Introduction

Despite advances in endoscopy, EUS-guided pancreatic duct drainage (EUS-PDD) remains a technically challenging procedure. There is still a high rate of adverse events ranging from 15-60% and the procedure can be life threatening. Until recently, a significant difficulty with this technique was the absence of dedicated devices. Proper patient selection is of utmost importance; EUS-PDD should be reserved for patients who have failed ERCP and must be performed by experienced endoscopists who are familiar with the technique. The most common indications include: chronic pancreatitis induced strictures and stones, disconnected pancreatic ducts, inaccessible ampulla, and post-surgical altered anatomy. This lecture will review the accessories used, techniques employed, and published literature reporting outcomes as well as adverse events regarding EUS-PDD.

I. Indications

1. Chronic pancreatitis

Chronic pancreatitis (CP) is an irreversible and progressive inflammatory process, featuring pathological fibrosis that can result in benign strictures of the main pancreatic duct (PD). Pain in CP is believed to be in part due to ductal pancreatic hypertension resulting from outflow obstruction caused by PD or papillary stricture, stones, or rupture of the main PD.

1) Strictures

PD strictures are seen in about half of patients of CP. These strictures are usually located in the pancreatic head and the ductal obstruction frequently leads to pain or acute pancreatitis superimposed on CP. The technical success rates of pancreatic stent placement for dominant pancreatic duct strictures are high (>95%), but even in technically advanced ERCP centers, failure rates can be up to 5 to 10%. Tight strictures non-amenable to typical endotherapeutic decompression via ERCP may require EUS-PDD. In one of the largest case series, 36 patients underwent EUS-guided pancreatic drainage and the most frequent indication was chronic pancreatitis (20 patients) with tight stricture (25%, 9/36 cases).
2) Stones
Pancreatic duct calculi develop during the natural course of chronic pancreatitis and is observed in 90% of patients. PD stone removal is believed to decrease upstream hypertension and parenchymal pressure thereby alleviating pain and improving pancreatic function by restoring pancreatic duct flow. When coupled with PD strictures, stone size and arrangement coupled with the typical characteristics of being hard and spiculated with sharp edges often leads to PD occlusion and impaction. In these cases, advanced therapies such as extracorporeal shock wave lithotripsy (ESWL) may be required. However, in cases where ESWL is not available or in cases where obstructive stones cannot be fragmented after multiple ESWL sessions, EUS-PDD may be a viable option.

2. Disconnected pancreatic duct
Disconnected pancreatic duct syndrome is a recognized complication of acute necrotizing pancreatitis, CP and abdominal trauma that results in viable upstream pancreas draining out of a low-pressure, either internal or external fistula. The consequent leakage of pancreatic secretions will either resolve spontaneously or lead to complications, such as ascites, fistula formation, pseudocyst, pancreatic abscess, and necrosis. Transpapillary stenting in conjunction with continued medical therapy has been reported to be successful in 55-84% of patients whereas surgical therapy, often a distal pancreatectomy, carries a high morbidity and defined mortality. Percutaneous rendezvous therapies for PD duct disruption have been described but are not routinely used. EUS-PDD has been reported in cases of chronic pancreatitis with complete rupture of the main PD and in cases of PD leaks.

3. Unable to access the papilla by ERCP
Successful cannulation of the PD at the major papilla has been reported in 90% to 98% of cases, whereas minor papilla cannulation is generally more difficult, with failure rates in the range of 5% to 10%. PD cannulation can fail because of the inability to identify and/or cannulate the pancreatic orifice particularly after endoscopic sphincterotomy or surgical sphincteroplasty, ampullectomy, distorted gastric anatomy, the presence of tumors obscuring papillary visibility, and papillas inside diverticulum. EUS-guided rendezvous for transpapillary pancreatic duct access was first described in a case report by Bataille and Deprez in 2002.

4. Post surgical anatomy
1) Strictures post Whipple: Pancreatoenteric anastomotic site stenosis can be a problematic late complication after pancreatoduodenectomy (Whipple). There are 2 methods of reconstruction after PD: pancreatogastrostomy and pancreatojejunostomy. Stenosis of anastomotic sites is more common after pancreatogastrostomy than pancreatojejunostomy. In general, pancreaticojejunal anastomotic site strictures can be observed in approximately 5 to 11% of post Whipple patients and up to 30% for pancreaticogastrostomy.

2) Pancreatic fistula accompanying pancreatoenteric stenosis or occlusion is also observed in 10% to 20% of these patients. In 2% to 3% of these patients, further stenosis can induce acute recurrent pancreatitis, necessitating repeat admission.
II. Accessories

1. Needle: 19G

Pancreatic duct access may be achieved with any of the currently available 25-, 22- or 19-gauge fine needle aspiration (FNA) needles. However, for attempted PD drainage, the largest published case series have utilized a 19-gauge FNA needle (Cook Medical, Bloomington, IN, USA) for duct access. The second largest case series utilized either a 19-gauge or 22-gauge FNA needle (EUS-19-T or ECHO-1-22; Cook Medical) or inner needle of a cystoenterostome (Cystostome CST10; Cook Medical). When selecting an FNA needle, one should be cognizant of whether the needle lumen is large enough to accommodate particular guidewire sizes. Consider utilizing larger caliber 19-gauge needles in cases where the PD is more dilated (>5mm).

2. Guidewires

When using a 0.035 inch guidewire, a 19-gauge needle is needed. The largest case series utilized either a 0.035 or 0.025 inches in diameter, both straight and angled hydrophilic versions (Glidewire, Jagwire; Boston Scientific, Natick, MA, USA). In the second largest case series, when a smaller wire (0.020) was used, it was subsequently exchanged for a larger 0.035 wire. The main benefit of utilizing smaller caliber 0.025 or 0.018 wires with either a 19- or 22-gauge needle is their flexibility, which can aid in maneuvering the wire into the duct and traversing strictures. Unfortunately, this lack of stiffness can then make passage of other devices and maintaining wire position more challenging. Although it can be more difficult to insert larger needles and stiffer wires into the PD initially, the added force may allow passage of wires and devices through obstructed areas and facilitate subsequent interventions.

3. Dilation devices

There is a wide array of endoscopic tools that may be used to perform EUS-PDD for the purposes of fistula creation between gut lumen and PD, facilitate passage of tools, and for dilation of strictures. For antegrade stent placement, transmural track dilation can be performed by hydrostatic balloons (Titan biliary dilation Balloon; Cook Medical or 4mm, Hurricane Biliary Dilation Balloon; Boston Scientific), tapered catheters (7-Fr, Sohendra; Cook Medical), and/or cannulas (Proforma; Conmed Endoscopic Technologies, Utica, NY, USA). To date, there are no comparative trials to evaluate the success rates of different types of available devices. Endoscopists rely upon their experience when deciding which equipment to use and often, different devices are employed within the same patient.

4. Plastic Stents

1) PD stents that have been used include both single and double pigtail stents. In the largest case series from Japan, 7 Fr and 5 Fr plastic stents were most commonly used with single cases of 8 mm SEMS and 5 Fr na-so-pancreatic duct drainage (with subsequent exchange to a 7Fr plastic stent).

2) Although not statistically significant, stent migration occurred less frequently in patients who had a double pigtail plastic stent placed (rather than straight plastic stents).

3) Recently a new, single pigtail 7-Fr plastic stent was developed specifically for EUS-guided PD placement by Dr. Itoi. The stent has a tapered tip, four internal flanges (two in the distal end and two at the proximal
end) and a single external pigtail (total length of 20 cm and effective length of 15 cm). The initial feasibility report of 8 patients achieved technical and treatment success in 100% of cases.

4) Metal Stents: Oh D, et al. just recently described EUS-PDD using a novel fully covered self-expandable metal stent (FCSEMS) with anti-migration properties in 25 patients with “painful obstructive pancreatitis” after failed ERCP.21 This modified FCSEMS (commercially available, silicone coated, nitinol wire, 6 or 8mm diameter, 6-10cm in length; M.I. Tech, Seoul Korea) with proximal and distal anchoring flaps was placed into either a pancreaticogastic or pancreaticoenteric fistula. EUS-guided pancreaticogastrostomy (n = 23), pancreaticoduodenostomy (n = 1), and pancreaticojejunostomy (n = 1) were performed. EUS-PDD had 100% technical and clinical success rates. Pain scores improved significantly after FCSEMS placement (P = .001). Early mild grade adverse events occurred in 5 patients (20%), 4 with self-limited abdominal pain and 1 with minor bleeding.

III. Techniques

1. Although a dilated PD is not a requirement for this procedure, we agree that it does appear to carry an advantage. Initially, the PD is localized on EUS and then it is punctured using an FNA needle. Once the needle has entered the PD, contrast is injected and fluoroscopy is used to obtain a pancreaticogram and ensure PD access. Then a guidewire is passed through the FNA needle into the PD, and then depending on the technique, advanced and looped into the duodenum or further into the PD with care taken to prevent wire dislodgement. Once PD puncture and guidewire has been performed, we rely on fluoroscopic imaging to for PD injection, prevent loss of the guidewire and ensure proper scope position.

2. Pancreatic Drainage techniques

1) Rendezvous (Retrograde)
   a. A retrograde, also known as rendezvous, stent placement technique uses the echoendoscope to puncture the PD to gain access and then exchanged out for a side viewing duodenoscope. The duodenoscope is then used to place a stent from the gut lumen via the papilla or anastomosis into the PD in unaltered gastric anatomy or extended forward viewing endoscope (colonoscopy) in patients with an afferent jejunal limb or Roux-en-Y reconstruction following pancreatic-duodenectomy.
   b. The guidewire is inserted into the main PD and passed in antegrade fashion across the major papilla or stenotic pancreaticoenteric anastomosis. Looping of the guidewire in the duodenum and jejunum is mandatory to avoid guidewire migration and loss of access.
   c. The luminal end of the guidewire is then captured with a snare, grasper, or biopsy forceps and the wire is then pulled through the endoscope until both ends of the guidewire exits the patient’s mouth. Once the selected instrument is properly positioned and guidewire control is achieved, pancreatic stent insertion and other interventions may be performed in standard fashion.
   d. Some have reported a higher rate of technical success with two endoscopists performing the different aspects of the rendezvous procedure, however this is not routinely practiced.22
2) Direct Drainage (Antegrade)
   a. In the antegrade or direct drainage technique, PD access and stent placement is performed with the echoendoscope alone. In this technique, a stent is deployed from the gut lumen into the PD with or without crossing the obstruction and papilla/anastomosis. This can be further subdivided based on whether the stent crosses the site of ductal obstruction and papilla/anastomosis (transpapillary or transanastomotic, respectively) or not (transluminal).
   b. For this technique, tract dilatation is required to pass the stent through the GI tract wall, the PD, and pancreatic tissue. Ideal stent placement would be having the distal end inside the small bowel and the proximal end lying in the stomach to prevent migration and hopefully provide adequate drainage. However, it may not be possible to advance the guidewire beyond the site of obstruction and/or papilla (or anastomosis) resulting in transluminal drainage. Here the distal end of the stent is left inside the PD with the proximal end in the stomach.

3) Tips and Tricks
   a) Tract dilation: This is considered one of the most challenging aspects in EUS guided PD stenting. This can be due to gastric wall thickness and/or the fibrotic nature of the pancreatic parenchyma in chronic pancreatitis.\(^\text{18}\) We try to avoid use of cautery to minimize complications. Initial dilatation with the needle sheath can aid passage as well. Also, try to avoid a perpendicular angle of approach and minimize tract dilation diameter to decrease risk of leakage.
   b) Avoiding side branch ducts: The guidewire often inadvertently passes into pancreatic duct side branches and can often be remedied by either switching to a different guidewire (alternative type, size, or angled/straight) and changing the angle of the needle’s approach to the PD.
   c) Crossing obstructions and strictures: Guidewire passage across the papilla, anastomosis, or other site of obstruction is often a difficult task. Tricks to employ include removing and advancing the guidewire again, changing the needle angle and/or the guidewire, and perhaps rotating fluoroscopy to gain additional views. As in ERCP, one can also inflate balloons near the obstruction to help direct guidewire passage through the obstruction.
   d) Avoiding wire stripping: There is always a risk of shaving off the wire tip when retracting the wire into the needle at tight angle. In order to minimize the risk, care should be taken to straighten out any acute angles prior to wire retraction and never pulling when resistance is felt. If the wire can be withdrawn easily, then we suggest removing both the guidewire and needle together.
   e) Transluminal stent placement is advised only if transpapillary/transanastomotic stent placement fails because of the potentially increased risk of stent dislodgement with subsequent pancreatic fluid leak causing pancreatitis or a pseudocyst.

IV. Outcomes

1. Summarizing the current literature, among 222 reported patients, the technical success of EUS-guided PD intervention occurred in 170 patients (76.6%).\(^\text{19}\)
2. In the largest report to date, Fujii, et al.\(^\text{15}\) reviewed their single center experience in 43 patients undergoing...
attempted EUS-guided pancreatic duct drainage. Long-term outcomes (at least 12 months of follow-up) were available for 29 patients and 91% were successfully stented. Complete clinical success defined as symptom resolution occurred in 69.6% and partial symptom resolution was found in the remaining 30.4%.

3. In a 12 patient case series, during a follow-up period that spanned 4 weeks to 3 years, 29% of patients required surgical intervention. Stent dysfunction, defined as migration or occlusion, has been reported to occur at 25% and up to 50-55%.

4. Adverse Events: In the available case series, complications developed in 42 patients (18.9%). Complications included abdominal pain ($n=17$), pancreatitis ($n=7$), bleeding ($n=4$), unspecified ($n=3$), perforation ($n=2$), peripancreatic abscess ($n=2$), shaving of the guidewire coating ($n=2$), and one patient each developed fever, pneumoperitoneum, pseudocyst alone, aneurysm with a pseudocyst, and perigastric fluid collection.

IV. Conclusions

EUS offers a method to drain pancreatic ducts when ERP is not successful. It can eliminate the need for more invasive procedures and surgery which can expose the patient to higher risks. Because EUS-guided pancreatic duct drainage is one of the most technically challenging EUS interventions performed and can result in severe complications. However, it can be successful and safely performed in the hands of adequately trained and experienced endoscopists who limit its use to appropriately selected patients.

References