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Multicenter retrospective cohort of EUS-guided anterograde pancreatic duct access

Authors
Douglas Motomura[1], Shayan Irani[2], Michael Larsen[2], Richard A Kozarek[2], Andrew S Ross[2], S Ian Gan[1]

Institutions
1 Division of Gastroenterology, Vancouver General Hospital, University of British Columbia, Vancouver, British Columbia
2 Gastroenterology Section, Digestive Disease Institute, Virginia Mason Franciscan Health, Seattle, Washington, United States

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Georg Thieme Verlag KG, Rüdigerstraße 14,
70469 Stuttgart, Germany

Corresponding author
S. Ian Gan, MD, FRCPC, 5153-2775 Laurel St, Vancouver BC, Canada
ian.gan@vch.ca

ABSTRACT

Background and study aims Pancreatic duct (PD) cannulation may be difficult during conventional endoscopic retrograde cholangiopancreatography (ERCP) due to underlying pathology, anatomical variants or surgically altered anatomy. Pancreatic access in these cases previously necessitated percutaneous or surgical approaches. Endoscopic ultrasound (EUS) allows for an alternative and can be combined with ERCP for rendezvous during the same procedure, or for other salvage options.

Patients and methods Patients with attempted EUS access of the PD from tertiary referral centers between 2009 and 2022 were included in the cohort. Demographic data, technical data, procedural outcomes and adverse events were collected. The primary outcome was rendezvous success. Secondary outcomes included rates of successful PD decompression and change in procedural success over time.

Results The PD was accessed in 105 of 111 procedures (95 %), with successful subsequent ERCP in 45 of 95 attempts (47 %). Salvage direct PD stenting was performed in 5 of 14 attempts (36 %). Sixteen patients were scheduled for direct PD stenting (without rendezvous) with 100 % success rate. Thus 66 patients (59 %) had successful decompression. Success rates improved from 41 % in the first third of cases to 76 % in the final third. There were 13 complications (12 %), including post-procedure pancreatitis in seven patients (6 %).

Conclusions EUS-guided anterograde pancreas access is a feasible salvage method if retrograde access fails. The duct can be cannulated, and drainage can be achieved in the majority of cases. Success rates improve over time. Future research may involve investigation into technical, patient and procedural factors contributing to rendezvous success.

Introduction

The role of endoscopic Ultrasound (EUS) in pancreatic disease has evolved from a purely diagnostic modality to one with increasing therapeutic applications. EUS-guided fine needle aspiration (FNA) is a well-established diagnostic technique with minimal risk of complication when performed by experienced therapeutic endoscopists [1–4]. Affording the opportunity to work through the walls of the stomach and duodenum has enabled EUS to take a leading role in the placement of cystogastrostomy tubes for pancreatic pseudocysts [5] and pancreatic necrosis [6]. It also provides an endoscopic alternative to endoscopic retrograde cholangiopancreatography (ERCP) as a

means to access the pancreatic duct (PD) without involving the interventional radiologist [7, 8].

In cases in which cannulation of the PD is unachievable with ERCP alone, EUS has been used to drain the duct directly [9, 10] or to facilitate rendezvous with ERCP [11–16]. Although the EUS rendezvous approach was described nearly 10 years ago [11], there remains a minimal amount of data in the medical literature describing its practice. Our objective in this study was to assess the rate of success for EUS-guided pancreatography, wire access, and rendezvous for ERCP intervention in the PD.

Patients and methods

The endoscopic database at Virginia Mason Medical Center in Seattle and Vancouver General Hospital in Vancouver were searched retrospectively to identify patients with a history of pancreatitis and an obstructed PD who had failed cannulation of their PD via ERCP and went on to have EUS-guided anterograde procedures, which included rendezvous procedures, and direct transgastric PD stenting/drainage. A retrospective chart review was conducted under the approval of the Institutional Review Board. Findings on ERCP and EUS were determined through a review of endoscopy reports, fluoroscopic images, echoendoscope images, and endoscopic images.

EUS

EUS was performed by one of five experienced therapeutic endoscopists (IG, SI, ML, AR, DS) using Olympus linear echoendoscopes (GF-UC140 or GF-UCT180; Olympus America, Center Valley, PA). The number of procedures performed by individual endoscopists was highly variable and was broken down as follows: IG 56; SI 45; AR 7; ML 2; DS 1.

The PD was visualized endosonographically and a 19– or 22-gauge EUS needle (Boston Scientific, Natick, Massachusetts, United States) (EchoTip Ultra HD Ultrasound Access Needle, Cook Medical) was advanced into the PD using a transgastric or transduodenal approach. Intravenous secretin was used at the discretion of the endoscopist to enhance PD dilation and facilitate EUS-guided needle access into the PD. Following advancement of the needle into the PD, contrast was then injected under fluoroscopic guidance to confirm intraductal positioning of the needle. Failure to position the needle within the duct would result in repositioning of the needle and/or echoendoscope followed by repeat injection of contrast. In instances of repeated failure to achieve PD access with contrast and/or wire, individual endoscopists at times elected to utilize an alternative needle gauge (e. g. 22-gauge instead of 19-gauge) for additional attempts. If duct access was confirmed by pancreatography, this was deemed technical success. Subsequently, efforts were then made to advance a guidewire into the PD. Guidewire selection was determined by the endoscopist at the time of the procedure and included 0.018-inch, 0.021-inch, 0.025 inch, and 0.035-inch wires (Roadrunner, Metro, or Tracer; Cook Medical, Bloomington, Ind, Jagwire; Boston Scientific, or Visiglide or Terumo, Olympus). Following wire access of the PD, the wire was manipulated to traverse any obstruction and cross the papilla or surgical anastomosis into the small intestine. In select cases, a wire was left within the PD without gaining access to the duodenum or jejunum to mark the position of the PD and direct the position of the sphincterotome and wire via ERCP. In some cases in which rendezvous could not be performed, the guidewire was left within the PD and transgastric or transduodenal stent placement was performed as has been reported previously [17–21]. These were deemed as “salvage” procedures after failed ERCP rendezvous. In these cases, the transmural tract was dilated using a needle-knife or a cystotome, sometimes followed by balloon dilation with a 4-mm biliary dilation balloon (Hurricane, Boston Scientific; Titan balloon, Cook Medical). Stents used were 7F straight Geenen pancreatic duct stents (Cook Medical) in varying lengths, or in one case, a 7F double-pigtail stent. In addition, there were select cases inwhich Rendezvous was not attempted. These were deemed direct transgastric/duodenal stenting attempts. All PD stents were positioned toward the head of the pancreas.

Post-wire access ERCP

Following EUS, in cases where wire access into the small intestine was achieved, a duodenoscope (TJF-160VF, TJF-Q180V; Olympus) or pediatric colonoscope (PCF-H180AL, PCF-Q180AL; Olympus) was maneuvered into the small intestine and the wire visualized. In most cases, a snare or foreign body grasper was then utilized to grip the wire and pull it back through the scope. Cannulation of the PD over or next to the wire was then performed. Additional therapy consisted of dilation, extraction of stones/debris, and placement of plastic stents into the PD. In select patients for whom wire access was not achieved, conventional ERCP techniques were re-attempted with limited success.

Data analysis

Pooled data over the study cohort were collected and presented descriptively using proportions, means and standard deviation. Comparison of success rates between groups was performed using Chi Square testing on Microsoft Excel with Data Analysis add-in, and presented as *P* values.

Results

Patient demographics and procedure indications

Over a period of 13 years (May 2009 to February 2022), a total of 111 EUS PD access procedures performed on 96 patients were identified (▶ **Table 1**). Nine patients (8 %) had two separate procedures, and three patients had three procedures (3 %). Average age of patients was 58 years. The youngest patient was 17 years old and the oldest was 92 years old. Fifty-six (50 %) of the patients were female. Fifty-two (47 %) patients had surgically altered anatomy with 44 patients (40 %) having undergone a Whipple procedure, five patients with previous gastrojejunostomy, one patient with duodenal switch, one patient with a central pancreatectomy and one patient with a Puestow procedure. Furthermore, 17 patients had evidence of pancreas divisum or pseudodivisum (15 %).

▶ **Table 1** Demographic details.

Age (mean + SD)	**58 + 16**	
Sex (F)	56	50 %
Indications		
Chronic Pancreatitis	55	50 %
Pain	79	71 %
PD Stricture	54	49 %
Recurrent Acute	42	38 %
Acute pancreatitis	16	14 %
Insufficiency	20	18 %
Leak or Fluid collection	31	27 %
Other	12	11 %
Reason for ERCP Failure		
Ampulla Not Reached	55	50 %
Cannulation failure	31	28 %
Tight PD Stricture	41	37 %
Previous Surgery		
Whipple	44	40 %
Gastrojejunostomy	5	5 %
Other reconstruction	3	3 %

SD, standard deviation; F, female; PD, pancreatic Duct; ERCP, endoscopic retrograde cholangiopancreatography.

▶ **Table 2** Procedure details.

PD size (mm, Mean ± SD)	**3.7 ± 2.2**	
Anesthetic type		
Conscious	14	13 %
GA	96	86 %
Unknown	1	1 %
Secretin usage	24	22 %
Patient position		
Supine	97	87 %
Prone	10	9 %
Other	4	4 %
No. passes (mean ± SD)	2.1 ± 1.1	
Needles used		
19-gauge	64	58 %
22-gauge	14	13 %
Both	33	30 %

PD, pancreatic duct; SD, standard deviation; GA, general anesthesia.

▶ **Table 3** Technical outcomes.

Pancreatogram	**105**	**95 %**
PD wired	94	85 %
SB wired	57	51 %
RDV success[1]	37	39 %
Parallel RDV success	8	8 %
Transgastric stenting success		
Direct	16	100 %
Salvage[2]	5	36 %
Overall PD decompression	66	59 %
Complications		
Pancreatitis	7	6 %
Wire shedding	2	2 %
Pneumoperitoneum	2	2 %
Other	2	2 %

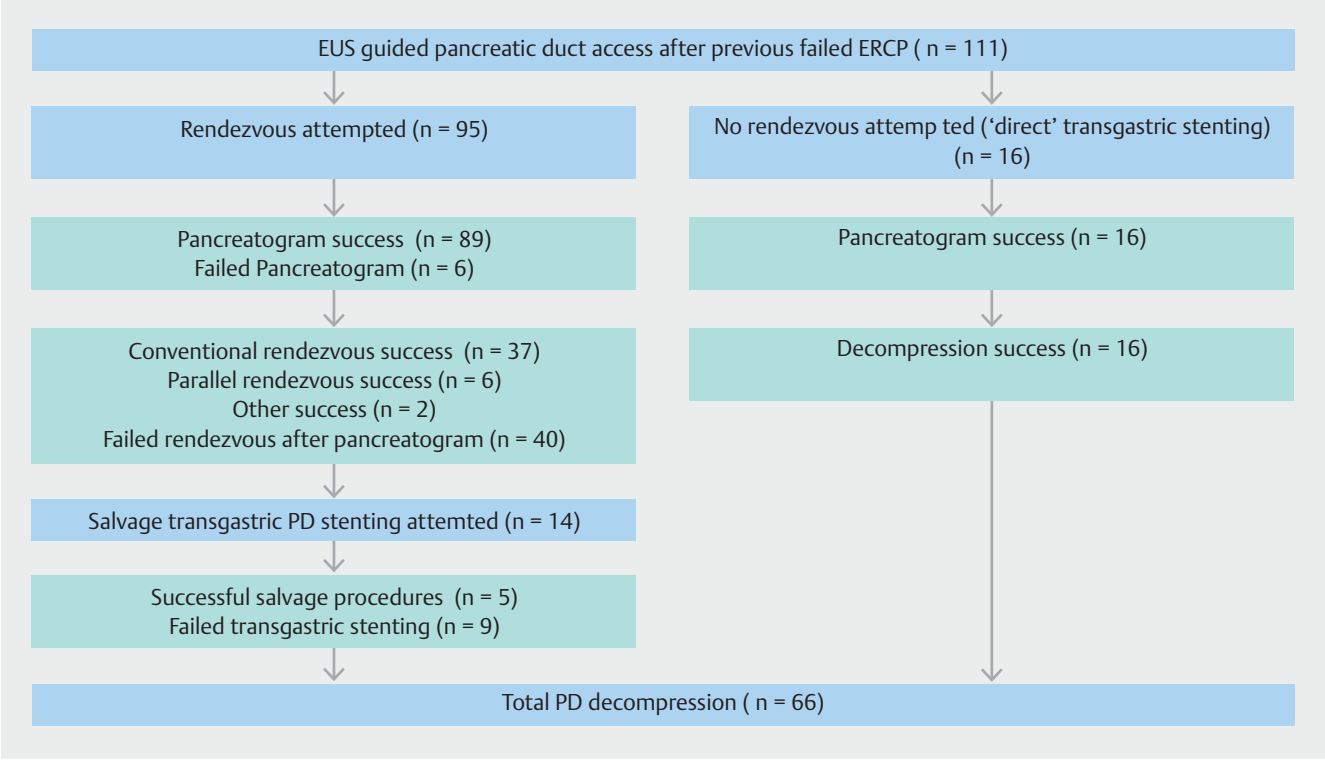
PD, pancreatic duct; SB, small bowel; RDV, rendezvous.
[1] n = 95 attempts.
[2] n = 14.

The indications for the procedures, many of which overlapped, included chronic pancreatitis/pancreatic insufficiency (n = 55; 50 %), pain (n = 79; 71 %), PD stricture (n = 54; 49 %), recurrent acute pancreatitis (n = 42; 38 %) acute pancreatitis (n = 16; 14 %), pancreatic fluid collection/pancreatic duct leak/fistula (n = 31; 28 %), PD stone (n = 10; 9 %) and retained/migrated PD stents (n = 2; 2 %). All patients had unsuccessful ERCP prior to EUS-guided PD access either at our institution or outside our institution. A number of patients underwent an additional (unsuccessful) attempt at PD cannulation via ERCP immediately prior to the EUS rendezvous attempt. The predominant cause of failed ERCP cannulation of the PD was an inability to locate the papilla or surgical anastomosis (n = 55; 50 %), cannulation failure (n = 31; 28 %), highgrade strictures (n = 41; 37 %) and other (n = 9; 8 %). Several patients had overlapping indications of failed ERCP cannulation.

Technical aspects

Sixty-six patients (59 %) had evidence of chronic pancreatitis on EUS. Eleven (10 %) were noted to have varices. Fourteen procedures (13 %) were performed with conscious sedation and 96 (86 %) were performed with general anesthesia, with one procedure missing data on sedation type (▶ **Table 2**). All procedures performed under general anesthesia were performed with patients supine, while the patients in whom the procedure was performed under conscious sedation were either in left-lateral decubitus or prone position. Mean maximal PD diameter measured during EUS was 3.7 mm (range 1–18 mm).

Secretin was given intravenously (8 or 16 mcg) during 24 procedures with a sustained increase in maximal PD diameter ≥ 1 mm in 14 patients. The average number of needle passes per



▶ **Fig. 1** Flowchart of attempted cases of anteretrograde pancreatic duct access.

procedure was 2.1. Nineteen-gauge needles were used in 64 procedures (58 %); 22-gauge needles in 14 procedures (13 %) and both needles were used in 33 patients (30 %). Disconnected duct syndrome was identified in eight patients (7 %).

Success rates

EUS-guided pancreatography (ie. needle access into the PD confirmed by contrast injection) was successful in 105 procedures (95 %), with successful wire access in 94 procedures (85 %) and passage of the wire into the downstream bowel in 57 patients (51 %) (▶ **Table 3**, ▶ **Fig. 1**). Successful rendezvous ERCP was possible in 37 procedures over 95 total attempts (39 %). An additional six patients had successful retrograde ERCP, despite rendezvous failure (often by using the intraductal wire as a guide, described as parallel rendezvous). Two patients had successful treatment after pancreatography, without insertion of a stent into the PD. Both patients had leakage into large fluid collections, which was controlled with transgastric drainage.

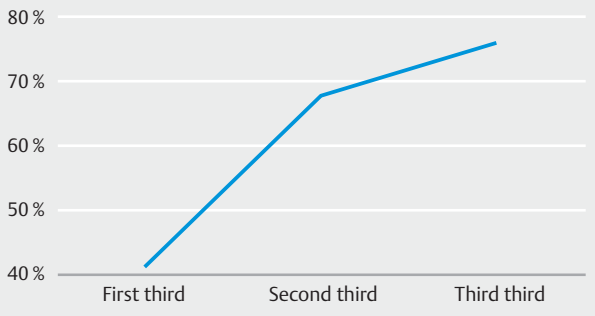
Direct transluminal PD drainage was attempted in 30 procedures with 21 (70 %) successful transluminal stents placed with PD decompression. When used for salvage, success rates were 36 % (5/14), whereas direct PD stenting (without rendezvous attempt) was successful in 100 % of cases (16/16). Most cases were transgastric, with one case being transduodenal. The overall rate of PD decompression was therefore 59 % (n = 66). Loss of EUS placed wire occurred in five cases (5 %).

Success by MD and learning curves

Numbers of procedures and success rates varied among different operators. Numbers of procedures were as follows: IG 56; SI 45; AR seven; other three. Successful PD decompression rates (which included successful rendezvous AND transmural PD decompression with stents) were 55 %; 69 %; 57 %; 0 % for the respective endoscopists. When procedures performed by the two most prolific operators (IG and SI) were divided into tertiles, success rates for PD decompression were 41 % in the first tertile (14/34), 68 % in the second tertile (23/34) and 76 % in the third tertile (25/33) (▶ **Fig. 2**).

Complications

The overall rate of complications was 12 %. Seven patients developed pancreatitis (6 %). One gastrointestinal bleed occurred, requiring 2 units of packed red blood cells. The source of bleeding was not evident on repeat upper endoscopy. Pneumoperitoneum was observed in two patients. Both patients were treated supportively. Wire shredding occurred in two patients with hydrophilic coating left in situ within the PD. One patient had the fragment retrieved immediately without complication. In a second patient, the fragment could not be removed and post-procedure acute chronic pancreatitis occurred. On a second attempt of EUS-guided access 4 days later, the hydrophilic coating was removed using a wire-guided basket. Transgastric stenting was performed thereafter.



▶ **Fig. 2** Pancreatic duct compression rates in first, second and final third of total cases.

Discussion

Traditionally endoscopic therapy for PD strictures or obstruction has relied on ERCP. In this technique, deep cannulation of the PD with establishment of wire access beyond the affected area is critical. Failure to achieve such access often necessitates further intervention involving a surgeon or interventional radiologist. EUS has offered a potential endoscopic alternative to achieving deep PD wire access to facilitate ERCP-mediated therapy [9, 11–16]. Alternatively, it is also being used increasingly as a means to achieve PD drainage to the gastrointestinal tract while bypassing the papilla entirely [9, 10, 22].

To date, EUS-guided rendezvous for ERCP access into the PD has been described in both case reports and retrospective case series such as ours. Anterograde success rates in the smaller series have ranged from 25 % up to 100 % [10, 12, 16, 23]. In a recent systematic review, pooled technical success rates, defined by successful pancreatogram or wiring [23], averaged 85 %. PD decompression was successful in 78 % of patients. The results in our cohort were comparable, with a technical success rate of 95 % and successful decompression rate of 59 %. The reasoning for the lower decompression rate can perhaps be explained by the methodology. Only a minority of patients had successful rendezvous (37/95 patients, 39 %). However, when the initial rendezvous attempt failed, only 14 of these patients (14/58, 24 %) had direct transgastric PD drainage attempted, possibly due to time constraints or operator experience. We hypothesize that more frequent usage of salvage transgastric PD stenting may have overall increased decompression rates.

Success rates in our cohort were shown to rise over time. The decompression success rate improved from 41 % in the first tertile to 76 % in the final tertile ($P<0.01$). The learning curve for anterograde pancreatic procedures is not well described. A recent review suggests 27 procedures are required for proficiency; however, in this analysis, median procedural time was used as a surrogate marker rather than change in success rate [24]. Continued improvement was seen after 27 cases, albeit at a slower rate. Irrespective of the number of cases, it seems clear that experience plays a key role in both efficiency and procedural success.

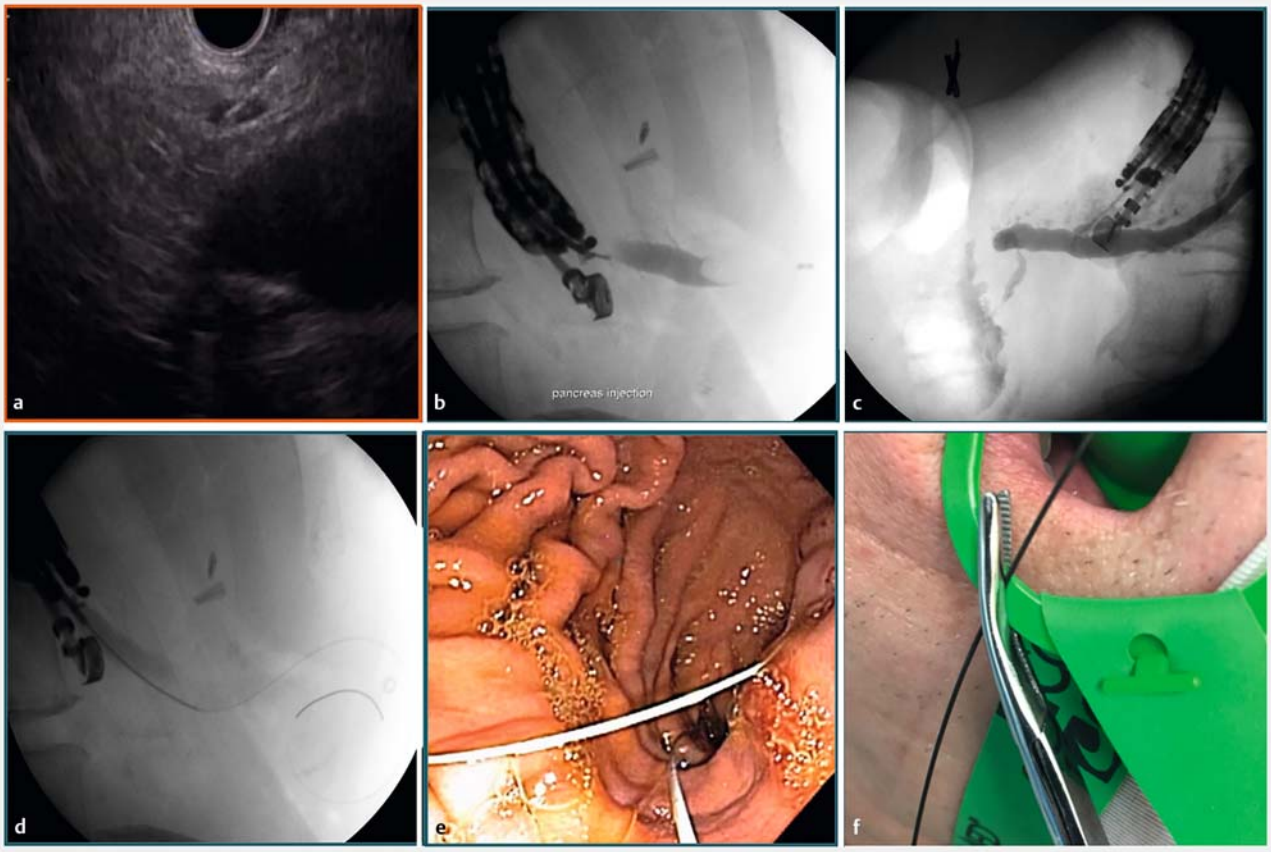
A unique aspect of our cohort was the large number of patients with postsurgical anatomy, which has been known to cause difficulty in both conventional ERCP and rendezvous [25–27]. A total of 52 patients (47 %) had surgical reconstructions, with the most common anatomy being post Whipple's (44 patients, 40 %). In the surgical reconstruction group, 32 patients had successful ductal decompression (62 %) compared to 34 patients in the native anatomy group (58 %, $P=0.68$). Interestingly, although the success rate was similar in these two groups, previous studies have suggested surgically altered anatomy to portend a mildly increased success rate [23]. When method of access was assessed in the surgical group it was found that direct PD stenting was successful in 77 % of cases (10/13), whereas conventional rendezvous was only successful in 56 % of cases (22/39). Although this difference did not reach significance due to sample size ($P=0.18$), future attempts in patients with altered anatomy could consider forgoing traditional rendezvous, as decompression rates with direct PD stenting seemed to be at least as good in our series.

Our overall complication rate was 12 %, including seven patients who developed pancreatitis (6 %). There were no deaths. This compares favorably with other reported studies describing rendezvous complication rates from 10 % to 16 % [9, 13, 23]. In meta-analysis, pancreatitis was found to be the most common complication at 6.6 %, similar to the rates seen in our series.

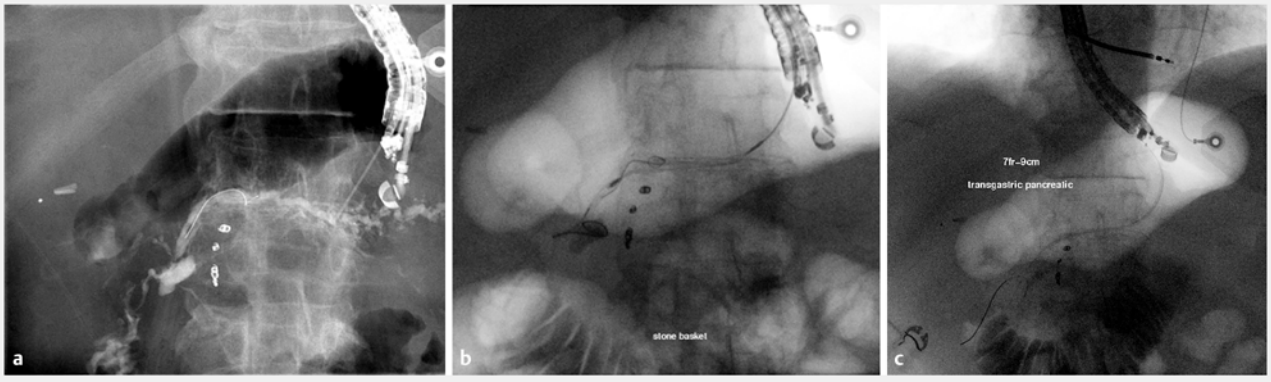
Limitations of our study include its retrospective nature as well as heterogeneity in the performance of the procedures. As mentioned above, there was a combination of attempted rendezvous procedures as well as direct pancreatic access. Five therapeutic endoscopists were responsible for contributing to the series. Each used similar, but non-standardized approaches in their procedures. Moreover, each operator had a different level of experience with anterograde pancreas access. It is unclear whether a dogmatic approach to needle/wire selection, secretin use, or patient position would have influenced decompression success rates.

Over the course of the study several pearls for success were acquired by the contributing endoscopists:

1. Some of the authors specifically preferred standard curvilinear array echoendoscopes as therapeutic linear echoendoscopes were less maneuverable, particularly with a 19-gauge needle in the working channel. Furthermore, larger working channels allowed more unintended lateral movement of the needles, reducing accuracy of puncture, especially when the PD diameter was small. The GF-UC140 has a distal outer end measurement of 14.2-mm with a 2.8-mm instrument channel. The insertion tube is 11.8 mm. The GF-UCT180 has a distal end diameter of 14.6-mm with a 3.7-mm instrument channel and 12.6-mm insertion tube.
2. Fluoroscopy was used to ensure appropriate scope position with the working channel of the scope facing downstream (▶ **Fig. 3**).
3. Chances of needle passage and wire access into the main PD (MPD) were increased when needle vector was parallel rather than perpendicular to the MPD, often as the MPD turns inferiorly at the genu (▶ **Fig. 3b**).



▶ **Fig. 3** **a** Sonographic image of a needle entering the main pancreatic duct. **b** Pancreatogram showing dilated pancreatic duct. **c** Pancreatogram with stricture near head of pancreas. **d** Wire crossing ampulla into small bowel. **e** Wire endoscopically visualized via endoscopic retrograde cholangiopancreatography. **f** Wire fastened to patient's bite guard via clamp.



▶ **Fig. 4** **a** Fluoroscopic image of hydrophilic tip of wire shed into pancreatic duct. **b** Usage of four-wire basket to grasp the shed wire. **c** Placement of the transgastric stent into the main pancreatic duct.

4. Use of the 19-gauge access needle (as opposed to standard 19-gauge FNA needles) reduced the risk of shredding of the hydrophilic component of the guidewires (▶ **Fig. 4**).
5. Twenty-two-gauge needles are particularly useful in the setting of chronic pancreatitis, where the gland is indurated and may not allow free passage of a 19-gauge needle. These require small-diameter 0.018-inch guidewires, as the smaller caliber precludes use of 0.025– and 0.035-inch guidewires.

6. After withdrawal of the stylet, air present in the needle lumen can be injected into the MPD with subsequent contrast injection, obscuring sonographic visualization of the MPD with air artifact (▶ **Fig. 3b**). We suggest use of a 10-cc syringe only half-filled with contrast to allow complete suctioning of air from the needle prior to contrast injection. One can also consider half-strength contrast to allow for improved guidewire visualization.
7. Once guidewire access into the downstream bowel lumen is acquired, the wire can be clipped to the gastric wall using a hemostatic clip, in hopes of preventing wire migration and looping in the stomach. It is possible that smaller clips may actually keep the wire in place better than wide-diameter clips. The wire can also be clipped to the bite-block using forceps, mitigating the need to hold the wire while the EUS scope is exchanged for a duodenoscope. Once the wire is retrieved successfully, the bite-block clip can be released (▶ **Fig. 3f**).
8. Once the guidewire is in place and visualized endoscopically, rendezvous retrieval of the wire through the duodenoscope/colonoscope can be tedious. Using a snare, grasp the wire beyond the hydrophilic tip if possible. Pull the wire slowly through the scope channel as the wire can easily be lost in the scope channel necessitating several attempts.
9. If true rendezvous (with the wire pulled back through the working channel of ERCP scope) cannot be achieved, often merely localization of the orifice and attempts to cannulate alongside the wire can be successful, a technique known as "parallel rendezvous."
10. If the MPD is needle-accessed in the body of the pancreas, stent length is limited by the distance between orifice and the site of needle access. If longer stents placed further distally are required, we suggest use of a Haber ramp or possibly an Oasis 10F stent introducer to allow a second guidewire to be placed alongside the transgastric wire OR direct cannulation alongside the transgastric wire.

Conclusions

This study serves to reinforce the message that EUS-guided pancreatic access is a challenging endeavor, but can be a feasible alternative when retrograde access fails. Operator experience is paramount to increasing success rate. Future studies may seek to investigate success rates and morbidity when comparing the rendezvous technique and direct PD stenting.

Competing interests

The authors declare that they have no conflict of interest.

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