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# Endoscopic Ultrasound-Guided Drainage of Pancreatic Fluid Collections (with Video)

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Endoscopic ultrasound (EUS) is often used to guide drainage of pancreatic fluid collections (PFCs). EUS enhances the diagnosis of cystic pancreatic lesions and enables real-time image-guided control of PFC drainage. EUS may facilitate the endoscopic treatment of patients with pancreatic necrosis and patients with disconnected pancreatic duct syndrome.

**Key Words:** Endoscopic ultrasound; Pseudocyst; Necrosis; Acute fluid collection; Disconnected pancreatic duct

## INTRODUCTION

Pancreatic fluid collections (PFCs) are consequences of acute or chronic pancreatitis, and may require drainage. Both transpapillary and transmural endoscopic drainage have been described, and the two methods may be combined. Endoscopic ultrasound (EUS) facilitates transmural drainage of PFCs, and may increase the success and safety of PFC drainage. In addition, EUS techniques may enhance the endoscopic treatment of pancreatic necrosis and disconnected pancreatic duct syndrome. This article reviews current methods and evidence for EUS-guided drainage of PFCs.

## DIFFERENTIAL DIAGNOSIS OF PANCREATIC CYSTIC LESIONS

Cystic pancreatic lesions include cystic neoplasms, true cysts, and PFCs. Cystic neoplasms must be distinguished from PFCs because they may require resection or ablation, not drainage. It is often possible to distinguish PFCs from cystic neoplasms on the basis of clinical history and imaging studies. A PFC will develop and mature over the course of an episode of pancreatitis on serial cross-sectional imaging studies. If the patient's initial computed tomography (CT) or magnetic resonance imaging (MRI) shows a mature cystic lesion the possibility of a cystic neoplasm must be considered, even if the patient is presenting with acute pancreatitis. EUS and EUS-guided fine needle aspiration may assist with differential diagnosis in indeterminate cases.

PFCs complicate pancreatitis, and may be categorized as acute fluid collections, pseudocysts, or necrosis.<sup>1</sup> Acute fluid collections are present <4 weeks after the onset of pancreatitis, do not replace pancreas parenchyma, and may not have a well-defined wall. They may appear complex on EUS. Acute fluid collections are common and usually resolve with medical management. Pseudocysts are fluid collections persisting for  $\geq 4$  weeks after the onset of pancreatitis. They have a well-defined wall, with either simple or complex contents. Pseudocysts may communicate with the pancreatic duct, and the possibility of an underlying ductal stricture or leak should be considered.

Necrosis is a region of necrotic pancreatic parenchyma and/or peri-pancreatic fat. Acute necrotic collections are <4 weeks old, and "walled-off necrosis (WON)" is  $\geq 4$  weeks old. Necrosis contains solid necrotic material as well as fluid, and often requires a more aggressive endoscopic approach for successful resolution. CT typically underestimates the presence of solid material, which is better demonstrated by MRI or EUS. The presence of non-dependent air within a PFC suggests infection of a necrotic collection.

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## INDICATIONS FOR AND TIMING OF PFC DRAINAGE

Many PFCs do not require intervention. Indications for drainage include infection, biliary or gastrointestinal (GI) tract obstruction, pain with attempts at oral feeding, and rapid enlargement of a PFC. It is desirable to wait until the collection develops a wall or fibrous capsule prior to drainage, if possible. Delays in drainage will also allow the PFC contents to liquify, simplifying subsequent drainage and/or necrosectomy. Drainage may, however, be performed <2 weeks after onset if there is a pressing indication, such as poorly controlled infection.

Endoscopic retrograde cholangiopancreatography may also be performed at the time of PFC drainage, particularly if an underlying pancreatic duct stricture, obstruction, or leak is suspected. Transpapillary drainage of PFCs may be preferred for collections <5 cm in size, particularly those located in the head of the pancreas.<sup>2</sup> Transpapillary and transmural drainage may be combined.

## DOES EUS IMPROVE OUTCOMES OF ENDOSCOPIC PFC DRAINAGE?

Two randomized, controlled, prospective trials have compared EUS-guided pseudocyst drainage to conventional endoscopic pseudocyst drainage.<sup>3,4</sup> In these trials the technical success rates were significantly higher for EUS-guided drainage (94% to 100%) than for conventional drainage (33% to 72%) ( $p<0.05$ ). There were trends toward fewer complications in the EUS-guided drainage groups. The main reason for failure of conventional drainage was the absence of an endoscopically visible bulge caused by the pseudocyst. Complications do occur with EUS-guided drainage and may include bleeding, visceral perforation, stent migration, and infection. In one large recent series the overall complication rate was 5%.<sup>5</sup>

Conventional drainage of non-bulging collections may be successful, but requires a highly experienced operator with a good understanding of cross-sectional anatomy and attention to subtle mucosal clues indicating the presence of an underlying PFC. At many medical centers EUS guidance is increasingly utilized for these collections. In addition to non-bulging collections, EUS may be preferred in patients with venous collaterals (such as those with splenic vein thrombosis), those with coagulopathy or thrombocytopenia, those with a small anatomic window for drainage, and those who would benefit from trans-duodenal rather than trans-gastric drainage.

EUS-guided pseudocyst drainage has been compared to surgical cystgastrostomy in a retrospective case-control study.<sup>6</sup> Success and complication rates were similar. The length of hospital stay and overall cost was significantly less in the EUS

group.

## CHOICE OF PFC DRAINAGE SITE

PFCs should be drained at a site of close approximation to the GI tract, ideally with <1 cm from the PFC lumen to the gut lumen. Intervening vessels and organs should be avoided. Trans-gastric drainage sites typically close within a few days of stent removal, while transduodenal drainage sites may remain open as chronic fistulas after stent removal.<sup>7</sup>

## TECHNIQUE OF EUS-GUIDED DRAINAGE

The technique of EUS-guided pseudocyst drainage is shown in Supplementary Video 1 (available online at <http://www.e-co.org/>). A linear echoendoscope should be used, preferably one with a working channel that will admit a 10 Fr stent. The chosen drainage site should meet the criteria mentioned above, but should also be a location where endoscopic visualization is good, the endoscope is not retroflexed, and the operator can work comfortably. A slightly “long” endoscope position is preferred, so that when pushing devices through the gut wall the endoscope is not displaced proximally.

Most American and Asian endoscopists use a needle and wire-guided technique without electrocautery. Many European experts puncture the PFC with a cystotome that incorporates electrocautery into a 10-Fr puncture device; this device may shorten the procedural time but does not appear to change the technical success or complication rate.<sup>8</sup> A 19-gauge EUS needle is preferred as it will admit a 0.035 inch guidewire. I try to puncture as perpendicular to the gut lumen as possible, to achieve the shortest and straightest tract from the gut lumen to the PFC lumen. After aspirating cyst fluid for gram stain, culture, and other diagnostic studies as appropriate, contrast may be injected. A guidewire is then advanced through the needle into the collection and coiled within it, usually under fluoroscopic guidance. The drainage may be safely performed without fluoroscopic, however, using EUS guidance alone.<sup>9</sup> After passage of a 0.035 inch guidewire into the collection, I predilate the tract to the PFC by withdrawing the needle into its sheath, then advancing the needle sheath over the wire into the collection. The hydrophilic coating on the guidewire may be damaged or shaved off the wire by the sharp, beveled tip of the EUS needle. This can also occur with needles designed with a non-beveled tip. This problem is likely to occur when the wire is advanced against resistance and then pulled back. Avoid damage to the guidewire by advancing the guidewire gently, avoiding resistance, and pulling back the needle slightly before pulling back the guidewire.

Once the wire is coiled in the cyst, the puncture site can be di-

lated with a balloon. If the balloon catheter will not traverse the puncture site it may first require dilation with a tapered catheter, dilating catheter, or over-the-wire needle knife electrocautery.<sup>10</sup> A balloon diameter of 8 to 10 mm is often chosen for drainage of simple pseudocysts, while a balloon diameter of 18 to 20 mm is preferable if immediate endoscopic necrosectomy is planned. When draining a non-bulging collection it is possible to inflate the balloon between the PFC and the gut, pushing the PFC away instead of truly dilating its wall. Avoid this pitfall by advancing the dilating balloon well into the PFC and partially inflating it before pulling it back to dilate the drainage site. The process of balloon inflation and tract dilation can be monitored by EUS.

After dilation, pigtail plastic stents are usually placed across the drainage site. When deploying a plastic stent the endoscope must often be pulled back to avoid deploying the entire stent within the PFC. Prior to placement, a mark may be placed on the shaft of the stent to indicate where the intraluminal pigtail begins. A novel self-expanding lumen-apposing metal stent has been described and appears to be an attractive alternative to plastic stents for PFC drainage.<sup>11</sup> Two internal plastic pigtail stents, or else a stent and a nasocystic drain, are often placed during PFC drainage. Re-accessing the PFC after placement of the first stent is usually straightforward, and correct placement of the guidewire back into the collection can be monitored by EUS. Alternatively, a double-wire technique allows placement of two guidewires simultaneously.<sup>12,13</sup> In this method a double-lumen cytology brush catheter or 10 Fr delivery catheter are passed into the PFC over the first guidewire, and a second guidewire (often 0.25 inches in diameter) is passed into the PFC through the catheter alongside the first wire. This may improve the ease and success of PFC drainage although it requires additional accessories.

## EUS AND PANCREATIC NECROSIS

Endoscopic drainage of pancreatic necrosis is more challenging and has been associated with lower success rates than endoscopic drainage of pseudocysts. It is important to recognize WON, as it will typically require a more aggressive approach to drainage, often with prolonged nasocystic lavage and/or endoscopic necrosectomy. EUS helpfully demonstrates the complex nature of WON, which often appears solid, with a discernible wall.

EUS guidance has been used to create multiple drainage sites for WON, the so-called “multiple trans-luminal gateway technique (MTGT).”<sup>14</sup> A nasocystic catheter is placed under EUS guidance into one part of the necrotic collection, and one or more internal drainage sites are created elsewhere in the gut, with placement of multiple internal plastic stents between

the necrotic collection and the gut lumen. Lavage of the collection is then performed through the nasocystic tube, with internal drainage of the lavage fluid through the other drainage sites into the gut lumen. This technique has been reported to enhance the resolution of WON, with fewer patients requiring endoscopic necrosectomy or surgery for inadequately drained necrotic collections.<sup>14</sup> MTGT typically requires EUS guidance for placement of drain sites into different parts of the collection. The drainage sites may be in the stomach and/or the duodenum.

Endoscopic pancreatic necrosectomy is increasingly favored over surgical necrosectomy.<sup>15</sup> Vascular injury is an uncommon but life-threatening complication of endoscopic pancreatic necrosectomy, and may result in either gas embolus or bleeding from major vessels such as the splenic vessels, gastroduodenal artery, or portal confluence. An intraductal ultrasound probe, passed through the working channel of the forward-viewing scope that is positioned within the necrotic collection, can be used to identify major vessels within necrotic material and avoid trauma to major vascular structures during endoscopic necrosectomy.

## DISCONNECTED PANCREATIC DUCT SYNDROME

Disconnected pancreatic duct syndrome occurs when a segment of pancreatic tail is isolated from the downstream pancreatic duct, and may be due to trauma, ductal stricture, or previous pancreatic necrosis. The isolated or “disconnected” segment of pancreatic tail may atrophy without clinical consequences, but may also leak pancreatic juice, forming pseudocysts adjacent to the pancreatic tail. While these pseudocysts are often easy to drain endoscopically into the stomach, they typically recur when the trans-gastric drains are removed and the trans-gastric fistula closes. Such patients may require long-term endoscopic stenting of the pancreatic duct obstruction, or surgical resection of the isolated pancreatic tail.

The fourth portion of the duodenum is a retroperitoneal structure that often lays adjacent to pancreas tail pseudocysts. Drainage of these pseudocysts into the fourth portion of duodenum under EUS guidance may result in a chronic pancreatico-duodenal fistula, preventing recurrence of the fluid collection in patients who would otherwise require resection of the disconnected pancreatic tail.<sup>7</sup> There is typically no endoscopically visible bulge, and EUS is required to avoid adjacent vessels and select an optimal drainage site.

## CONCLUSIONS

EUS facilitates safe and successful drainage of PFCs, and

expands the possibilities for endoscopic drainage. EUS enhances the endoscopic treatment of some patients with pancreatic necrosis.

### Conflicts of Interest

The author has no financial conflicts of interest.

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