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# Endoscopic Ultrasonography-Guided Versus Percutaneous Drainage for the Recurrent Pancreatic Fluid Collections

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Data Collection B  
Statistical Analysis C  
Data Interpretation D  
Manuscript Preparation E  
Literature Search F  
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**Background:** Ultrasonography-guided percutaneous drainage for pancreatic fluid collections is associated with a high recurrence rate and endoscopic ultrasonography (EUS)-guided drainage is a valuable approach. Our aim was to compare the efficacy and safety of percutaneous and EUS-guided drainage for the recurrent pancreatic fluid collections.

**Material/Methods:** A retrospective analysis of percutaneous-guided and EUS-guided procedures for pancreatic fluid collections drainages at a single tertiary care center between February 2017 and May 2018 was performed. Treatment success, adverse events, recurrence, need for surgery, length of hospital stays, and number of follow-up computed tomography (CT) scan were assessed.

**Results:** A total of 119 pancreatic fluid collections treated with initial percutaneous drainage were included in this study and 35 patients had recurrent pancreatic fluid collections. Recurrent patients were classified based on drainage method: EUS-guided drainage (18 patients) and the second percutaneous drainage (17 patients). EUS-guided drainage revealed a shorter length of hospital stays ( $P<0.001$ ), less re-intervention ( $P=0.047$ ), fewer number of follow-up CT scans ( $P=0.006$ ) compared with the initial percutaneous drainage. Furthermore, we also compared the clinical outcomes between the EUS-guided drainage and the second percutaneous drainage for the recurrent PFC after initially failed percutaneous drainage. EUS-guided drainage showed higher clinical success ( $P=0.027$ ), shorter length of hospital stays ( $P<0.001$ ), less re-intervention ( $P=0.012$ ), fewer number of follow-up CT scan ( $P<0.001$ ) and less recurrence  $P=0.027$  compared to the second percutaneous drainage procedure.

**Conclusions:** EUS-guided drainage is an effective and appropriate method to treat the recurrent pancreatic fluid collections after initially failed percutaneous drainage procedure, with the advantage of higher clinical success, shorter length of hospital stays, less re-intervention, fewer number of follow-up CT scan and less recurrence compared to the percutaneous drainage.

**MeSH Keywords:** **Collections • Drainage • Endosonography • Pancreas**

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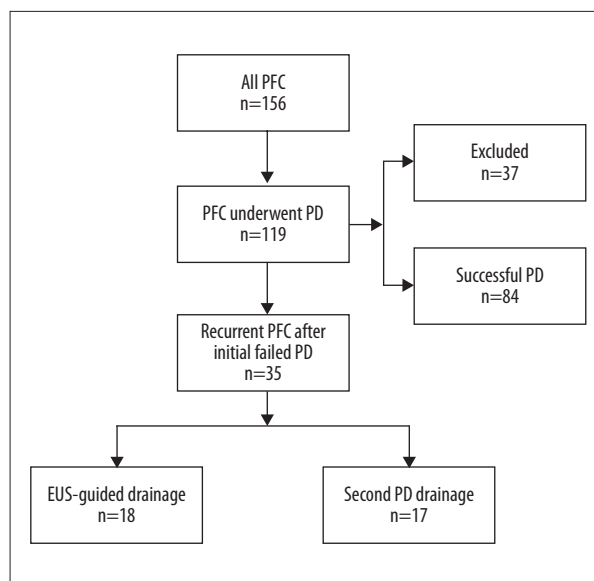


## Background

Pancreatic fluid collections (PFC) are a frequent complication of acute or chronic pancreatitis and may also result from pancreatic damage due to trauma, malignancy, or surgery [1,2]. Currently, the management of symptomatic PFC includes surgical, percutaneous, and endoscopic drainage [3]. However, the surgical approach is an invasive therapy, and it has a high recurrence, mortality, and adverse events rate [4]. Percutaneous drainage, by contrast, is a minimally invasive approach. Previous studies have confirmed that PFC drained via the percutaneous method is associated with risk of cutaneous fistula formation, cyst recurrence, and infection [5,6]. Furthermore, it requires complicated and special nursing care, such as frequent monitoring of fluid output and catheter changes at intervals. Although the success rate of percutaneous drainage ranges from 60% to 84% [7,8], recurrence is reported in 20% to 23% of patients [8,9]. Recurrent PFC after treatment of initial failed ultrasonography-guided percutaneous drainage has become a challenging clinical issue.

Currently, endoscopic drainage is now generally preferred over non-endoscopic drainage procedures and has become an optimal modality, superior to surgical or percutaneous approaches [10,11]. Endoscopic ultrasonography (EUS)-guided drainage has been successfully used to treat postoperative fluid collections. In a multicenter study reported by Mudireddy et al. [12] described that EUS-guided drainage for postsurgical fluid collections has a high technical success rate of 93.6% and a clinical success rate of 89.3%; moreover, adverse events are rare, with intra-procedure adverse events reported in only 4.25% and post-procedure adverse events in 6.4% patients. In another retrospective comparative study [13] of 23 patients who underwent partial pancreatectomy and subsequently developed PFC, EUS-guided drainage was demonstrated to be a safe and effective procedure, with a success rate of 100% and an adverse events rate of 9%. Similar results have been reported by Tilara et al. [14].

In recent years, EUS-guided drainage has become the mainstay of management for PFC [15,16]. Improvements in EUS devices and techniques have greatly improved treatment outcomes. The technical success rate ranges from 90% to 100% and the clinical success rate from 85% to 98% [17,18]; recurrence is reported in only 5% to 11% [19,20]. However, there is little data regarding the efficacy and safety of EUS-guided drainage in patients with recurrent PFC after initially failed percutaneous drainage. The primary aim of this study was to compare the treatment success, adverse events, recurrence rate, need for surgery, mortality, length of hospital stays, and number of follow-up CT scans in PFC patients treated with EUS-guided drainage and percutaneous drainage.



**Figure 1.** Flow chart of the study design. PFC – pancreatic fluid collections; PD – percutaneous drainage; EUS – endoscopic ultrasonography.

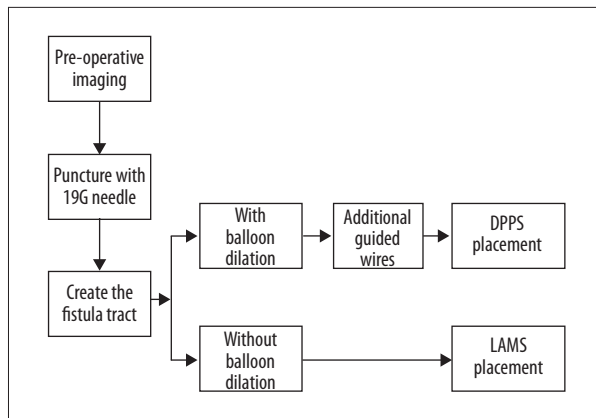
## Material and Methods

### Patients

This study was a retrospective analysis of percutaneous and EUS-guided PFC drainages performed at a single tertiary care center between February 2017 to May 2018. The study was approved by our institutional ethics committee. We included patients with symptomatic PFC, including pancreatic pseudocyst or walled-off necrosis, requiring drainage and patients who had undergone an initial percutaneous-guided PFC drainage. Both pancreatic pseudocyst and walled-off necrosis were defined per the 2012 revised Atlanta classification [21]. Patients were excluded if 1) coagulopathy (international normalized ratio >1.5) or thrombocytopenia (platelets <50 000/mm<sup>3</sup>); 2) pseudoaneurysm within the PFC or splenic vein thrombosis; 3) imaging showing immature cyst wall or >1 cm distance between the cyst wall and the gastrointestinal tract wall, especially for EUS drainage; 4) at least 6-month follow-up after drainage was not available; or 5) pregnancy. Figure 1 shows the flow chart of the study design.

### Procedure of the technique

All procedures were performed under anesthesia by experienced interventional operators (Dr. Jiang and Dr. Zhao). Cross-sectional computed tomography (CT) or magnetic resonance imaging (MRI) imaging of the abdomen was first performed to assess the features of the PFC (i.e., location, nature, size, number, maturity of wall, and distance from upper gastrointestinal tract) and to rule out the presence of pseudoaneurysm



**Figure 2.** Procedure of endoscopic ultrasonography-guided drainage. DPPS – double pigtail plastic stents; LAMS – lumen-apposing metal stents.

or splenic vein thrombosis, and color Doppler imaging of ultrasonography (US) was used to identify the presence of intervening vessels.

### Ultrasonography-guided percutaneous drainage

Percutaneous drainage was performed under US guidance. An 18-gauge needle (Cook Medical) was placed percutaneously into the PFC and fluid was aspirated. The Seldinger technique was used and the catheter tract was sequentially dilated over a 0.035-in guidewire (Boston Scientific, Natick, MA, USA). Then, an 8F-12F (Boston Scientific, Natick, MA, USA) drainage catheter was inserted into the collection over the guidewire and secured to the skin. At last, the collection was emptied as completely as possible. The drain output was monitored, and post-drainage follow-up imaging was performed. Catheter exchange or removal was decided by the operator based on clinical improvement as well as drainage catheter output, catheter

malfunction or dislodgement, and evidence of persistent fluid on repeat imaging.

### Endoscopic ultrasonography-guided drainage

EUS was performed using a linear array echoendoscope (Olympus Ltd., Tokyo, Japan) under fluoroscopic guidance to identify the ideal puncture site. Figure 2 shows the procedure of EUS-guided drainage. A 19-gauge needle (Cook Medical, Winston-Salem, NC, USA) was inserted into the cyst under real-time imaging. A long 0.035-inch guidewire was inserted through the 19-gauge needle into the cyst cavity and then coiled under fluoroscopic guidance. The needle was removed, leaving the guidewire in place. A 10F cystotome (Boston Scientific, Natick, MA, USA) was used to dilate the fistula tract. For the patients with walled-off necrosis a 10-mm balloon dilator (Boston Scientific, Natick, MA, USA) was used to dilate the tract, and endoscopic debridement was conducted. After the dilation, either 10F double pigtail plastic stents (DPPS; Cook Medical, Winston-Salem, NC, USA) or 1-cm lumen-apposing metal stents (LAMS; Boston Scientific, Marlborough, MA, USA) were deployed over the guidewires. Fluoroscopic guidance was used at the operator's discretion. The operator decided the type, size, and a number of stents to be placed, and whether or not debridement was performed.

### Follow-up and outcome measurement

We recorded the results of follow-up abdominal imaging including US, CT, or MRI, and radiographic examination obtained to specifically evaluate the PFC after the procedure until the time of resolution or recurrence. CT was performed in all patients at 4–8 weeks after the procedure for evaluation of resolution of the fluid collections. The stent was removed when the multiple imaging shows the PFC was completely resolved and without any residual

**Table 1.** Definitions of procedural outcomes.

Procedural outcomes	Definitions
Technical success	Technical success is defined as the ability to deploy the stent successfully at the time of endoscopic drainage
Clinical success	Clinical success is defined as complete resolution or decrease in the size of the pancreatic fluid collections to 2 cm or smaller on follow-up cross-sectional imaging and the resolution of symptoms without the need for further interventional therapy
Adverse event	Adverse event includes bleeding, perforation, infection, stent migration, pancreatic fistula et al. The intra-procedural adverse events occur during the endoscopic ultrasonography (EUS)-guided drainage procedure. The post-procedural adverse events occur after the procedure
Recurrence	Recurrence is defined as a collection reoccurring after removal of drains and requires another interventional therapy
Re-intervention	Re-intervention is defined as the requirement for a repeated procedure of the same pancreatic fluid collections (PFC)

**Table 2.** The demographics of patients.

Characteristic	Initial US-PD (n=119)		EUS-GD (n=18)		Second US-PD (n=17)	
Age(y)*	52	(25–78)	47	(28–61)	49	(25–68)
Gender						
Male	61	(51.3)	10	(55.6)	9	(52.9)
Female	58	(48.7)	8	(44.4)	8	(47.1)
Etiology of pancreatitis						
Gallstone	43	(36.1)	7	(38.9)	6	(35.3)
Alcoholic pancreatitis	30	(25.2)	5	(27.8)	5	(29.4)
Post-surgery/ERCP	21	(17.6)	3	(16.7)	4	(23.5)
Malignancy	15	(12.6)	2	(11.1)	1	(5.9)
Traumatic pancreatitis	8	(6.7)	1	(5.6)	1	(5.9)
Idiopathic	2	(1.7)	0	(0)	0	(0)
Symptoms						
Abdominal pain	89	(74.8)	14	(77.8)	12	(70.6)
Abdominal distension	76	(63.9)	12	(66.7)	11	(64.7)
Nausea and vomiting	47	(39.5)	6	(33.3)	6	(35.3)
Anorexia and early satiety	36	(30.2)	5	(27.8)	3	(11.6)
Size of PFC (cm)*	8.0	(6.1–12.9)	9.7	(6.1–12.6)	7.2	(6.0–10.7)
Location						
Pancreatic head	37	(30.1)	3	(16.7)	7	(41.2)
Pancreatic body and tail	82	(68.9)	15	(83.3)	10	(58.8)
Type of PFC						
PPC	95	(79.8)	11	(61.1)	9	(52.9)
WON	24	(20.2)	7	(38.9)	8	(47.1)
Blood examination						
Amylase (U/L)*	75	(20–551)	48	(29–272)	56	(26–381)
Serum white cell count (×10 <sup>9</sup> /L)*	6.8	(1.9–10.1)	8.3	(2.2–11.7)	6.7	(3.1–10.6)
Serum albumin (g/L)*	50	(24–84)	43	(30–55)	45	(26–58)

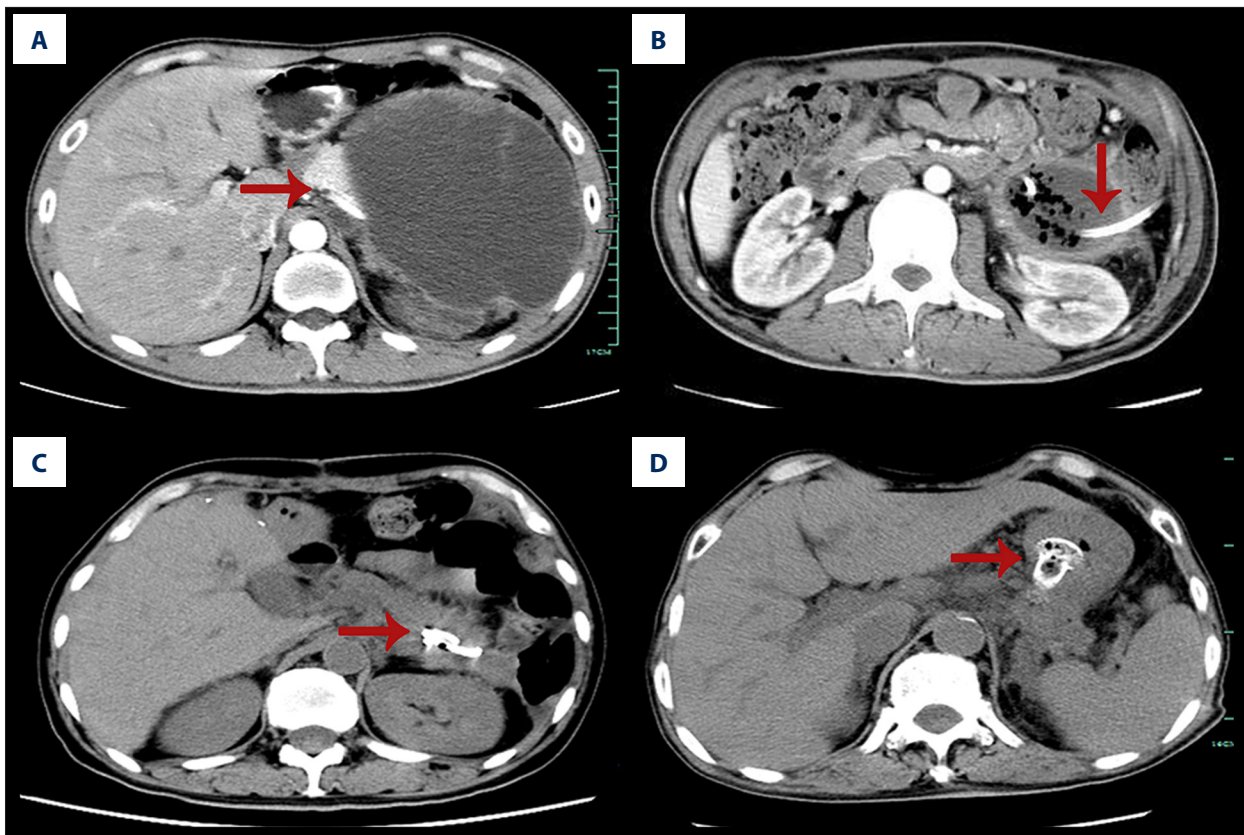
Unless otherwise specified, data are the numbers of patients, with percentages in parentheses. US-PD – ultrasonography-guided percutaneous drainage; EUS-GD – endoscopic ultrasonography-guided drainage; ERCP – endoscopic retrograde cholangiopancreatography; PFC – pancreatic fluid collections; PPC – pancreatic pseudocysts; WON – walled-off necrosis.

\* Data are presented as median with range.

fluid component left. Patients were then followed at regular intervals after stent removal. Outcome measures were treatment success, adverse events, recurrence, need for surgery, mortality, re-intervention, length of hospital stay, and number of follow-up CT scan. Definitions of procedural outcomes are revealed in Table 1.

### Statistical analysis

Statistical analysis was performed using SPSS for Macintosh, version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as median with range and the categorical



**Figure 3.** Representative computed tomography images. (A) show a huge pancreatic fluid collection (PFC) in the pancreatic tail (arrow); (B) showed the resolution of the PFC and the catheter (arrow) after percutaneous drainage (PD). (C, D) Show a plastic stent and a metal stent deployed between the stomach and pancreatic fluid collections, respectively (arrow).

data were summarized as number and percentages. For categorical variables, differences between the two groups were analyzed with the chi-squared test or Fisher's exact test. For continuous variables, Mann-Whitney U-test was used to analyze.  $P < 0.05$  was considered as statistically significant.

#### Ethics statement

The Ethics Committee of the First Affiliated Hospital, College of Medicine, Zhejiang University approved the study (Ethics Committee Approval: 09/07/2018-769).

## Results

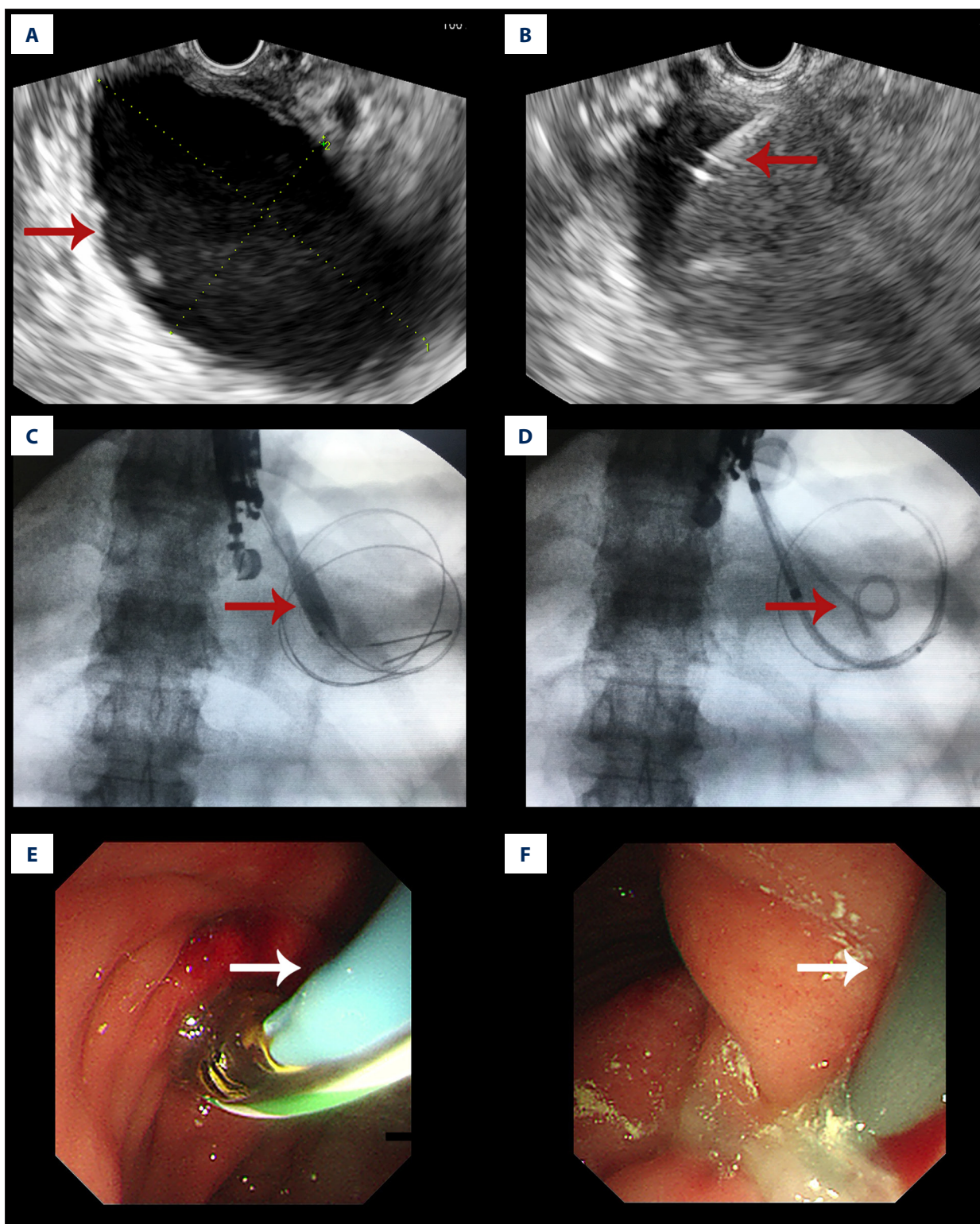
#### Patient characteristics

From February 2017 to May 2018, a total of 156 PFC patients were initially selected for this study. Patient demographics are outlined in Table 2. There were 37 patients excluded for spontaneously resolved ( $n=15$ ), non-percutaneous drainage ( $n=12$ ), did not accept drainage in our hospital ( $n=10$ ) (Figure 1), which leaved 119 patients with symptomatic PFC in whom

experienced initial percutaneous drainage for analysis. Then, 35 patients were recurrent, and 18 patients were treated with EUS-guided drainage, while the remaining 17 patients were addressed by the second percutaneous drainage procedure. The most common etiologies of pancreatitis were gallstones (36.1%) and alcoholic pancreatitis (25.2%), and the most frequent symptoms were abdominal pain (74.8%) and distension (63.9%). Figures 3 and 4 show representative CT and EUS images of PFC patients, respectively.

#### Technical success and recurrence

We performed the initial percutaneous drainage for PFC in 119 patients. No patient was lost to follow up. Statistical differences in the main outcomes are shown in Table 3. The technical success of the initial percutaneous drainage was achieved in 119 out of 119 patients (100%), while the clinical success was achieved in 84 out of 119 patients (70.1%). Thirty-five patients (29.4%) developed recurrent fluid collections after catheter removal and required alternative treatments: 18 patients were treated with EUS-guided drainage and 17 patients were managed with the second percutaneous drainage procedure. The technical success of the second percutaneous drainage



**Figure 4.** Endoscopic ultrasonography images and fluoroscopic images: (A, B) representative endoscopic ultrasonography (EUS) images. (A) Shows a big pancreatic pseudocyst in the pancreatic tail (arrow). (B) Shows the 19-gauge needle used to puncture the pancreatic fluid collection (arrow). (C, D) Show representative fluoroscopic images. (C) Shows a long 0.035-inch guidewire inserted into the collection and then coiled under fluoroscopic guidance (arrow). (D) Shows a plastic stent deployed under fluoroscopic guidance (arrow). (E, F) Endoscopic images showing the deployed plastic stent (arrow).

**Table 3.** The clinical outcomes of patients treated with percutaneous-guided and endoscopic ultrasonography-guided drainage.

Clinical outcomes	Initial US-PD (n=119)	EUS-GD (n=18)	Second US-PD (n=17)	P value*	P value**
Success rate					
Technical success	119 (100)	18 (100)	17 (100)	1.000	1.000
Clinical success	84 (70.1)	16 (94.4)	9 (52.9)	0.154	0.027##
Adverse events					
Total	19 (16.0)	2 (11.1)	5 (29.4)	0.739	0.228
Intra-procedural	5 (4.2)	1 (5.6)	2 (11.8)	0.578	0.603
Post-procedural	14 (11.8)	1 (5.6)	3 (17.6)	0.692	0.338
Recurrence	35 (29.4)	2 (11.1)	8 (47.1)	0.154	0.027##
Re-intervention	41 (34.5)	2 (11.1)	9 (52.9)	0.047##	0.012##
Need for surgery	1 (0.8)	0 (0)	5 (29.4)	1.000	0.019##
Mortality	0 (0)	0 (0)	0 (0)	1.000	1.000
Length of hospital stays length(day)#	12 (4–65)	8 (5–16)	13 (7–56)	<0.001##	<0.001##
Follow-up(month)#	14 (6–21)	10 (6–15)	12 (6–18)	<0.001##	0.052
No. of follow-up CT scan(time)#	3 (2–4)	2 (1–3)	4 (2–5)	0.006##	<0.001##

Unless otherwise specified, data are the numbers of patients, with percentages in parentheses. \* *P* was compared between the initial PD group and EUS group; \*\* *P* was compared between the second PD group and EUS group. US-PD, ultrasonography-guided percutaneous drainage; EUS-GD, endoscopic ultrasonography-guided drainage. # Data are presented as median with range; ## data are <0.05.

was in 17 out of 17 patients (100%), while the clinical success was only achieved in 9 out of 17 patients (52.9%). Eight patients (47.1%) developed recurrent fluid collections during the follow-up period and needed more percutaneous drainage or surgery.

A total of 18 patients underwent EUS-guided drainage, all the patients had experienced the initial percutaneous drainage and the PFC was recurrent. Similarly, the overall technical success rate of EUS-guided PFC drainage was also 100%. The overall clinical success rate was 94.4%, only 1 patient (5.6%) had stent migration and required a second endoscopic intervention. Recurrence was in 2 patients (11.1%) due to disconnected pancreatic duct syndrome and alcoholic chronic pancreatitis.

### Adverse events

In the initial percutaneous drainage group, adverse events occurred in 19 out of 119 patients (16.0%), including 5 intra-procedural adverse events (4.2%) and 14 post-procedural adverse events (11.8%). There were 3 episodes of bleeding and 2 patients had intense pain during the procedure. The 3 bleeding patients were treated by emergency operation, hemostatic drugs, and continuous compression, respectively; while the

2 patients with pain were addressed by lidocaine. There were 6 patients with infection, 4 cases with fistula, 2 patients with bleeding, and 2 cases of catheter dislodgements after the procedure. Among them, the infectious patients were managed with anti-infective therapy and changed to a new catheter. All the pancreatic fistulas were addressed by more percutaneous drainage until the fistula was closed. Additionally, 2 bleeding patients were controlled by intravenous administration of hemostatic drugs. The remaining 2 patients experienced catheter dislodgement treated by changing a new catheter. In the second percutaneous drainage group, adverse events existed in 5 out of 17 patients (29.4%), including 2 intra-procedural adverse events and 3 post-procedural adverse events. Two cases of intra-procedural bleeding and 1 post-procedural bleeding were treated by radiologic embolization and hemostatic drugs. Besides, 2 infectious patients were addressed by anti-infection drug and changing a new catheter.

Adverse events occurred in 2 out of 18 patients (11.1%) in EUS-guidance drainage group, including 1 intra-procedural adverse events (5.6%) and 1 post-procedural adverse events (5.6%). One pancreatic pseudocyst patient experienced acute and severe bleeding during the procedure, which has been reported by our team [22]. In brief, the bleeding was controlled by balloon

dilatator compression under endoscopic guidance and did not recur during the 10-month follow-up. The post-procedural adverse event was infection, and the patient was managed with intravenous antibiotics for 7 days. However, the follow-up CT imaging revealed total migration of the stent into the cavity at 20 days post procedure. Then, the stent was removed, and the patient was successfully managed with endoscopic nasocystic drainage.

### Need for surgery and re-intervention

There were 1 out of 119 patients (0.8%) who needed surgery in the initial percutaneous drainage progress, and 41 out of 119 patients (34.5%) required re-intervention during the follow-up. The median hospital stays length and follow-up CT scan were 12 days and 3 times, respectively. There were 5 out of 17 patients (29.4%) needed surgery in the second percutaneous drainage progress, and 9 patients (52.9%) required re-intervention. The median hospital stays length and follow-up CT scan were 13 days and 4 times, respectively. There was no need for surgery and only 2 patients (11.1%) needed re-intervention in the EUS-guidance drainage progress. The median hospital stays length and follow-up CT scan were 8 days and 2 times, respectively. Fortunately, there were no deaths in all processes.

## Discussion

EUS-guided drainage is now a recognized first-line procedure for the management of symptomatic pancreatic collections [4,23,24]. Furthermore, previous studies have reported that EUS-guided drainage is better than percutaneous drainage for PFC due to the high success rate and low recurrence rate [7,25]. However, there is minimal data available regarding the efficacy and safety of EUS-guided drainage for the treatment of recurrent PFC after initial percutaneous drainage. In the present study, we observed that EUS-guided drainage is an effective and safe approach in patients with recurrent PFC. Therefore, it is understandable that EUS-guided drainage would be a useful modality of choice to treat those conditions where an initial percutaneous drainage for PFC has failed.

A clearly positive trend to EUS-guided drainage is shown regarding its shorter length of hospital stays, less re-intervention, less number of follow-up CT scan although there was not reached statistical significance compared with initial percutaneous drainage in the technical success, clinical success, total adverse events rates, and recurrence (all  $P>0.05$ ), possibly because of the small sample size of the EUS-guided drainage. Therefore, further studies that include larger sample populations and prospective design are needed. Additionally, in our study, we also found EUS-guided drainage had higher clinical

success, shorter length of hospital stays, less re-intervention, fewer number of follow-up CT scan and less recurrence compared with the second percutaneous drainage procedure, and there was also no difference in the technical success and total adverse events rates (all  $P>0.05$ ). These results revealed EUS-guided drainage is a more appropriate procedure than percutaneous drainage for the recurrent PFC due to a better clinical outcome.

The previous study [26] compared endoscopic drainage versus percutaneous drainage for symptomatic pseudocysts and showed technical success, clinical success, and adverse events (all  $P>0.05$ ) were similar between the 2 approaches; however, patients who underwent percutaneous drainage had higher re-intervention rate, longer length of hospital stays, and more follow-up abdominal imaging than patients who underwent endoscopic drainage. Another comparative study [13] reported a higher clinical success and a lower adverse events rate of EUS-guided drainage compared to percutaneous drainage for PFC patients following partial pancreatectomy (100.0% versus 78.6% and 8.3% versus 35.1%). In the studies reported by Akshintala et al. [26] and Kwon et al. [13], the authors included patients with initial PFC treatment. Their results reported are similar to our data, despite our sample including patients with recurrent PFC after originally failed percutaneous drainage. This is a very important point because, with our data, the importance of EUS drainage in different settings not only for initial PFC but for the recurrent PFC is demonstrated; additionally, we found EUS drainage had improved the efficacy for the recurrent PFC after previously failed percutaneous drainage procedure.

The use of EUS-guided drainage is increasing. The previous study has demonstrated that EUS-guided drainage for initial PFC has a high success rate and low adverse events rate. In a recent retrospective single-center study of 103 PFC patients treated with EUS-guided drainage, Lang et al. [27] reported overall technical success rate and clinical success rate of 99.0% and 95.0%, respectively; There were 4 episodes of PFC recurrence (3.9%) and the adverse events were observed in 19 out of 103 (18.4%). In a multicenter study, Vazquez-Sequeiros et al. [28] reported the clinical and technical success rates were 97% and 94%, respectively; and the adverse events were in 44 out of 211 (20.9%). In both studies, patients treated with EUS-guided drainage had a shorter length of hospital stays, quicker post-procedure recovery, and significantly lower morbidity than patients receiving non-endoscopic treatment. These reports are in line with a meta-analysis of 688 PFC patients treated by EUS-guided drainage [5] and our study results.

It is important to highlight that no patient in our sample needed surgical intervention and no procedure-related deaths occurred in the EUS-guided drainage group. The previous study has also reported a low incidence of recurrence. In a retrospective study,



Siddiqui et al. [29] found that no patient had a recurrence of PFC after stent removal. Another multicenter study by Lakhtakia et al. [30] revealed PFC recurrence after stent removal occurred in 2.4% of patients. A recent study evaluated the clinical outcomes of pancreatic pseudocyst and reported that 8.5% of patients had the recurrence of pancreatic pseudocyst after stent removal [31]. In the present study, only 2 patients (11.1%) had a recurrence for EUS-guided drainage, while 32 out of 119 patients (26.9%) were recurrent in the initial percutaneous drainage group. There could be several reasons for the relatively low incidence of adverse events and recurrence with EUS-guided drainage treatment than with percutaneous drainage treatment [32–34]. EUS-guided drainage is a minimally invasive technique that allows accurate pre-procedure evaluation of lesion, the surrounding vessels, and the distance between the PFC and the stomach, which decreases the risk of bleeding and perforation. Minimizing recurrence is an important aim of treatment.

The major strength of this study is that we tried to solve an important and challenging clinical problem. The clinical outcomes of EUS-guided drainage for recurrent PFC after initial failed

percutaneous drainage treatment is yet to know. Our present study revealed that EUS-guided drainage for recurrent PFC had high efficacy and good performance. This study has several limitations. First, the sample size of the EUS drainage group was small. Second, the follow-up period was relatively short. However, long-term follow-up of these patients is continuing. Third, this was a retrospective study of patients from a single center. Fourth, there is a risk of operator bias because the study design was not blinded. Therefore, large-scale multicenter and prospective studies are needed to confirm the findings of this study.

## Conclusions

In conclusion, EUS-guided drainage appears to be an effective and appropriate procedure for the treatment of recurrent PFC after initial percutaneous drainage and it should be a useful modality to treat those collections. The clinical success rate is high, and the incidence of adverse events and recurrence is low, the number of follow-up CT scan is less, and hospital stay length is short.

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