Original Article

Potential factors affecting success rate and long term outcome in single balloon enteroscopy-assisted therapeutic endoscopic retrograde cholangiopancreatography in patients with pancreaticojejunal anastomotic stenosis: a retrospective study

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Background: Pancreaticojejunal anastomotic stenosis (PJS) after pancreaticoduodenectomy (PD) is difficult to treat. Single-balloon enteroscope-assisted endoscopic retrograde pancreatography (SBE-assisted ERP) is a safe way to treat PJS with the strength of minimally invasion and repeatability, but since its technical difficulty and few patient number, data on long-term outcomes remain limited. The optimal treatment is still unknown. We aim to study the safety, effectiveness, and long-term outcome of single balloon enteroscopy-assisted (SBE-assisted) therapeutic ERP in patients with PJS in this study.

Methods: The clinical information of patients undergoing SBE-assisted therapeutic ERP from March 2016 to March 2021 were retrospectively analyzed. All patients were diagnosed as PJS and without any contraindication for therapeutic endoscopy. Treatment details, postoperative complications, factors influencing technical success rate were evaluated. Long-term outcomes results were obtained by clinical or telephone follow-up.

Results: Sixteen patients with median age of 51 years were included in this study, surgical reconstruction methods including PD with Whipple reconstruction, PD with Child reconstruction, pylorus-preserving pancreaticoduodenectomy (PpPD) with Whipple reconstruction. Eight patients were successfully treated. No serious complications happened. Risk factors for the failure of pancreaticojejunal anastomotic site identification include the digestive tract reconstruction sequence, pancreaticojejunostomy method, pancreatic duct tube implantation, pancreatic duct width before surgery, and pancreatic fistula during perioperative period. The median follow-up time was 77.2 months, the mean indwelling time of the stent was 62.3 months [interquartile range (IQR), 6.8–153.7 months]. Two of eight patients developed recurrent PJS. The variation in body mass index (BMI) was +2.46 in the non-recurrence group compared to –1.09 in the recurrence group and –2.12 in the endoscopic retrograde cholangiopancreatography (ERCP) treatment failure group.

Conclusions: ERP intervention should be carried out early once PJS occurs in order to increase success rate. BMI is a crucial indicator which can reflex PJS rehabilitation degree during follow-up. In order to reduce PJS recurrence rate, a wider pancreatic stent and a longer stent indwelling time are recommended.

Keywords: Pancreaticoduodenectomy (PD); pancreaticojejunostomy anastomotic stricture (PJS); endoscopic

retrograde pancreatography (ERP); single balloon enteroscopy (SBE); BMI

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Introduction

With the progress of surgical techniques and the improvement in comprehensive treatment, the safety of pancreaticoduodenectomy (PD) and treatment effectiveness of malignant tumours have been significantly improved. Many patients have achieved long-term postoperative survival (1,2). Late complications after PD are common, and include bile duct stones, choledochojejunal anastomotic stenosis (CJS), pancreaticojejunal anastomotic stenosis (PJS), and recurrent pancreatitis (3), which seriously affect the quality of life of patients. Among these complications, PJS and chronic pancreatitis are difficult to treat, although relatively rare (4,5). Operative revision of the PJ is one of the main intervention to remedy the symptomatic and physiologic complications of this anastomotic stricture. Recently endoscopic treatments such as endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic ultrasonography-guided pancreatic drainage (EUS-PD) has been increasingly used as it has the advantages of being minimally invasive and repeatable, and has been shown to be superior to traditional surgical operations (6-8). However, effective treatment methods and standardized treatment strategies are still lacking. We conducted a retrospective study to analyse patients with PJS who were treated by therapeutic ERCP using single-balloon-assisted enteroscopy (BAE) at our centre over the past 5 years. We analysed and summarized the clinical data, diagnostic and treatment processes, and follow-up conditions with the goal of providing insights for the optimal diagnosis and treatment of such patients in the future. We present the following article in accordance with the STROBE reporting checklist (available at https://gs.amegroups.com/article/view/10.21037/gs-22-692/rc).

Highlight box

Key findings

- Thicker pancreatic duct stents and long stent indwelling time can reduce the recurrence odds of PJS.

What is known and what is new?

- ERP is a safe alternative to treat PJS, although anastomotic site identification successful rate is relatively low.
- Late ERP intervention, digestive tract reconstruction method, pancreaticojejunostomy method, pancreatic duct tube placement during PD, pancreatic duct dilation before PD, and postoperative pancreatic fistula are potential factors affecting success rate.

What is the implication, and what should change now?

- Early endoscopic intervention should be carried once PJS occurs.

Methods

Patient selection

We retrospectively analyzed the clinical data and conducted follow-up of patients with PJS who underwent BAE-ERCP from March 2016 to March 2021 at Xinhua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, and their following characteristics were evaluated: Gender, age, reason for surgery, operation course, perioperative time recovery information, PJS occurrence time and symptoms. Indications for BAE-ERCP included the following: (I) abdominal pain, emaciation, and other clinical symptoms consistent with chronic pancreatitis; (II) CT or MRCP indicating dilation of the pancreatic duct, with or without pancreatic duct stones; and (III) elevation in amylase levels three times higher than normal. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of Xinhua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine (No. XHEC-D-2022-044). Individual consent for this retrospective analysis was waived.

Enteroscopy and therapeutic equipment

We used SIF-260 single balloon enteroscope with a working length of 200 cm, a outer diameter of 9.2 mm and a 2.8 mm biopsy channel (Olympus Medical Systems, Tokyo, Japan). The sphincterotome or catheter with 320 cm length and a 600 cm guidewire (COOK, United States) were used for cannulation. Balloon dilator and 5 or 7 Fr pancreatic stent (Cook, United States) were also employed.

ERCP procedure

For the ERCP procedure, the anaesthesiology, digestive endoscopy, and surgery departments worked cooperatively to enhance the diagnostic and treatment success. The patient was placed in the supine position, and a ventilator was used to assist endotracheal intubation anaesthesia. SBE was performed by an endoscopist and a nurse who worked together to perform the operation. A CO_2 supply was used.

First, the enteroscope was positioned near the gastrointestinal anastomotic site. During intubation, the endoscopist frequently checked under X-ray to move the scope towards the upper right abdomen and to ensure it was placed in the afferent loop. After the scope was positioned under the lower margin of the liver, the pancreaticojejunal anastomotic site was located, and cannulation was performed. For patients whose site was difficult to identify, the scope was carefully and slowly withdrawn after reaching the end of enteric cavity then repositioned. In the process of searching, the orientation and position of the endoscope tip was monitored by X-ray. Since the surface projection of the pancreatic duct opening is often located at the right side of the spine and the pancreatic duct is axially perpendicular to the spine, the search area could be narrowed to the loop where the scope direction and location were both concordant. For patients with many intestinal wall folds, a sphincterotome or catheter tip was used to gently lift the folds. After successful cannulation of the pancreatic duct, pancreatography was conducted, then, anastomotic dilation, pancreatic duct stone removal, or pancreatic duct stent placement was performed according to the diameter of the pancreatic duct and severity of PJS (*Figure 1*).

Outcome definitions and follow-up

Enteroscopy was considered successful when access to the pancreatic-enteric anastomotic site was achieved. Diagnostic success was defined as the acquisition of a pancreatogram, while treatment success was defined as completion of the intended intervention procedure. ERCP-related adverse events were categorized using ERCP consensus guidelines (9). Recurrence of pancreatic duct stenosis was defined as abdominal pain, pancreatic duct dilation, or the repeat elevation of amylase levels (10). All patients were followed up every 3 months to determine whether further ERCP was needed, and the end point of the follow-up was April 10, 2021, or the date of death.

Statistical analysis

Analyses were performed using SPSS version 23.0. The results are expressed as the median and interquartile range (IQR). Continuous variables were compared using Student's *t*-test, and non-continuous variables were compared using Fisher's exact test. A P value <0.05 was considered statistically significant.

Results

Patient demographics and clinical characteristics

A total of 16 patients underwent BAE-ERCP, comprising seven men and nine women, and their average age was 51 (range, 18–70) years. The detailed characteristics of patients are shown in *Table 1*. Surgical procedures included PD with Whipple reconstruction (n=11), PD with Child reconstruction (n=4), and pylorus-preserving pancreaticoduodenectomy (PpPD) with Whipple reconstruction (n=1). All patients had varying degrees of abdominal pain and weight loss, and abdominal CT showed abnormal manifestations, such as pancreatic duct thickening, peripancreatic exudation, or pancreatic duct stones.

Treatment details and ERCP success rate

The treatment success rate and complication rate are shown in *Table 2*. Of all 16 patients, successful enteroscopic access to the intestinal loop where the pancreaticojejunal anastomotic site was located was achieved in 14 patients, with a scope intubation success rate of 87.5%, while two cases failed due to bending of the afferent loop. When the enteroscope was successfully placed, the pancreaticojejunal anastomotic sites of seven cases could be successfully identified, with a success rate of 50%. In one case, the initial ERCP failed to identify the anastomotic site, but EUS-PD + ERCP was successfully performed (*Figure 2*). Therefore, eight patients were successfully treated, and the overall success rate of the treatment was 50%. Among these eight patients, one underwent catheter dilation, seven underwent catheter or balloon dilation and then pancreatic duct stent placement (ERPD), and six patients received multiple ERCP treatments. The main goals of subsequent treatment included the assessment of anastomotic site dilation effectiveness or the replacement or removal of stents. All subsequent ERCP procedures were

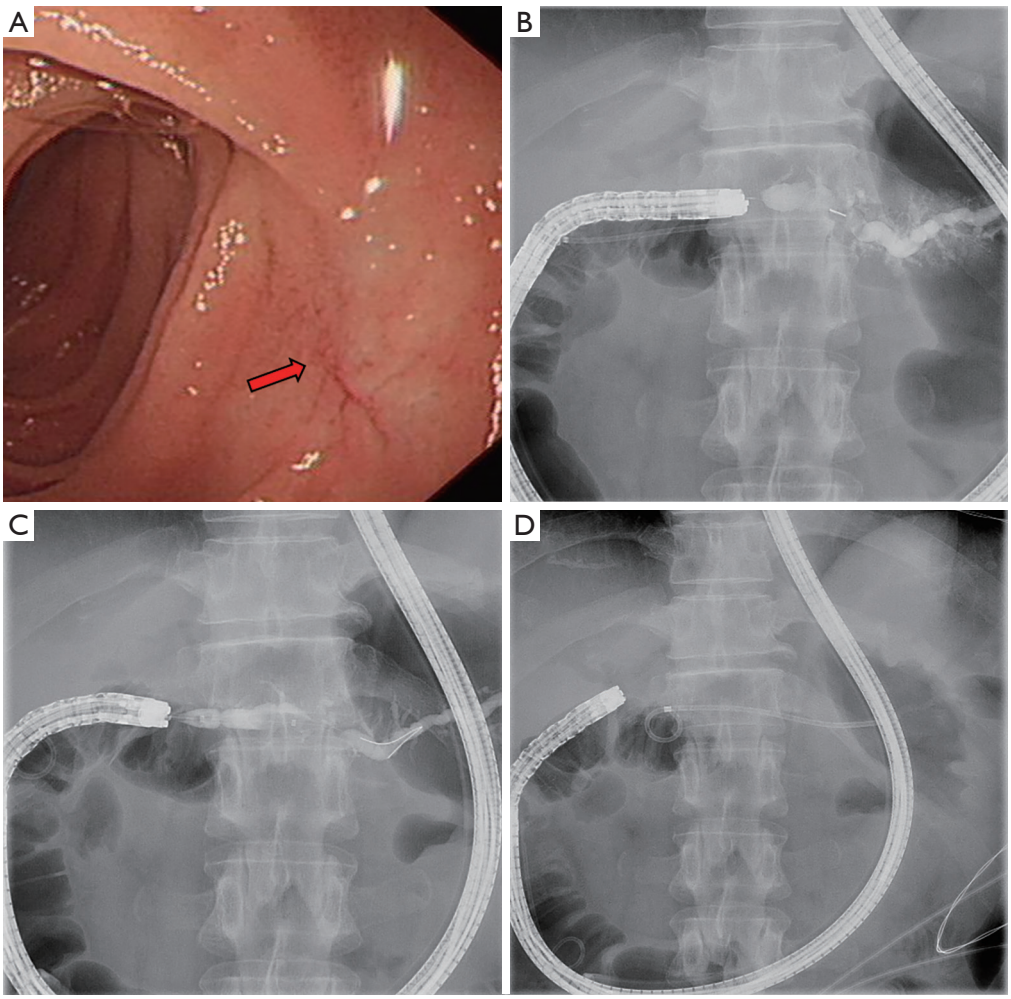

Figure 1 The procedure of single balloon enteroscopy-assisted endoscopic retrograde pancreatic drainage. (A) Endoscopic view of the PJ anastomotic stricture with pinhole-like opening and scar tissue. The red arrow indicates pancreaticojejunostomy. (B) Pancreatogram showing a dilated pancreatic duct. (C) A balloon catheter was used to dilated PJ anastomotic stricture. (D) A 7 Fr plastic stent was placed. PJ, pancreaticojejunostomy.

successful, and no patient experienced severe pancreatitis, gastrointestinal perforation, gastrointestinal bleeding, or other serious complications.

Analysis of risk factors for the failure of pancreaticojejunal anastomotic site identification

Of the 14 patients in whom enteroscopic entry was successful, seven achieved successful anastomotic site identification and there were seven cases of failure. The interval between the first occurrence of abdominal pain after PD operation in the successful group was significantly longer than in the failed group, while the time from symptom onset to the first ERCP intervention was shorter than in the failed group, with statistically significant differences (*Table 3*). The interval between PD surgery and the first ERCP intervention was not significantly different between the two groups. Univariate analyses were performed to evaluate the factors associated with anastomotic site identification failure, and the results showed this was related to the digestive tract reconstruction method, pancreaticojejunostomy method, pancreatic duct tube placement during PD, pancreatic duct dilation before PD, and postoperative pancreatic fistula (*Table 4*).

Table 1 Patient characteristics

Patients	N=16
Sex (male/female)	7/9
Age (years), median [range]	51 [18–70]
Primary disease	
Bile duct cancer	1
Pancreatic cancer	3
Ampullary cancer	2
Cystadenoma of the pancreas	2
SPNs of the pancreas	2
Duodenal malignant tumour	3
IPMN	3
Reconstruction methods	
PD with Whipple reconstruction	11
PD with Child reconstruction	4
PpPD with Whipple reconstruction	1
Symptom	
Abdominal pain	16
Fever	2
Diarrhoea	4
Weight loss	16
Diabetes	3
Imaging findings	
PD dilation	9
PD stone	2
Peripancreatic exudation	6

SPNs, solid pseudopapillary neoplasms; IPMN, intraductal papillary mucinous neoplasm; PD, pancreaticoduodenectomy; PpPD, pylorus-preserving pancreaticoduodenectomy.

Table 2 ERCP treatment details

Outcome	Number (%)
Success rate (N=16)	
Enteroscopy success rate	14 (87.5)
Diagnostic success rate	8 (50.0)
Treatment success rate	8 (50.0)
Number of ERCP procedures (N=8)	
Once	2 (25.0)
Twice	5 (62.5)
Three times	1 (12.5)
Characteristics of the anastomotic site (N=8)	
Pinhole-like	3 (37.5)
Split-like	3 (37.5)
Membranous stenosis	2 (25.0)
Cannulation (N=8)	
A combination of EUS-PD	1 (12.5)
Enteroscope	7 (87.5)
Intervention (N=8)	
Pre-cutting of anastomotic site	1 (12.5)
Dilation of anastomotic site	8 (100.0)
Dilating catheter	6 (75.0)
Cylindrical balloon	2 (25.0)
Extraction of PD stone	1 (12.5)
Stent placement	7 (87.5)
The initial placement of 5 Fr	4 (50.0)
The initial placement of 7 Fr	3 (37.5)
Replace 5 Fr with 7 Fr	3 (37.5)
Stent removal	3 (37.5)
Complications after ERCP	
Pancreatitis	0
Gastrointestinal perforation	0
Gastrointestinal bleeding	0

ERCP, endoscopic retrograde cholangiopancreatography; EUS-PD, endoscopic ultrasonography-guided pancreatic drainage.

Subsequent treatment and follow-up

The median follow-up time of the eight patients in whom ERCP treatment was successful was 77.2 months (IQR, 6.8–187.7 months), and the mean indwelling time of the stent in seven of these patients was 62.3 months (IQR, 6.8–153.7 months). The follow-up results are shown in *Table 5*. The BMI of all patients who received successful clinical treatment increased significantly in the years after ERP. Patients who experienced treatment failure or recurrence of PJS all suffered different degrees of weight loss, while the BMI in one patient was found to have increased by 1.12 within 16 months after the initial successful treatment. However, after recurrence, his BMI decreased by 1.46 within 3 months. The detailed treatment process of all

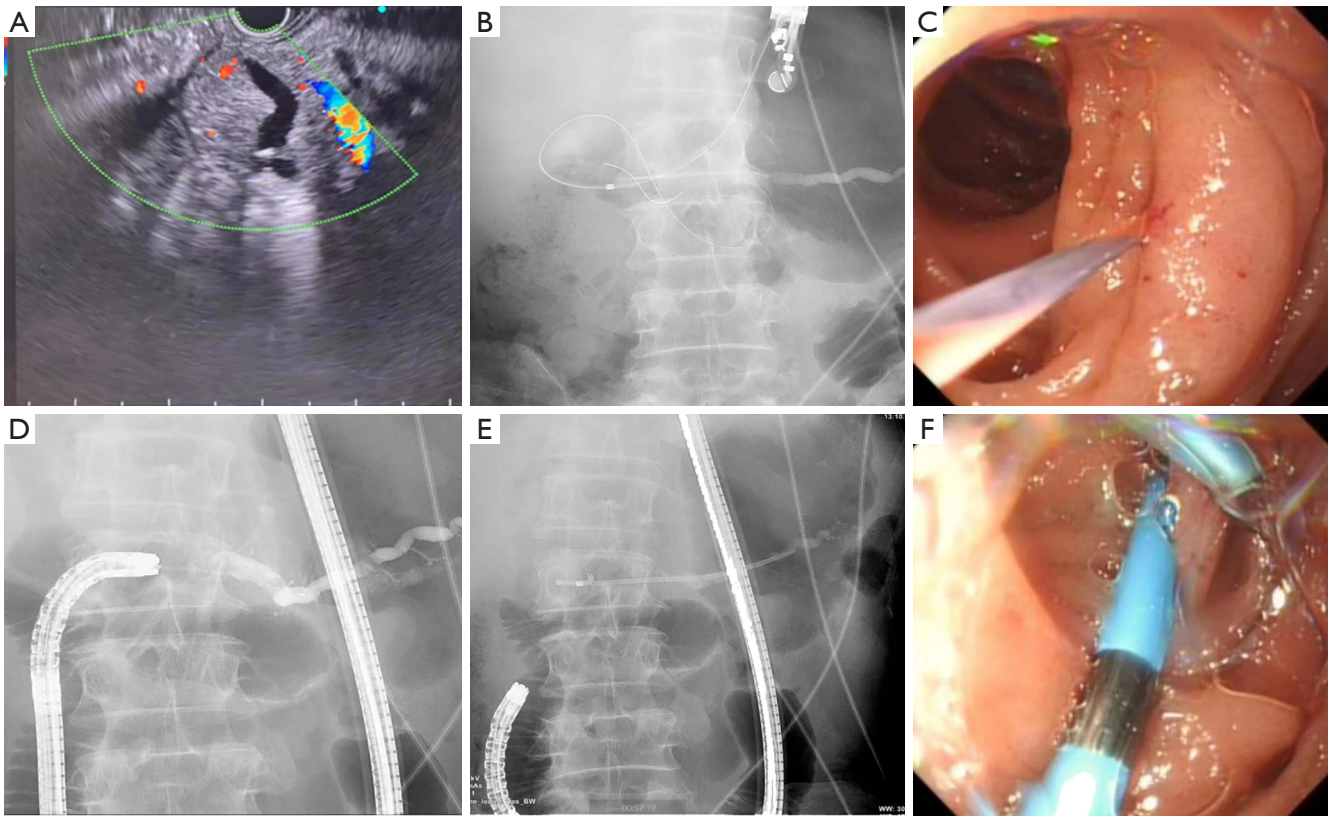

Figure 2 The procedure of EUS-guided pancreatic duct drainage using rendezvous technique for PJ stricture. (A) Endosonographic view of the dilated main pancreatic duct. (B) The pancreatic duct was successfully punctured by FNA needle. (C) A 0.025-inch guidewire was then advanced through the stricture and curled in the small bowel. (D) A single balloon enteroscopy was then advanced into the afferent limb and the guidewire located and grasped with a biopsy forceps. (E,F) A 7-Fr plastic stent was placed. EUS, endoscopic ultrasonography; PJ, pancreaticojejunostomy; FNA, fine needle aspiration.

Table 3 Anastomotic site identification failure and related factors

Factors	Successful anastomotic site identification	Failed anastomotic site identification	P
Time from the operation to the first abdominal pain event (months)	44.71	19.86	0.044
Time from the operation to the first ERCP intervention (months)	53.14	42.29	0.372
Time from symptom onset to the ERCP intervention (months)	8.43	22.43	0.021

ERCP, endoscopic retrograde cholangiopancreatography.

patients is shown in *Table 6*. Among the two patients who experienced recurrence of pancreatitis, the first only underwent dilation of the pancreaticojejunal anastomotic site without stent implantation during the ERP process. However, the pancreatitis recurred 2 months later, and the patient then chose surgical treatment. The second patient underwent anastomotic dilation and 5-Fr pancreatic duct stent implantation for the first ERP, and his pancreatitis symptoms were initially relieved. However, 16 months later, he requested stent removal and refused to replace it with a 7-Fr stent, and pancreatitis again recurred one month later. Remedial ERP to insert another stent after another 2 months was unsuccessful due to failure of anastomotic site identification, and he finally chose surgery but died of

Table 4 Single-factor analysis of anastomotic site identification failure

Factors	Category	Successful anastomotic site identification	Failed anastomotic site identification	P
Age	<60 years	3	3	1.000
	≥60 years	4	4	
Sex	Male	4	3	0.606
	Female	3	4	
Primary disease (benign or malignant)	Benign	4	4	1.000
	Malignant	3	3	
Digestive tract reconstruction method	Whipple	7	3	0.001
	Child	0	4	
Method of pancreaticojejunostomy	Invagination	4	0	0.001
	Duct to mucosa	3	7	
Pancreatic duct dilation before PD	Yes	6	2	0.037
	No	1	5	
Pancreatic duct tube placement during PD	Yes	6	2	0.037
	No	1	5	
Postoperative pancreatic fistula	Yes	1	6	0.010
	No	6	1	
Pancreatic duct dilation before ERCP	Yes	3	3	1.000
	No	4	4	
Pancreatic duct stones	Yes	1	2	0.530
	No	6	5	
AMY increases before ERCP	Yes	5	4	0.591
	No	2	3	

PD, pancreaticoduodenectomy; ERCP, endoscopic retrograde cholangiopancreatography; AMY, amylase.

postoperative bleeding. Among the remaining six patients who did not experience recurrence, two underwent ERP with implantation of 7-Fr stents, which have been retained to date; two patients underwent another ERP procedure to replace the 5-Fr stent with a 7-Fr stent after more than one year, which have been retained to date; and two patients underwent 7-Fr stent implantation after more than one year, and no recurrence occurred after stent removal.

Discussion

According to research, the success rate of endoscopic treatment for bile duct-related disease after PD is relatively high, at approximately 50–94% (11-14). However, the success rate of endoscopic treatment for pancreatic diseases is only 8–38% (15-17), because the pancreaticojejunal anastomotic site is difficult to identify and pancreatic duct cannulation is challenging. Repeatability is one of the advantages making endoscopic treatment better than traditional surgery, and in this study, the success rate of BAE-ERCP treatment was 50%, which was superior to the results reported in relevant articles (18,19), with six patients undergoing successful treatment multiple times. The first ERCP intervention was beneficial for confirming the digestive tract structure and for dilating the pancreaticojejunal anastomotic site, which made subsequent ERCP procedures easier to perform. No severe complications occurred in our study, including

Table 5 Follow-up results

Characteristic	Value
Median follow-up time (n=8, months)	77.2 (6.8–187.7)
Stent indwelling time (n=7, months)	62.3 (6.8–153.7)
Stent displacement (yes/no)	0/7
Stent congestion (yes/no)	0/7
Stent removal (yes/no)	3/4
Relapse (yes/no)	2/6
Recurrence time after last ERCP (n=2, months)	1.1
Treatment for recurrent patients (surgery/ERCP/conservative)	2/0/0
Treatment results (success/failure)	0/2
BMI variation	
Non-recurrence group (n=6)	2.46
Recurrence group (n=2)	–1.09
ERCP treatment failure group (n=8)	–2.12

ERCP, endoscopic retrograde cholangiopancreatography; BMI, body mass index.

gastrointestinal perforation, acute major pancreatitis, or gastrointestinal bleeding. Two patients elected to undergo surgery after ERCP failure or the reoccurrence of pancreatitis, and one suffered from intra-abdominal haemorrhage after surgery, which resulted in his death. While one article reported the overall morbidity rate after PJ revision was 26% (20), in contrast, ERCP has the advantages of minimal invasiveness and high safety. As an unsuccessful endoscopic attempt will not cause trauma or affect the implementation of other treatments, it can be used as the first choice for centres with extensive endoscopic experience and a full set of equipment.

Pancreaticojejunal anastomotic site identification is one of the biggest challenges of this procedure, and has been categorized into three types: pinhole-like, split-like, and membranous stenosis (6). Among these, the pinhole and split-like openings are easier to identify, while membranous stenosis openings are often accompanied by atresia of the anastomotic site (*Figure 3*). When the anastomotic site cannot be identified under the enteroscope, indirect signs should be considered instead, such as changes in intestinal mucosal continuity or the formation of scar tissue. In some cases, the physician might need to observe the intestinal wall for a long duration to capture the moment when a small amount of secreted pancreatic fluid flows. Cannulation of several suspicious depressions can then be attempted after further narrowing the area of the pancreatic duct under enteroscopic visualization. When cannulating, the sphincterotome or a catheter can be used to access the possible opening position of the pancreatic duct, and the assistant can use the tip of the guidewire to gently tap the depression. If the tip can be pushed deep, the assistant can continue to penetrate the guidewire under X-ray, and penetration to a depth of approximately 5 cm outside the contour of the intestinal cavity without resistance usually indicates it has successfully entered the pancreatic duct. At this time, the physician can insert the sphincterotome or catheter into the opening and inject contrast agent to determine whether the pancreatic duct is developed. During the cannulation attempt, forcing the sphincterotome or the tip of the catheter against the mucosa should be avoided, and the assistant must also avoid rough penetration with the guidewire. These steps can easily cause oedema or bleeding of the intestinal mucosa so that the pancreaticojejunal anastomotic site, which is originally difficult to identify, disappears into the swollen mucosa, leading to the subsequent failure of enteroscopic treatment. Contrast agent should also not be injected in these circumstances. For anastomotic sites that cannot be identified by the methods above, methylene blue could be used to dye the intestinal wall, or patients can be administered a pancreatic secretion accelerator before surgery to improve the success rate of identification (21). In addition, EUS-PD is a common alternative, with a reported success rate of 50–100% (22-24). In this study, the anastomotic site could not be identified by enteroscopy in one patient, but pancreatic duct stent implementation was performed successfully by EUS-PD, and satisfactory treatment results were achieved. However, the success rate of this technically difficult method is closely related to the dilation diameter of the pancreatic duct, and a complication rate of 5–35% has been reported (25,26), including serious complications such as gastrointestinal perforation and abdominal bleeding. Due to the limited number of cases reported in the relevant literature, the effectiveness and safety of this method require further study.

In this study, we analysed the factors associated with anastomotic site identification failure in 14 patients whose pancreatic intestinal anastomotic site area could be successfully reached by endoscopy. We found for the first time that the failure of anastomotic site identification was related to the method of gastrointestinal reconstruction,

Table 6 Detailed treatment process

Patient No.	Number of ERCP treatments	Duration and course of ERCP treatment	Follow-up time (month)	Relapse or not	Time of recurrence after the last ERCP (month)	Stent indwelling time (month)	BMI change
A	1	2018.1; 5-Fr dilation catheter tip dilated anastomotic site	39.0	Yes	1.0	0.0	–1.81
B	2	2016.8; 5-Fr stent was inserted after 5-Fr catheter dilation	20.2	Yes	1.2	15.7 (5 Fr)	–0.34
		2017.11; removal of pancreatic duct stent					
C	2	2019.6; 5-Fr catheter dilation, followed by placement of a 7-Fr stent	21.8	No	–	13.3 (7 Fr)	+3.9
		2020.7; removal of the pancreatic duct stent					
D	2	2019.11; 4 mm cylindrical balloon dilated anastomotic site + 5-Fr stent placement	17.7	No	–	15 (5 Fr) + 2.7 (7 Fr)	+0.32
		2021.2; 4 mm cylindrical balloon dilated anastomotic site + placement of 7-Fr stent					
E	2	2020.12; anastomotic site could not be identified	2.7	No	–	2.7 (7 Fr)	0.00
		2021.1; cannulation was successful with a combination of enteroscopy and EUS-PD; the anastomotic was dilated with a 7-Fr dilation catheter, and a 7-Fr stent was inserted, which has been retained to date					
F	1	2016.3; a 7-Fr stent was inserted after dilation, which has been retained to date	61.5	No	–	61.5 (7 Fr)	+6.76
G	3	2015.2; the anastomotic site was dilated with a 5-Fr catheter, and 5-Fr stent was inserted	75.1	No		29.8 (5 Fr) + 25.5 (7 Fr)	+2.00
		2017.8; the anastomotic site was dilated with a 7-Fr catheter, and a 7-Fr stent was inserted			–		
		2019.8; removal of the pancreatic duct stent					
H	2	2020.7; 6 mm cylindrical balloon dilated anastomotic site + partial stone extraction + 5-Fr stent placement	9.0	No	–	6 (5 Fr) + 3 (7 Fr)	+1.83
		2021.1; 6 mm cylindrical balloon dilation anastomotic site + removal of all stones + placement of 7-Fr stent, which has been retained to date					

ERCP, endoscopic retrograde cholangiopancreatography; BMI, body mass index.

the appearance of the anastomotic site, the placement of a pancreatic duct support tube during PD, the diameter of the pancreatic duct before PD, the occurrence of pancreatic fistula after PD, and the occurrence time and first endoscopic intervention time of postoperative pancreatitis. According to digestive tract reconstruction methods, the anastomotic site is more difficult to identify during the Child procedure than during the Whipple procedure. This is because for Whipple cases, the anastomotic site is close to the end of the afferent loop, so when the enteroscope enters, the axial direction of the pancreatic duct is parallel to the endoscope, and the opening of the duct is in the middle of view. In Child cases, it is difficult for the operator to estimate the position of the intestinal segment where the

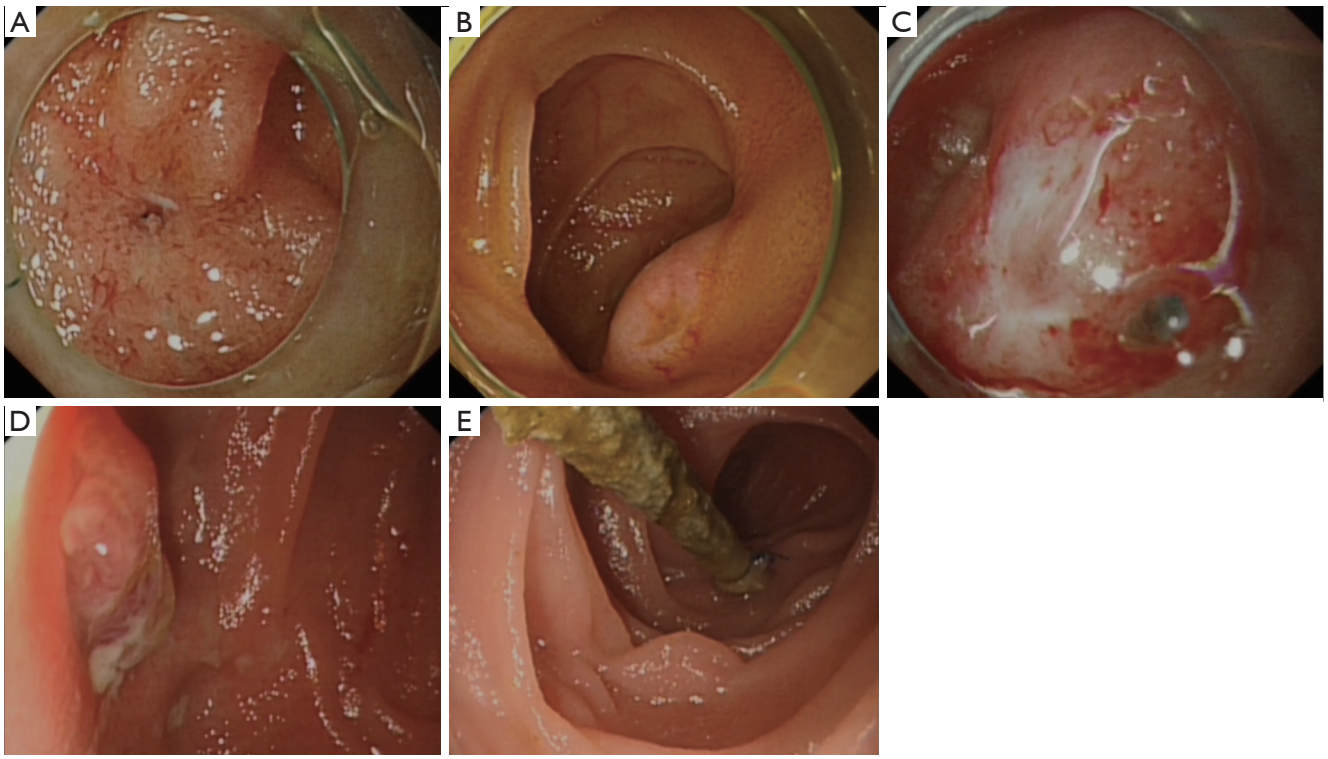

Figure 3 Endoscopic findings at the anastomotic site. (A) The anastomotic site with pinhole-like opening. (B) The anastomotic site with slit-like opening. (C) The anastomotic site with membranous stenosis. (D) Neoplasm was found at the PJ anastomotic site in one case with biopsy indicating adenocarcinoma. (E) A clogged silicone tube placed in pancreatic duct during a Whipple procedure was found and removed. PJ, pancreaticojejunostomy.

anastomotic site should be, and the axial direction of the pancreatic duct is perpendicular to the endoscope, which makes the site at the edge of view and difficult to find. In this study, the anastomotic site could not be identified under endoscopy in all four patients who underwent the Child reconstruction method. The diameter of the pancreatic duct and pancreaticojejunostomy method during PD are also risk factors affecting the success rate of endoscopic treatment. Thin pancreatic ducts and pancreaticojejunal mucosa-to-mucosa anastomosis during PD make reconstruction difficult and increase postoperative pancreatic fistula rates. Once pancreatic fistula occurs after PD, local inflammatory stimulation is induced, which often leads to pancreaticojejunostomy stricture, or the anastomotic site becomes covered by mucosa. If the pancreatic duct support tubes are not placed during PD, the possibility of pancreatic fistula will increase, or early anastomotic site collapse will occur. In this study, we also found that the time to the first pancreatitis event after PD and the ERCP intervention time were significantly different. The early occurrence of pancreatitis is often related to defective anastomosis or poor healing of the anastomotic site, and the lesion becomes covered by inflammatory hypertrophic scar tissue, complicating subsequent ERCP treatment. On the other hand, with the passage of time after the first pancreatitis event, the more severe the pancreaticointestinal anastomotic site stenosis level could be when subsequent ERCP intervention is conducted. When needle-like stenosis or complete atresia is observed, patients lose the opportunity for successful enteroscopic treatment, and the risk of stenosis recurrence increases. Therefore, we suggest patients with postoperative pancreatitis, especially those with symptoms at early time points after surgery, should be treated with ERCP as early as possible to maximize the clinical benefit of enteroscopic treatment.

In this study, we revealed for the first time that a change in BMI is closely related to the efficacy of ERCP and the recurrence of pancreatitis. We hope that with the inclusion of more cases in later phases, a scoring system can be established to evaluate the effectiveness of ERP treatment

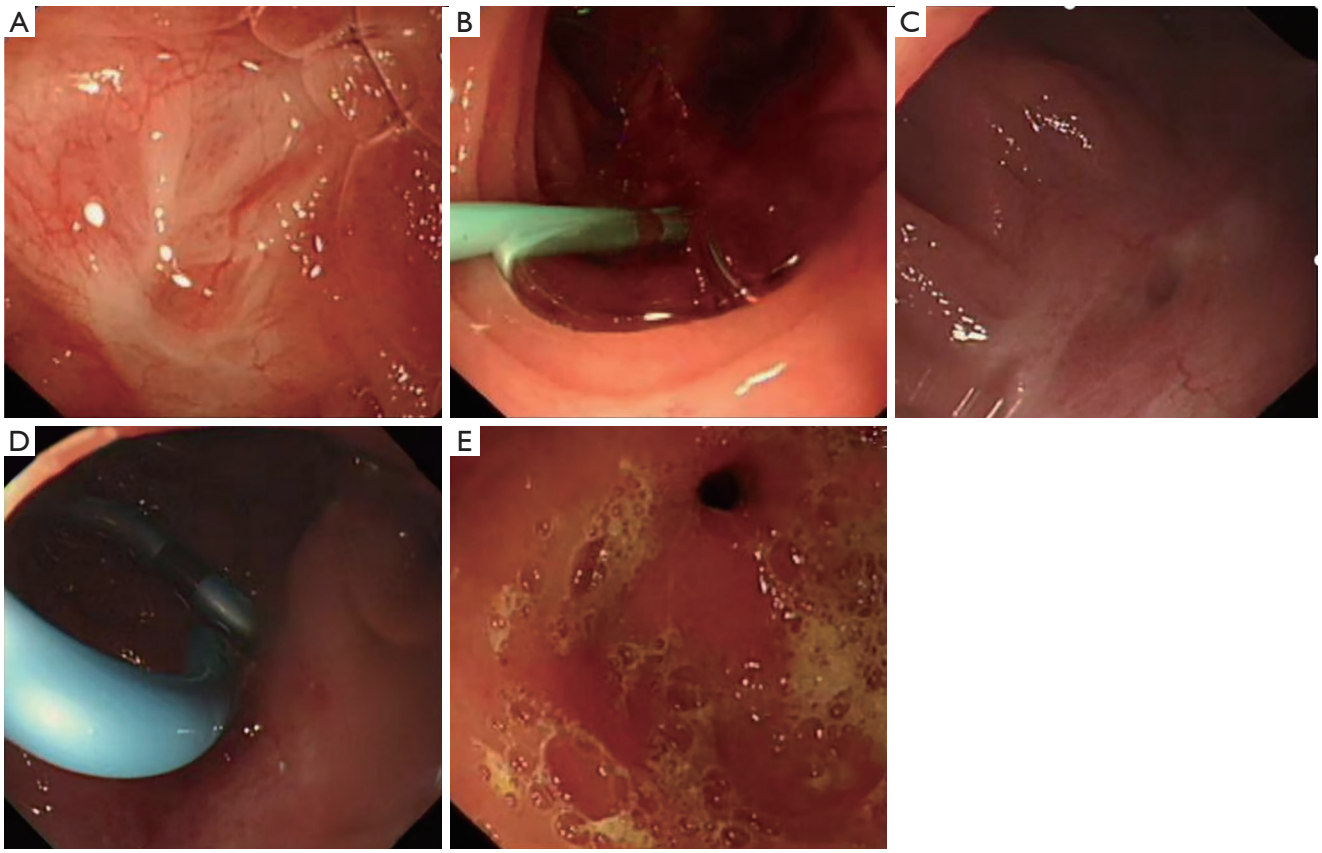

Figure 4 Changes of PJ anastomotic site in one patient after multiple ERP treatments. (A) Initial endoscopic view of anastomotic site showed scar and membranous stenosis. (B) A 5-Fr plastic stent was placed during the first ERP. (C) 2.5 years later the first stent was endoscopically removed and the anastomotic site was widened but was still narrow. (D) The anastomotic site was dilated with a 7-Fr catheter, and a 7-Fr stent was inserted during the second ERP. (E) After another 2 years the second stent was removed during the final ERP and shows the anastomotic site to be fully dilated. The patient received complete rehabilitation and did not experience recurrence (20 months to date). PJ, pancreaticojejunostomy; ERP, endoscopic retrograde pancreatography.

and to predict whether pancreatitis relapse will occur. Based on patient follow-up, we summarized several preliminary findings and hope to motivate further research to determine optimal ERCP treatment strategies: (I) patients who underwent only pancreaticojejunal anastomotic site dilatation without stent implantation relapsed early after surgery. (II) The need for pancreaticojejunal anastomotic site dilatation and catheter or balloon dilatation are not directly related to the recurrence of pancreatitis, which is also consistent with other research results (27). (III) No patient experienced pancreatitis recurrence during stent indwelling. Similar studies have shown that stent detachment after ERP is the only risk factor for the recurrence of pancreatitis (7,28). (IV) One patient with anastomotic site dilatation and a 5-Fr pancreatic duct stent placed for one-year experienced recurrent pancreatitis in a short time after stent removal, suggesting the expansion effect of a 5-Fr stent on the anastomotic site may be insufficient. (V) Cases with a 7-Fr stent placed for more than one year did not experience pancreatitis recurrence after stent removal. According to the above findings, we believe the effective expansion of the anastomotic site with stents is the key to ensuring treatment efficacy (*Figure 4*). Therefore, we suggest that during ERCP treatment, thicker pancreatic duct stents should be placed, and if only 5-Fr stents can be placed during ERP for the first time due to severe pancreatic duct stenosis, 7-Fr stents should replace them in subsequent endoscopic treatment. In this study, no stent occlusion was observed. In some studies stent indwelling time longer than six months may result in stent obstruction and pancreatitis (29,30). However,

in PJS cases, stent obstruction rate is relatively low even the patients experienced a long-term or permanent stent placement (8). And based on this, we do not recommend pancreatic duct stents be removed. For patients who have a strong desire for stent removal, it is recommended the 7-Fr stent be retained for at least one year before removal. When removing the stents, we recommend careful visualization of the appearance of the anastomotic site or to fill it with a small-diameter dilation balloon to observe whether there is a narrow ring at the site. If anastomotic site stenosis still exists, stent reinsertion is recommended, which should be retained for at least another year.

This study has several limitations. First, this was a single-centre retrospective study, and second, the small number of cases meant some statistical analyses were difficult to conduct. In addition, the follow-up time of some patients was relatively short, and finally, there was no control group.

Conclusions

This study preliminarily verified the safety and effectiveness of enteroscopy ERCP treatment for PJS after PD, proposed operative techniques, and identified risk factors for pancreaticojejunal anastomotic site identification failure for the first time. Our results show ERCP intervention should be carried out early if chronic pancreatitis caused by PJS occurs, and BMI is an important index to be monitored during the follow-up of such patients. The use of thicker pancreatic duct stents over a long period of time to reduce the recurrence odds of anastomotic stenosis is recommended.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://gs.amegroups.com/article/view/10.21037/gs-22-692/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://gs.amegroups.com/article/view/10.21037/gs-22-692/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of Xinhua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine (No. XHEC-D-2022-044). Individual consent for this retrospective analysis was waived.

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