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Feasibility of Percutaneous Pancreatic Stent Placement in Postoperative Pancreaticojejunostomy Stenosis

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Objective: To evaluate the role of percutaneous pancreatic stent placement in postoperative pancreaticojejunostomy stenosis (PJS).

Materials and Methods: This retrospective single-center study included seven procedures in five patients (four males and one female; median age, 63 years) who underwent percutaneous pancreatic stent placement for postoperative PJS between January 2005 and December 2021. The patients were referred to interventional radiology because of unfavorable anatomy or bowel abnormalities. The pancreatic duct was accessed under ultrasound and/or computed tomography guidance. A stent was placed after balloon dilatation of the PJS. Moreover, plastic stents were placed for the first two procedures, whereas bare-metal stents were used for the remaining five procedures. Technical success was defined as the successful placement of stents for the PJS, meanwhile, clinical success was defined as the normalization of pancreatic enzymes without recurrence of pancreatitis.

Results: Pancreatic duct access and stent placement were successfully performed in all patients (technical success rate: 100%). All the procedures initially yielded clinical success. However, recurrence of pancreatitis was observed after two procedures that used plastic stents because of stent migration at 0.3 and 3 months after the procedure. In contrast, no instances of recurrent pancreatitis were noted after metal stent placement for a follow-up duration of 1–36 months. No serious procedure-related adverse events were observed.

Conclusion: Percutaneous pancreatic stent placement may be a viable option for patients with postoperative PJS in whom an endoscopic approach is not feasible. Metal stents may be considered over plastic stents for the management of PJS, considering the possible lower stent migration and infeasibility of frequent endoscopic stent exchange due to the altered anatomy.

Keywords: Pancreaticojejunostomy stenosis; Pancreaticoduodenectomy; Percutaneous access; Postoperative

INTRODUCTION

Pancreaticoduodenectomy is the primary treatment option for diseases involving the periampullary region, including the pancreas, distal bile duct, and duodenum [1]. Surgery involves removing the head of the pancreas and connecting the remaining portion of the pancreas to the jejunal loop, creating a pancreaticojejunostomy that preserves both the endocrine and exocrine functions of the organ [2]. Late complications of pancreaticoduodenectomy include pancreaticojejunostomy stenosis (PJS), hepaticojejunostomy stenosis, and anastomotic ulceration with bleeding [3].

Although PJS is often asymptomatic, the condition is observed in 25%–60% of patients during postoperative follow-up, including magnetic resonance cholangiopancreatography [4,5]. Symptomatic PJS can lead to chronic pain, recurrent pancreatitis, and exocrine pancreatic dysfunction [6]. Two treatment options for PJS are surgical revision of the anastomosis and endoscopic drainage of the pancreatic duct [3]. The reported postoperative morbidity rate for surgical revision is 20%, and the clinical success rate varies widely (25%–65%) [7-9]. Although various endoscopic techniques have been developed to access the pancreatic duct through altered small bowel anatomy, the success

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rates of pancreatic duct cannulation, stent placement in the duct, and clinical success are 79%, 72%, and 79%, respectively [6]. Percutaneous pancreatic stent placement for PJS may be a viable option for patients in whom surgery or an endoscopic approach is not feasible [10,11]. Although, a previous study reported a high technical success rate (96.7%) of percutaneous image-guided pancreatic duct drainage for obstruction due to pancreatic head cancer or pancreatitis [12], the role of percutaneous stent placement in PJS has not been studied. Therefore, this study aimed to assess the role of percutaneous pancreatic stent placement in the management of PJS.

MATERIALS AND METHODS

Patients

This single-center retrospective study was approved by Severance Hospital institutional review board (Approval No. 2022-3695-001). Owing to the study's retrospective nature, the need to obtain informed consent was waived. Between January 2005 and December 2021, seven percutaneous stent placements for postoperative PJS were performed in five patients (four males and one female; median age, 63 years; range: 51–79 years) for whom the endoscopic approach had either failed or had not been attempted at the discretion of the endoscopists. However, one such procedure was described in a previous case report [11]. The patients underwent a Whipple operation or pylorus-preserving pancreaticoduodenectomy for periampullary cancer or pancreatic head trauma. Such patients visited the emergency room multiple times (range: 1–14; median 8) because of recurrent pancreatitis resulting from PJS. After multidisciplinary discussions involving gastroenterologists, surgeons, and interventional radiologists, percutaneous stent placement for PJS was considered the last resort before surgical revision.

The severity of pancreatitis during the most recent emergency visit before stent placement for PJS was evaluated using the Systemic Inflammatory Response Syndrome (SIRS) score according to the International Association of Pancreatology Pancreatic Association guidelines and computed tomography (CT) Severity Index [13,14].

Percutaneous Access of Pancreatic Duct

All patients had typical imaging findings of recurrent pancreatitis, such as pancreatic duct dilatation and peripancreatic infiltration on preprocedural CT. Percutaneous access to the pancreatic duct was achieved after the resolution of pancreatitis. Interventional radiologists carefully reviewed preprocedural images to determine the percutaneous access route to the pancreatic duct. After planning the access route, operators decided whether to perform percutaneous transhepatic biliary drainage (PTBD) for through-and-through approach. For patients undergoing PTBD, an 8.5F pigtail catheter (Dawson-Mueller Drainage catheter; Cook) was inserted under ultrasound (US) and fluoroscopic guidance several days before accessing the pancreatic duct.

In case feasible, a transmesenteric access route not passing through any other organs was used. For patients in whom the pancreatic duct was obscured by the bowel, bowel preparation was performed 2 days before the procedure. Patients were fed a low-fiber diet and received 200 g of polyethylene glycol dissolved in one liter of water. The pancreatic duct was punctured using a 21-gauge, 20 cm needle (Chiba Biopsy Needle; Cook) under transabdominal US guidance (LOGIQ E9; General Electric). If the pancreatic duct was not readily visible in the US, the needle was inserted along the planned trajectory of the access route, which was deemed safe for device placement between the abdominal organs under CT guidance (Aquilion; Toshiba Medical Systems).

Pancreatic Duct Stent Placement

After accessing the pancreatic duct, a 5F sheath (Terumo) or 5F angiographic catheter (Newton; Cook) was inserted into the pancreatic duct depending on the stability of the access tract. Pancreatic ductography was performed to evaluate the anatomy of the pancreatic duct and the pancreaticojejunostomy. A 0.035-inch hydrophilic guidewire (Radiofocus, Terumo) and a 5F catheter were used to negotiate the stenotic portions of the pancreaticojejunostomy. However, if the pancreatic duct was punctured near the pancreaticojejunostomy site, a snare catheter (ev3) was used via the PTBD tract to capture the guidewire, providing through-and-through access. In cases with pancreaticojejunostomy completely occluded, sharp recanalization was attempted using the backend of a 0.035-inch guidewire.

Before stent placement, predilatation of the pancreaticojejunostomy was performed using a balloon catheter (Mustang, Boston Scientific), with the balloon size varying from 3 to 6 mm depending on the diameter of the pancreatic duct. Retrograde stent placement was

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performed for patients with through-and-through access, whereas anterograde stent placement was performed for patients without through-and-through access. The first two procedures used plastic stents (Cotton-Leung, Cook), but due to stent migration, the remaining five procedures used self-expanding bare-metal stents (Innova, Boston Scientific). After metal stent deployment, post-dilatation was performed, followed by ductography to evaluate stent placement and passage of contrast media through the pancreatic duct and pancreaticojejunostomy. The punctured tract was embolized using a mixture of *n*-butyl cyanoacrylate and lipiodol.

Technical Success, Clinical Success, and Complications

Technical success was defined as successful percutaneous stent placement in the PJS. Clinical success was determined by the normalization of elevated pancreatic enzymes, amylase, and lipase levels, without recurrence of pancreatitis. Pancreatic enzyme levels were recorded within 1 month before and after the procedure. Any adverse events that occurred after the procedure were recorded and classified according to the Society of Interventional Radiology Classification System [15].

RESULTS

Patients

The technical and clinical details of each procedure are presented in Table 1. In three patients, the preprocedural endoscopic approach failed due to surgical alteration, while endoscopic approaches were not attempted in two patients as the anatomy was assumed to be unfavorable. The interval between the initial presentation of pancreatitis and stent placement for PJS, number of emergency room visits, severity of pancreatitis according to the SIRS score and CT severity index, and length of hospitalization are summarized in Supplementary Table 1.

Percutaneous Access of Pancreatic Duct

The pancreatic duct was successfully accessed using the US as the primary imaging tool in all three procedures, as the pancreatic duct was well visualized. However, in the remaining four procedures, US was used to guide the needle along the planned trajectory, and CT imaging was used to fine-tune the needle placement until the pancreatic duct was successfully punctured.

Transmesenteric access was used in five procedures, while

Table 1. Technical and clinical details of stent placement for pancreaticojejunostomy stenosis

Procedure	Patient	Age, yr	Sex	History	Preprocedural endoscopic approach	PTBD	Guide	Access route	Stent approach	Stent	Technical success	Period without recurrent pancreatitis, month	Complications
1	1	63	F	Pancreas head cancer s/p PPPD	Cannulation failure	Y	US	Transmesenteric	Retrograde	5F plastic	Y	0.3	N
2	2	51	M	Pancreas head trauma s/p PPPD	Not attempted	Y	US/CT	Transmesenteric	Retrograde	8Fr plastic	Y	3	N
3	2	51	M	Pancreas head trauma s/p PPPD	Not attempted	N	US/CT	Transmesenteric	Anterograde	8 mm metal	Y	36	N
4	3	60	M	Pancreas head cancer s/p PPPD	Cannulation failure	Y	US	Transmesenteric	Anterograde	6 mm metal	Y	1	N
5	4	69	M	Pancreas head IPMN s/p PPPD	Cannulation failure	Y	US/CT	Transcolonic	Retrograde	6 mm metal	Y	24	N
6	1	63	F	Pancreas head cancer s/p PPPD	Cannulation failure	N	US	Transmesenteric	Anterograde	6 mm metal	Y	23	N
7	5	79	M	AoV cancer s/p Whipple's op	Not attempted	N	US/CT	Transgastric	Anterograde	6 mm metal	Y	13	N

PTBD = Percutaneous transhepatic biliary drainage, F = female, M = male, s/p = statue post operation, PPPD = pylorus-preserving pancreaticoduodenectomy, Y = yes, N = no, US = ultrasound, CT = computed tomography, IPMN = intraductal papillary mucinous neoplasm, AoV = ampulla of Vater, op = operation

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trans-colonic and transgastric access were used in procedures #5 and #7 because the bowel surrounding the pancreas made the transmesenteric approach not feasible. Bowel preparation was performed 2 days before the procedure. Figure 1 depicts the trans-colonic stent placement.

Pancreatic Duct Stent Placement

Three stents were deployed in a retrograde manner via through-and-through access using the PTBD tract, whereas four stents were inserted in the anterograde direction. Plastic stents were used in the first two procedures according to the guidelines published by the American Society of Gastrointestinal Endoscopy for benign pancreatic duct strictures [16]. However, due to the migration of plastic stents, recurring symptoms of pancreatitis, and difficulty in accessing the pancreatic duct percutaneously, bare metal stents were used in the remaining five procedures. The migration of the plastic stent and placement of the metal stent are demonstrated in Figure 2.

Technical Success, Clinical Success, and Complications

All seven percutaneous stent placement procedures for PJS were successfully performed. All the procedures initially yielded clinical success. However, recurrence of pancreatitis was observed after two procedures that used plastic stents because of stent migration at 0.3 and 3 months after the

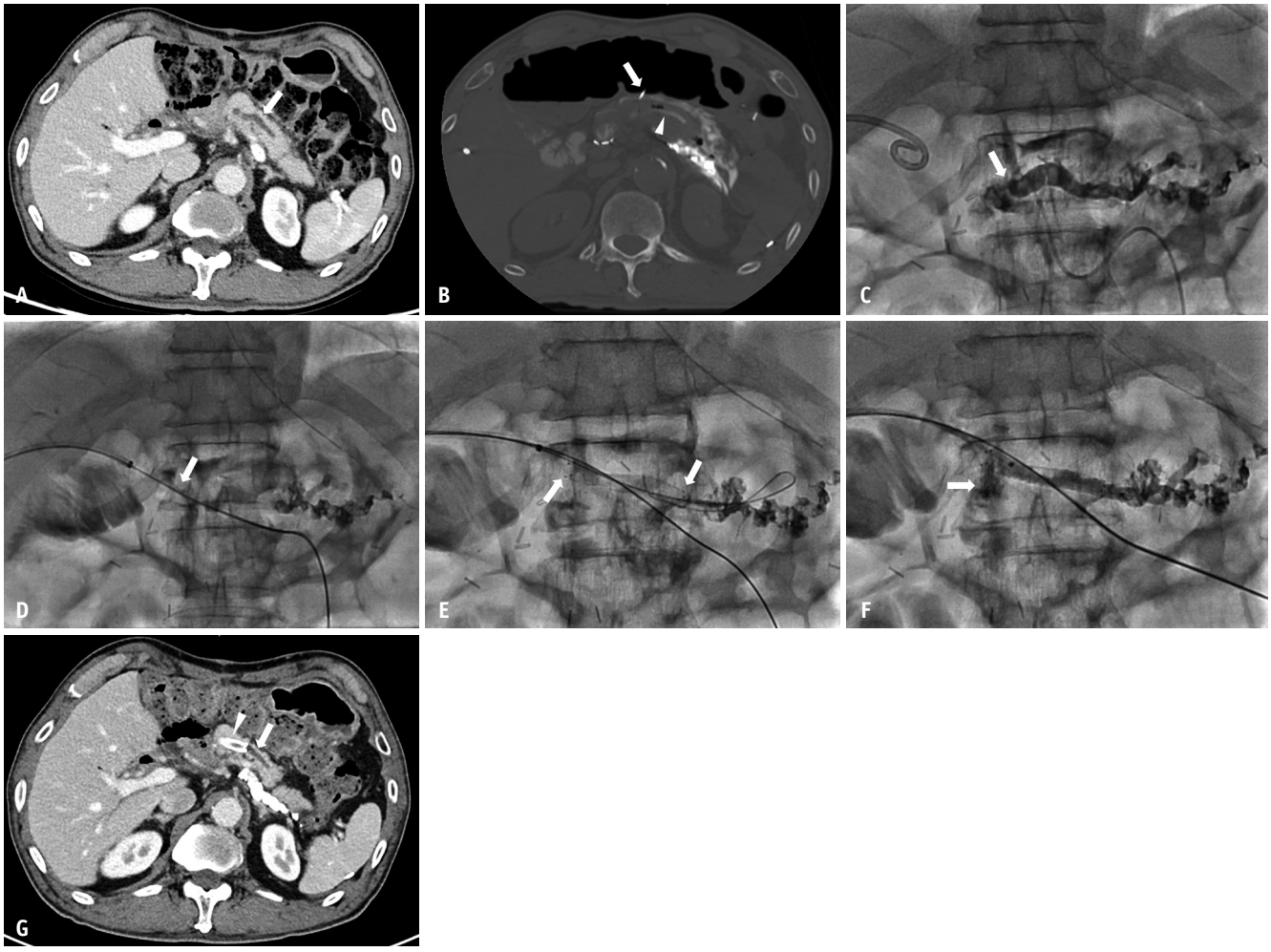

Fig. 1. A metal stent insertion via trans-colonic access in a 69-year-old male. **A:** The portal phase of the initial computed tomography (CT) demonstrates a dilated pancreatic duct (arrow). **B:** CT obtained during the procedure demonstrated the Chiba needle (Cook; arrow) in the trans-colonic access route. The dilated pancreatic duct (arrowhead) is opacified with contrast media injected via the Chiba needle. **C:** A ductogram revealed an abrupt cutoff (arrow) of the dilated pancreatic duct. **D:** Through-and-through access (arrow) is established using a percutaneous transhepatic biliary drainage tract. **E:** A bare metal stent (arrows) is placed at the pancreaticojejunostomy. **F:** Final ductogram displaying the flow of contrast media into the jejunum (arrow). **G:** The portal phase of the follow-up CT demonstrates a metal stent in the pancreatic duct (arrowhead) with an improved state of dilated pancreatic duct (arrow).

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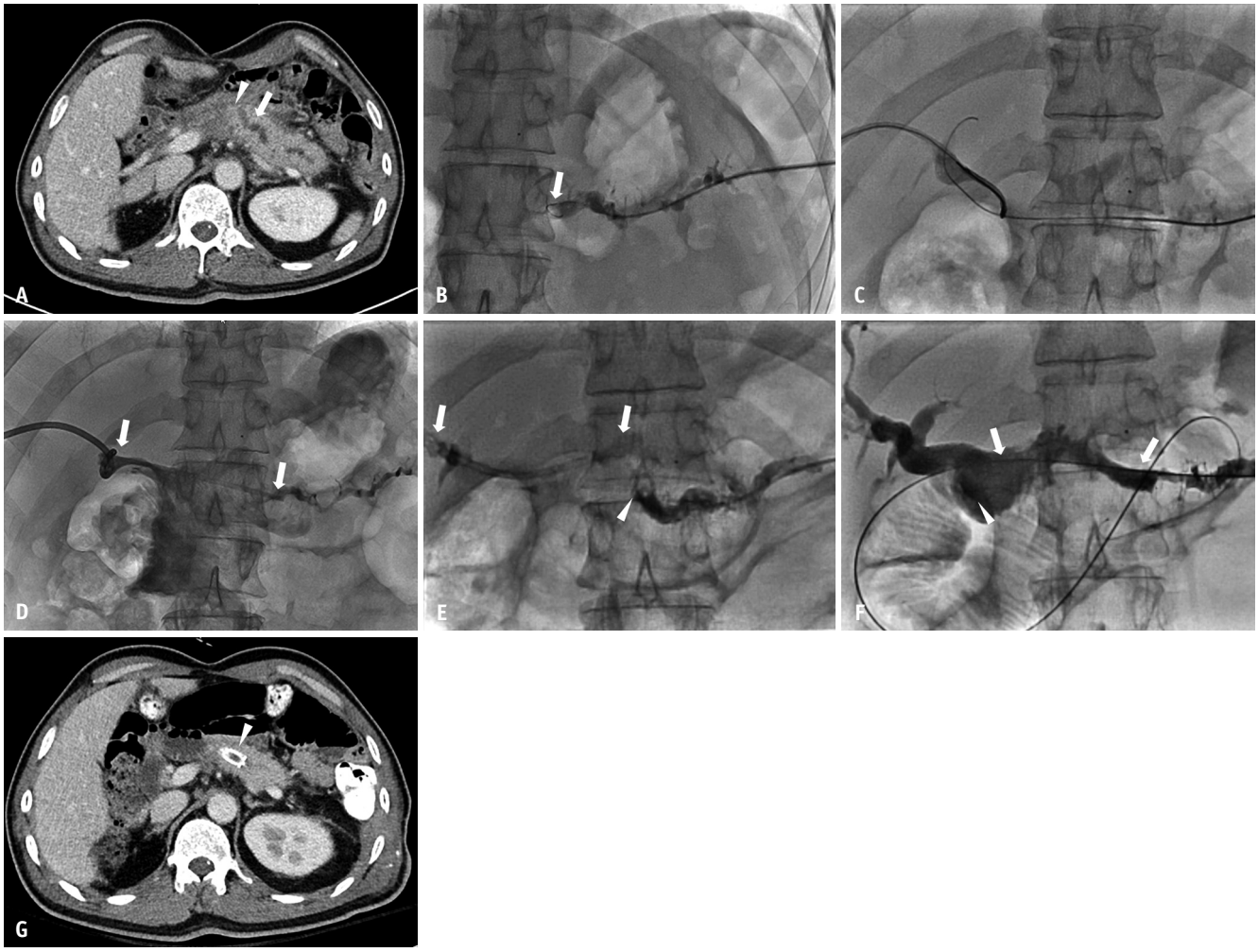

Fig. 2. A metal stent insertion after migration of plastic stent in a 51-year-old male. **A:** The portal phase of the initial computed tomography (CT) displays an abrupt cutoff (arrowhead) of the pancreatic duct with dilation of the upstream pancreatic duct (arrow). **B:** A ductogram exhibiting abrupt cutoff (arrow) in the pancreatic duct. **C:** Through-and-through access is established using a percutaneous transhepatic biliary drainage tract. **D:** A plastic stent (arrows) is placed at the pancreaticojejunostomy. **E:** The spot image obtained during the second procedure performed 4 months after the initial procedure demonstrates the migrated plastic stent (arrows) with an abrupt cutoff in the dilated pancreatic duct (arrowhead). **F:** Final ductogram displaying the flow of contrast media into the jejunum (arrowhead) via the metal stent (arrows). **G:** The portal phase of the follow-up CT demonstrated a metal stent in the pancreatic duct (arrowhead) with a nearly resolved state of the dilated pancreatic duct.

procedure. In contrast, no instances of recurrent pancreatitis were noted after metal stent placement for the follow-up duration of 1–36 months. Before the procedure, the median maximum amylase and lipase levels were 210 U/L (range: 116–2198 U/L) and 3029 U/L (range: 153–9370 U/L), respectively. The levels of amylase and lipase decreased to a median of 74 U/L (range: 42–10 moU/L) for amylase and 50 U/L (range: 18–97 U/L), respectively, after the procedure. Changes in both amylase and lipase levels in each patient are illustrated in Figure 3. No procedure-related complications occurred.

DISCUSSION

This case series demonstrated a high technical success rate of 100% for percutaneous pancreatic stent placement in postoperative PJS, with no reported adverse events. Although the overall clinical success rate of stent placement was 74% (5/7), no instances of recurrent pancreatitis were noted after metal stent placement during the follow-up period, suggesting that metal stents may be more effective than plastic stents in the treatment of postoperative PJS. Furthermore, percutaneous access to the pancreatic duct may be a viable alternative for patients with

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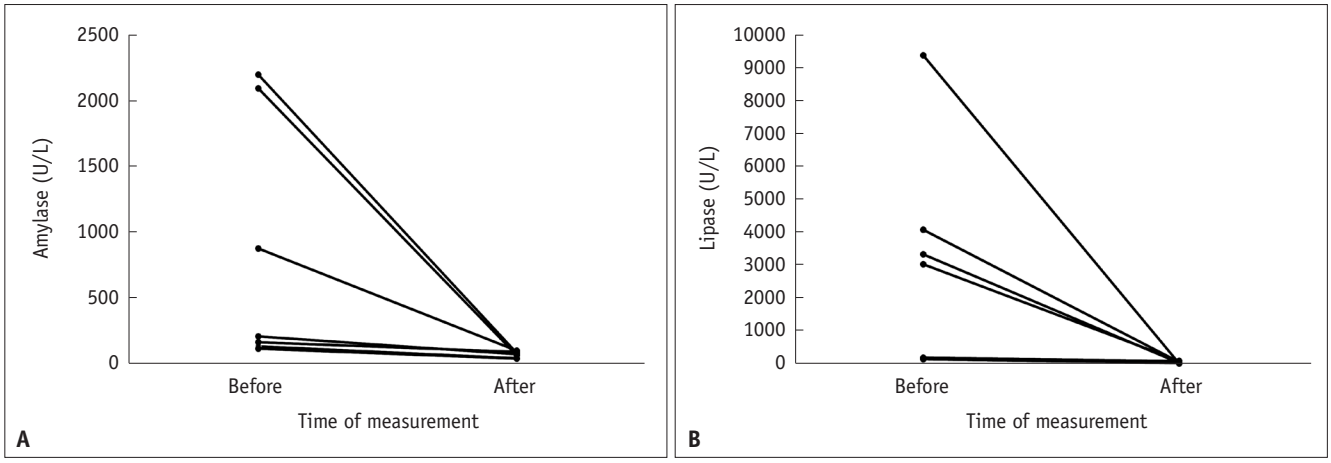

Fig. 3. Changes in laboratory findings before and after the procedure: serum amylase **(A)** and serum lipase **(B)**.

recurrent pancreatitis due to postoperative PJS in cases of unsuccessful endoscopic access.

In the study, the percutaneous access to the pancreatic duct was successful. Previous research investigating the feasibility of percutaneous image-guided pancreatic duct access has reported a success rate of 96.7% (29/30) [12]. In both procedures, access to the pancreatic duct was achieved after traversing either the stomach or the colon. Bowel preparation was performed when bowel penetration was expected during pancreatic duct access. A previous study reported no procedure-related complications following transgastric access to the pancreatic duct [12]. Similarly, trans-colonic access is often performed during transabdominal thoracic duct embolization. A previous study reported no serious complications after trans-colonic access to the cisterna chyli [17]. Therefore, transgastric or trans-colonic access to the pancreatic duct after appropriate bowel preparation should not be ruled out when a transmesenteric approach is not feasible.

Endoscopic plastic stents are commonly used for treating PJS [18-20]. However, stent-related adverse events such as stent migration, stent occlusion, pancreatic duct leaks, and abscesses may be problematic with plastic stents [20-22]. Therefore, fully covered self-expandable metal stents have been suggested as an alternative with an acceptable rate of stent-related adverse events [23]. In this case series, plastic stents were used in the first two procedures within 3 months, resulting in recurrent pancreatitis. Therefore, the remaining five procedures, along with two repeated procedures for patients in whom plastic stents were deployed, used bare-metal stents. After metal stent placement for PJS, recurrent pancreatitis was relieved in all five patients. The overall clinical success rate of percutaneous stent placement is similar to that of endoscopic plastic stent placement (70%–100%) [23]. Given the unfavorable anatomy of pancreaticojejunostomy for the endoscopic approach, the burden of percutaneous access to the pancreatic duct, and frequent stent-related adverse events after plastic stent placement, metal stents may be preferred for PJS.

Various treatment techniques were considered before the procedure to alleviate the PJS. Although endoscopic pancreatic duct balloon dilatation has demonstrated effectiveness and safety for various pancreatic diseases in several studies [24,25], the procedure has not yet been incorporated into guidelines. Balloon dilatation without stent placement was not an option as the procedure may not have prevented recurrent pancreatitis, and reintervention may not have been feasible. A retrievable biliary stent graft requires an introducer with a large profile, and endoscopic removal of the stent graft may not be technically feasible due to altered bowel anatomy. Additionally, the diameter of the pancreatic duct is small (4–6 mm in width), which is not suitable for retrievable biliary stent grafts. Although the use of biodegradable biliary stents has been widely reported in the literature, their efficacy and safety must be further scrutinized before using them for percutaneous stent placement for postoperative PJS, which is an experimental procedure in itself.

In terms of complications, a previous study reported that the complication rate of the endoscopic approach varied greatly (5%–35%) [23]. However, no adverse events were observed in this case series, even with transgastric or trans-colonic access to the pancreatic duct. With careful planning

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of the access route and bowel preparation, percutaneous stent placement for the PJS may result in favorable outcomes without serious adverse events.

This study had several limitations. Firstly, it was a retrospective study without a control group. Secondly, the number of procedures included in this study was limited. However, considering that PJS is a late complication after pancreaticoduodenectomy and that percutaneous access to the pancreaticojejunostomy is the last treatment option before surgical revision, including a large number of patients in the acceptable control group was challenging. Finally, the type of stent used for PJS changed after plastic stent migration and the follow-up period varied. Given that this study was more of a feasibility study introducing novel techniques for percutaneous stent placement for postoperative PJS, further research is needed to investigate the long-term efficacy of bare metal stents in managing PJS.

In conclusion, percutaneous stent placement appears to be a safe and effective option for the management of postoperative PJS that is not amenable to endoscopic intervention. Considering that frequent stent exchange is not feasible owing to altered anatomy and the possibility of stent migration, metal stents may be considered over plastic stents in the management of PJS.

Supplement

The Supplement is available with this article at https://doi.org/10.3348/kjr.2023.0459.

Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Kichang Han. Data curation: all authors. Formal analysis: Juil Park, Kichang Han. Investigation: Juil Park. Methodology: Juil Park, Kichang Han. Project administration: Kichang Han. Resources: all authors. Software: Juil Park. Supervision: Kichang Han. Visualization: Juil Park. Writing—original draft: Juil Park. Writing—review & editing: Kichang Han.

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