?

Main question is: what's the best route to drain PPCs? To

try to obtain a response, Kahaleh *et al.*³⁶ have reported a prospective comparative study on the 2 techniques. A total of 99 consecutive patients underwent endoscopic management of pancreatic pseudocysts according to this predetermined treatment algorithm: patients with bulging lesions but without obvious portal hypertension underwent a transmural drainage; all remaining patients underwent EUS-guided drainage. Patients were followed prospectively, with cross-sectional imaging during clinic visits. The authors compared short-term and long-term results (effectiveness and complications) at 1 and 6 months post procedure. Forty-six patients (37 men) underwent EUS drainage and 53 patients (39 men) had endoscopic transmural drainage. There were no significant differences between the two groups regarding short-term success (93% *vs.* 94%) or long-term success (84% *vs.* 91%); 68 of the 99 patients completed 6 months of follow-up. Complications occurred in 19% of EUS *vs.* 18% of endoscopic patients, and consisted of bleeding in three, infection of the collection in eight, stent migration into the pseudocyst in three, and pneumoperitoneum in five. All complications but one could be managed conservatively. No clear differences in efficacy or safety were observed between conventional and EUS-guided cystenterostomy. The choice of technique is likely best predicted by individual patient presentation and local expertise.

From the technical point of view, the EUS-guided approach has two crucial steps. The first is the identification of an optimal point to puncture without intervening vessels and with a short distance between the cyst and the gut wall. Once this point is identified, the endoscope should be straightened as much as possible in a stable position.³⁵ The second critical step is that once the puncture has been performed and the guide wire is curled inside the cyst cavity, the wall dilator must be introduced without losing the endoscope position and under ultrasonographic view. Once the dilator has been inserted through the parietal fistula, the ultrasonographic view is no longer needed, and the dilation and stent insertion can be made under endoscopic view.³⁶⁻³⁹

More recently, Varadarajulu *et al.*³⁸ reported a randomized study to compare the rate of technical success between EUS and esophagogastroduodenoscopy (EGD) for transmural drainage of pancreatic pseudocysts. A total of 30 patients were randomized to undergo pseudocyst drainage by EUS ($n = 15$) or EGD ($n = 15$) over a 6-month period. Except for their sex, there was no difference in patient or clinical characteristics between the 2 cohorts. Although all the patients ($n = 14$) randomized to an EUS underwent successful drainage (100%), the procedure was technically successful in only 5 of 15 patients (33%) randomized to an EGD ($P < 0.001$). All 10 patients who failed drainage by EGD underwent successful drainage of the pseudocyst on a crossover to EUS. There was no significant difference in the rates of treatment success between EUS and EGD after stenting, either by intention-to-treat (ITT) analysis (100%

vs. 87%; $P = 0.48$) or as-treated analysis (95.8% *vs.* 80%; $P = 0.32$). Major procedure-related bleeding was encountered in 2 patients in whom drainage by EGD was attempted; one resulted in death and the other necessitated a blood transfusion. No significant difference was observed between EUS and EGD with regard to complications either by ITT (0% *vs.* 13%; $P = 0.48$) or as-treated analyses (4% *vs.* 20%; $P = 0.32$). Technical success was significantly greater for EUS than EGD, even after adjusting for luminal compression and sex (adjusted exact odds ratio 39.4; $P = 0.001$). The author concluded when available, EUS should be considered as the first-line treatment modality for endoscopic drainage of pancreatic pseudocysts given its high technical success rate.

Recently, a large study on EUS-guided PPC drainage showed a low rate of complication.⁴⁰ Of 148 patients who underwent EUS, perforation was encountered at the site of transmural stenting in 2 (1.3%, 95% CI: 0.41-4.76) patients with a PPC in the uncinata. Other complications included bleeding in 1 (0.67%, 95% CI: 0.16, 3.68), stent migration in 1 (0.67%, 95% CI: 0.16, 3.68) and infection in 4 (2.7%, 95% CI: 1.09, 6.73) patients. Bleeding occurred in 1 patient with underlying acquired factor VIII inhibitors, stent migration in 1 patient who underwent drainage via the gastric cardia, and infection in 2 patients with pseudocysts and 2 with necrosis. While 2 patients who developed post-procedural infection and 1 with stent migration were managed endoscopically, both perforations required surgery. Surgical debridement was performed in 2 patients who developed infection with successful outcomes in one and death from underlying comorbidity in another.

In addition to its safety and therapeutic success rate, EUS also allows a diagnostic evaluation of the pancreatic cystic lesions. Thus, based on the EUS findings, the management plan is changed in 5%-9% of patients since EUS identifies other cystic lesions misdiagnosed as pseudocysts.⁴¹⁻⁴³

Which technique and accessories are best ?

EUS guided PPC drainage should be performed under propofol anesthesia with a tracheal intubation to avoid regurgitation in the fluoroscopy suite with the patient in the left lateral or prone position. The patient should receive broad spectrum antibiotics during and after the procedure to reduce the risk of PPC infection. CT scan should be performed immediately before the intervention. It more easily than an endoscopic procedure gives information about important anatomical details (e.g., varices, arterial pseudoaneurysms, multiple cysts or extended necrosis, ascitis, large or atypically located gall bladder, pleural effusion).

The individual steps are delineated below (Fig. 4): 1) Locate the cyst and the contact zone between the gastric or duodenal wall and the cyst wall; 2) Doppler assessment of the stomach or duodenal wall for interposed vessels. Doppler ultrasound is now mandatory prior to cyst drainage; 3) Having determined the optimal site

for puncture, the PPC is punctured using a 19-G FNA needle or the new access 19-G needle which prevent to damage the Teflon part of the 0.035-inch guide wire. A sample of the cyst contents is aspirated and submitted for biochemical, cytological, and tumor marker (e.g., CEA) analysis. If infection is suspected, a sample should be sent for gram stain, culture and sensitivity; 4) Contrast filling of the PPC is performed under fluoroscopy to document the size and anatomical boundaries of the cyst. Communication of the cyst with the pancreatic duct may be seen. Filling of the cyst can also be verified by EUS seen as a visible streamline effect; and 5) The tract is dilated using a 8-mm balloon over the wire or the 8.5- or 10-Fr cystostome. The main advantage of the cystostome is to create a large cysto-enterostomy due to the diffusion of the cautery at the level of the puncturing tract; 6) A chronic cyst with clear liquid contents can be drained with two 7- or 8.5-Fr double pig tail stents. An infected cyst mandates irrigation by nasocystic catheter or two 10-Fr double pig tail stents and a nasocystic drainage can be placed. The nasocystic catheter can be removed 2 or 3 days after a CT examination showing a resolution of the PPC. Pancreatic cysts complicating necrotizing pancreatitis can be managed endoscopically, but require aggressive irrigation and drainage over an extended period time. Pancreatogram is not necessary, but a pancreatic magnetic resonance imaging (MRI) should be obtained before to remove the stents to know if a pancreatic stenosis is present or not. If a pancreatic stenosis is diagnosed, it will be treated endoscopically.

Another technique of EUS-guided PPC drainage has been reported, it's a "one step drainage". Using the Needle-Wire Oasis system (NWOA, Cook corporation), this accessory associated in one device a needle-knife, a catheter dilatator of 6.5-Fr and a straight plastic stent of 8.5- or 10-Fr. For performance of this technique there is a commercially available device for use with large-channel echoendoscopes without the need for any exchanges, using the Needle-Wire Oasis System. This is an all-in-one stent introduction system, containing a 0.035-inch needle wire suitable for cutting current, 5.5-Fr guiding catheter and a pushing catheter with a back-loaded straight stent (8.5- or 10-Fr, 6-cm length). This procedure can be performed with the patient under conscious sedation by using standard monitoring in the left lateral position. Intravenous broad-spectrum antibiotics must be used before and after the procedure. The optimal location for carrying out the procedure is the fluoroscopy suite, since in some cases the radiologic view can be helpful either for insertion of the stent at a better angle or for completing the drainage with cyst irrigation and/or additional stent placement.

First thing to do is to locate the cyst with the linear array echoendoscope, looking for an optimal contact with the gastric or duodenal wall. Doppler assessment is included to eliminate interposition of large vessels. The needle-wire is

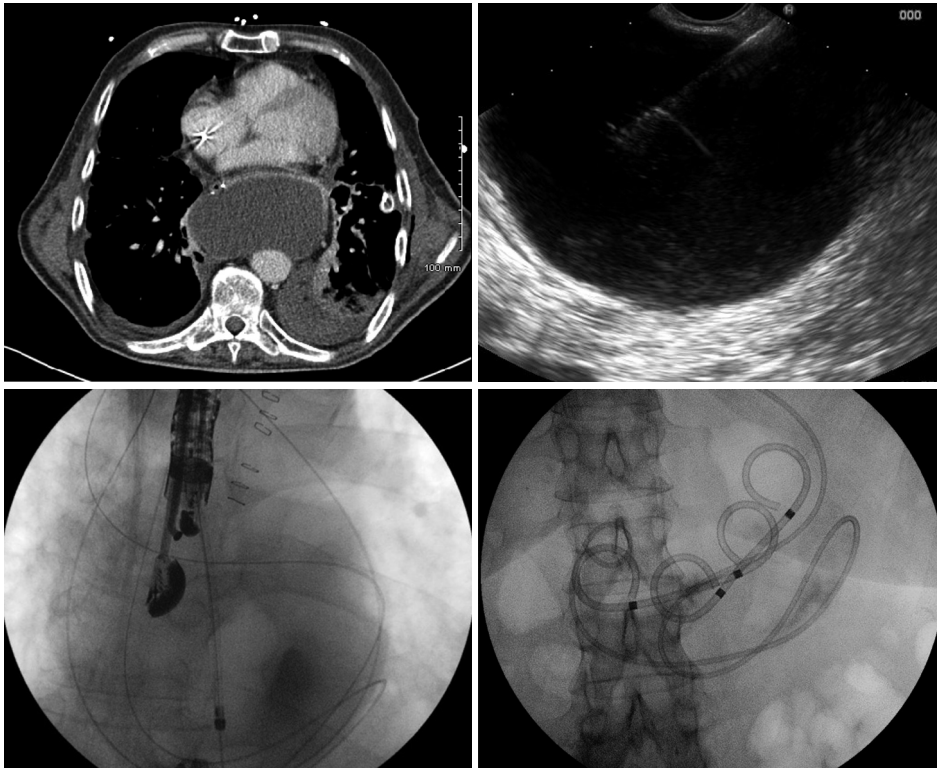


Figure 4. EUS-guided PPC drainage using a 10-Fr cystostome allowing the insertion of 2 plastic double pig tail stents of 8.5-Fr and a naso-cystic drain.

then introduced into the intestinal wall and the cyst wall is penetrated under continuous pressure and cutting current. Once inside the cyst, the internal rigid part of the needle-wire is removed and it becomes a soft wire that can be easily inserted into the cyst followed by the dilator catheter and finally the straight plastic endoprosthesis under endoscopic and ultrasound monitoring.

The single step technique was first described in 1998 by Vilmann *et al.*⁴⁴ and Giovannini *et al.*⁴⁵ In a prospective study, Kruger and co-workers⁴⁶ evaluated the one-step device for drainage of pancreatic pseudocysts and abscesses. Endoscopic stent placement was successful in 33 of 35 patients (94%), whereas repeated needle passages were unsuccessful in 2 cases. No procedure-related complications, such as bleeding, perforation, or pneumoperitoneum, were observed. All subsequent complications, such as ineffective drainage (9%), stent occlusion (12%), or cyst infection (12%), were managed endoscopically. The overall resolution rate was 88%, with a recurrence rate of 12%, during a mean follow-up period of 24 months. The author concluded that the one-step EUS-guided technique with a needle-wire device provides safe transmural access and allows effective subsequent endoscopic management of pancreatic pseudocysts and abscesses.

Clinical Algorithm

In summary, EUS-guided pancreatic pseudocyst drainage improves the safety of pancreatic pseudocyst endoscopic drainage and increases the number of patients suitable for this procedure by avoiding percutaneous and surgical

drainage which are associated with a higher morbidity and mortality. Therefore the EUS-guided procedure seems to be the best and safest technique for transmural endoscopic pseudocyst drainage, and it should be considered the first choice option (Fig. 5).

EUS-GUIDED PANCREATICO-GASTROSTOMY (EPG)

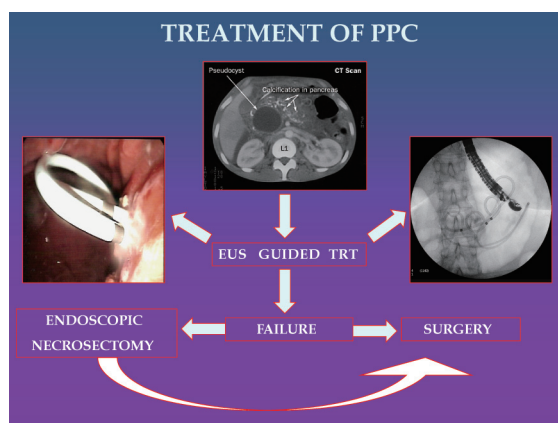
Indications

The pain associated with chronic pancreatitis (CP) is caused, at least in part, by ductal hypertension. Both surgical and endoscopic treatments can relieve pain by improving ductal drainage. Endoscopic drainage requires transpapillary access to the pancreatic duct during ERCP.

The development of interventional EUS has provided better access to the region of the pancreas. Just as pancreatic fluid collections, such as pseudocysts, can be successfully drained from the stomach or duodenum by endoscopic cystenterostomy or cystgastrostomy, the same technique could be used to access a dilated pancreatic duct in cases in which the duct cannot be drained by conventional ERCP because of complete obstruction. Main indications are stenosis of pancreatico-jejunal or pancreatico-gastric anastomosis after Whipple resection which induces recurrent acute pancreatitis, main pancreatic duct (MPD) stenosis due to chronic pancreatitis, post-acute pancreatitis or post pancreatic trauma after failure of ERCP. EUS-guided pancreatico-gastro- or bulbostomy offers an alternative to surgery.

Table 2. Studies on EUS-guided pancreatico-gastrostomy

Authors	Number of patients	Success (%)	Complication (%)	Follow-up (mo)
Tessier Gie, 2007	36	70	11	16.5
Kahaleh Gie, 2007	13	92	16	14
Barkay Gie, 2010	21	48	2	13

**Figure 5.** Treatment of pancreatic pseudo-cyst.**Technical considerations (Fig. 6)**

By using a linear interventional echoendoscope, the dilated MPD was well visualized. EUS-guided pancreatogastrostomy (EPG) was then performed under combined fluoroscopic and ultrasound guidance, with the tip of the echoendoscope positioned such that the inflated balloon was in the duodenal bulb while the accessory channel remained in the antrum. A needle (19-G or access needle) was inserted transgastrically into the proximal pancreatic duct and contrast medium was injected, opacification demonstrated a pancreaticogram. The needle was exchanged over a guidewire for a 6.5- or 8-Fr diathermic sheath, which was then used to enlarge the channel between the stomach and MPD. The sheath was introduced by using cutting current. After exchange over a guidewire (rigid 0.035-inch in diameter), a 7-Fr, 8-cm-long pancreaticogastric stent was positioned. This stent will be exchanged for two 7-Fr or one 8.5-Fr stent 1 month after the first procedure.

The results of the three series⁴⁷⁻⁴⁹ of patients published are much too preliminary in nature to recommend wider use of EPG, which in any case should be restricted to tertiary centers specializing in biliopancreatic therapy with a pain relief in 70% of cases (Tab. 2). But the complication rate is still high around 15% including bleeding, pancreatic collection and perforation. Nevertheless, the possibility of MPD into the digestive tract through an endoscopically created fistula, with patency maintained by stent placement, might be interesting as an alternative method of drainage without the complication of stent occlusion that is associated with transpapillary drainage.

The largest series was published by Tessier *et al.* on 36

patients. Indications were chronic pancreatitis, with complete obstruction (secondary to a tight stenosis, a stone, or MPD rupture); inaccessible papilla or impossible cannulation ($n = 20$); anastomotic stenosis after a Whipple procedure ($n = 12$); complete MPD rupture after acute pancreatitis (AP); or trauma ($n = 4$). EPG or EUS-guided pancreatobulbostomy (EPB) was unsuccessful in 3 patients; 1 was lost to follow-up. Major complications occurred in 2 patients and included 1 hematoma and 1 severe acute pancreatitis. The median follow-up was 14.5 months (range, 4-55 months). Pain relief was complete or partial in 25 patients (69%, ITT). Eight patients treated had no improvement of their symptoms (4 were subsequently diagnosed with cancer). Stent dysfunction occurred in 20 patients (55%) and required a total of 29 repeat endoscopies.

Clinical algorithm

It's very difficult to find today the place of EPG. In our experience the best indication is anastomotic stenosis after Whipple procedure for benign pancreatic lesions (cystadenoma, intraductal papillary mucinous neoplasm of the pancreas, neuroendocrine tumor). EPG offers an alternative to surgery and the best results in the 3 series published (Tab. 2) were showed in this indication. In another hand, surgery should be considered as the elective treatment of chronic pancreatitis after failure of the endoscopic route.

Conclusion

Curved linear array echoendoscopes have made transmural pseudocyst puncture under EUS guidance technically possible. With the ability to "see" pseudocysts through the wall of the stomach or duodenum, pseudocysts should be as accessible to the endoscopist as they have been to the radiologist performing percutaneous drainage. Dedicated pseudocyst drainage accessories and large channel interventional echoendoscopes designed for stent placement will improve the results of EUS-guided pseudocyst drainage. Data in the literature seem to show that EUS route should be the Gold Standard for the treatment of pancreatic collection, and anyway EUS guidance is mandatory for the non-bulging pseudocyst or in case of portal hypertension.

Therapeutic EUS as pancreatico-gastrostomy and EUS-guided biliary drainage represent today an alternative to surgery or percutaneous biliary drainage when ERCP failed or was impossible due to previous surgery as gastrectomy or Whipple resection. These techniques should be performed in

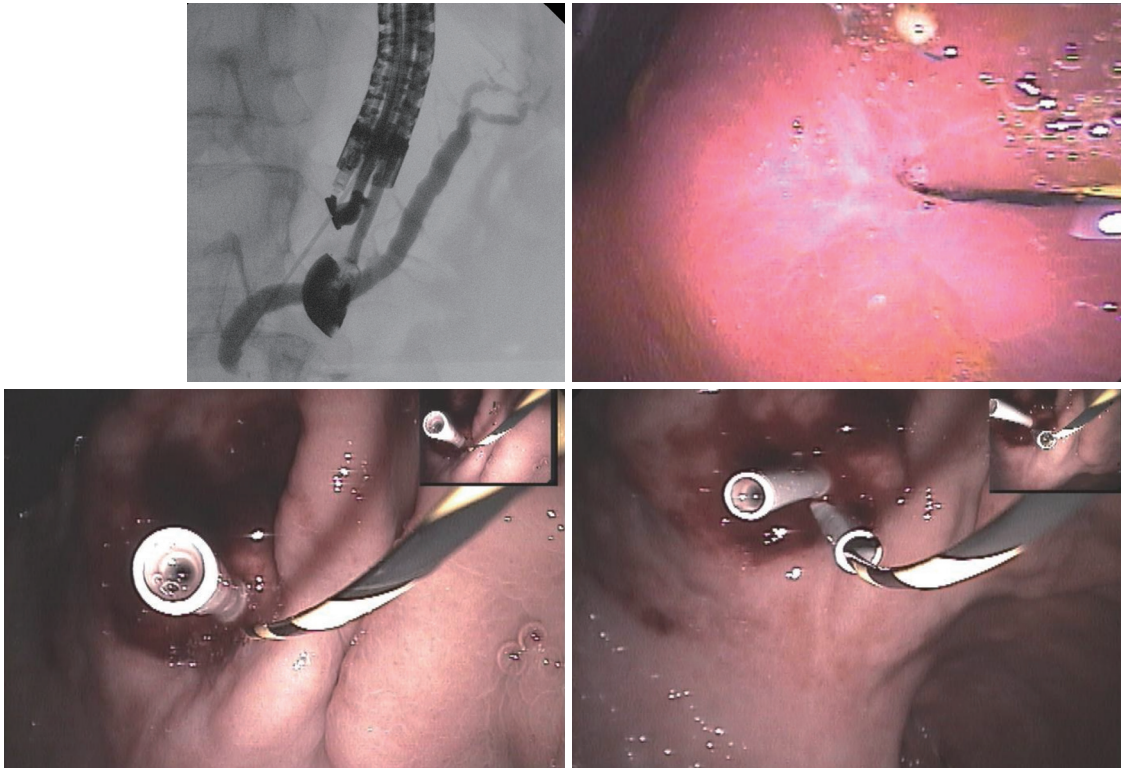


Figure 6. Pancreatico-gastrostomy / stenosis of a wirsung-gastro anastomosis after wipple resection for benign cystic lesion of the head of the pancreas.

centers specializing in therapeutic endoscopy.

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