Evaluation of pancreaticogastrostomy using pancreas-transfixing sutures versus a single purse-string seromascular nonpancreatic suture in Whipple operation: a prospective randomized-controlled trial

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Background
Pancreatic fistula (PF) remains a persistent problem after pancreaticoduodenectomy (PD). The existence of soft, nonfibrotic pancreatic tissue is one of the critical risks for pancreatic leakage. Our aim was to compare continuous single purse-string sutures and transfixing suture for performing pancreaticogastrostomy to the pancreatic stump in terms of the outcome and the rate of postoperative complications for PD.
Patients and methods
Our study included 40 patients who were diagnosed with different stages of pancreatic cancer and admitted to the general surgery department of Suez Canal University Hospital. These patients were enrolled in the study and underwent PD.
Results
The rate of postoperative PF rate was lower when using single purse-string suture for performing pancreaticogastrostomy than when using the transfixing suture (0 vs. 15%, respectively).
Conclusion
We found a link between the occurrence of postoperative PF and possible risk factors such as soft pancreas and small Wirsung duct diameter.

Keywords:
fistula, pancreaticogastrostomy, purse-string, Whipple

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Introduction

Pancreatic carcinoma is the 11th most common carcinoma type and is the fourth leading cause of death worldwide. It was found that in 2016, 53 670 Americans were diagnosed with pancreatic cancer and 30 390 died from the disease [1]. Nationally, the incidence of pancreatic malignant tumors in Egypt reached 5.6% in 2014 [2].

Most resectable malignant tumors are those of the pancreatic head and the procedure of choice is pancreaticoduodenectomy (PD) [3]. Leakage after pancreatic cancer surgery remains a frequent and crucial complication after both standard PD and pylorus-preserving PD. Pancreatic fistula (PF) is, in certain cases, accompanied by a few other possibly life-threatening consequences, as well as massive hemorrhage of the eroded vessels and peritonitis [4]. Because of this, surgeons are providing more care and paying more attention toward finding the appropriate technique of pancreatic reconstruction [5]. Traditionally, pancreatojejunostomy (PJ) was considered almost certainly the most widespread method of reconstruction, accompanied by several alternatives, such as telescoping, single layer, and double-layer end-to-end techniques [6].

The utilization of the stomach as an easy way for reinstating pancreatic continuity has additionally been defined and analyzed as a substitute for jejunal anastomosis in either observational studies or randomized-controlled trials (RCTs). It has actually been advocated that adverse effects after reconstruction with Pancreaticogastrostomy (PG) can certainly be controlled conservatively more frequently than after pancreatojejunostomy reconstruction; also, the anastomosis in PG can be more readily conceived a result of the proximity of the stomach to the pancreas [7]. The posterior wall of the stomach is thick and highly vascularized compared with the jejunum [8].

Patients and methods

After obtaining approval from our ethics committee, this prospective randomized-controlled case-series study was carried out in the General Surgery Department, Surgical Oncology Unit, Suez Canal University Hospital, on 40 patients who were admitted to the General Surgery Department of Suez Canal University Hospital after they were diagnosed with resectable pancreatic cancer. All patients in our study underwent PD. PG was performed using two different techniques: transfixing pancreatic suture in the first 20 patients (group 1) and single purse-string seromuscular nonpancreatic suture in the next 20 patients (group 2). After obtaining an informed written consent from all the patients, they were subjected to the following: a thorough assessment of history, and general and local examinations, and were referred for abdominal ultrasonography and abdominal computed tomographic scan with pancreatic protocol. The patients who showed radiological evidence of pancreatic cancer and fulfilled the inclusion criteria and were not included in the exclusion criteria were included in the study. Preoperative investigations were performed for all patients including full blood count, random blood sugar, coagulation profile, liver enzymes, serum creatinine, CA 19-9, and CEA. The eligible patients were admitted to the hospital and were prepared for PD with PG.

Operative details

A bilateral subcostal incision with upper midline extension was performed. The PD was performed according to our institutional standardized technique as described elsewhere. Transection of the pancreatic distal stump was generally performed at the pancreatic neck or body, depending on the tumors' location, by a blade and a frozen section was performed at this level to detect the presence of tumor invasion. Then, the distal pancreatic stump was transfixed at its cranial and caudal edge with two 3-0 PDS stay sutures (Ethicon, Inc., NJ, USA).

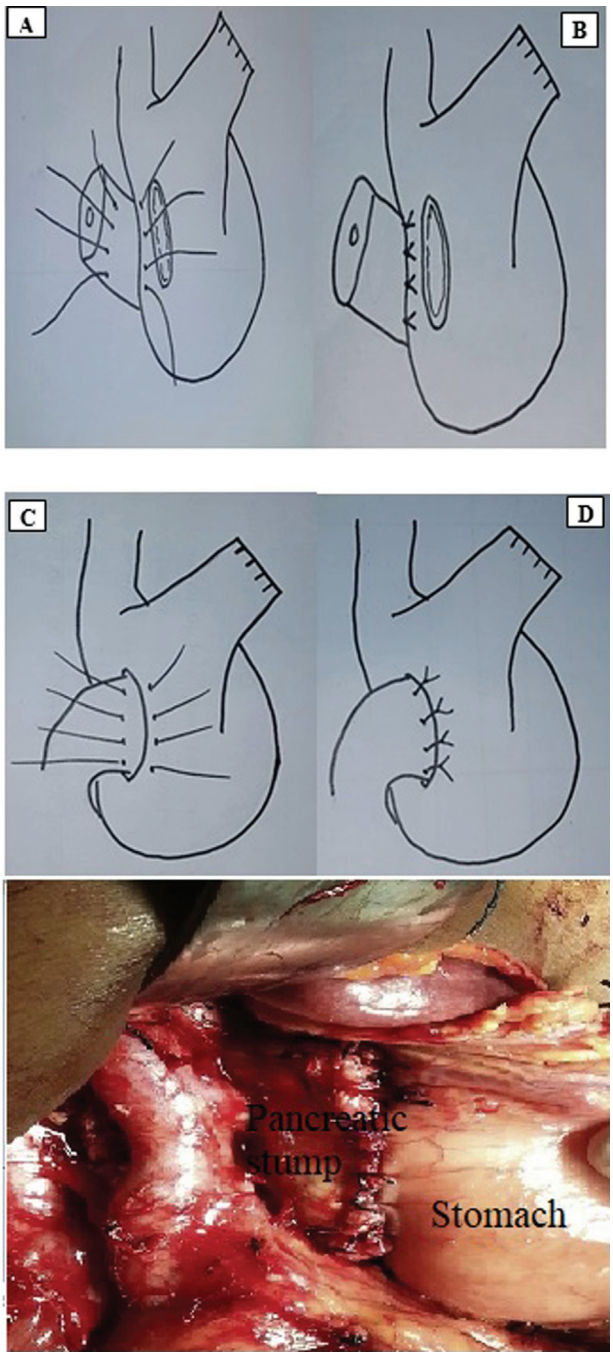
In the first group, we performed PG as follows:

A 2-cm-long seromuscular incision was made in the posterior wall of the stomach, followed by invagination of the pancreatic stump into the stomach and an end-to-side pancreaticogastric anastomosis was performed in a single layer of sutures consisting of 3-0 PDS placed by a curved 35-mm-long needle from the posterior inferior wall to the superior wall of the stomach, and then passed from the anterior to the posterior surface of the pancreas. The sutures on the stomach were placed widely so that the pancreatic stump could be embedded into the wall of the stomach at the seromuscular incision. The sutures on the pancreas were placed 1 cm away from the cut edge. Six to eight sutures were generally used, although the number depended on the size of the stump of the pancreatic remnant (Fig. 1).

In the second group, we performed PG as follows:

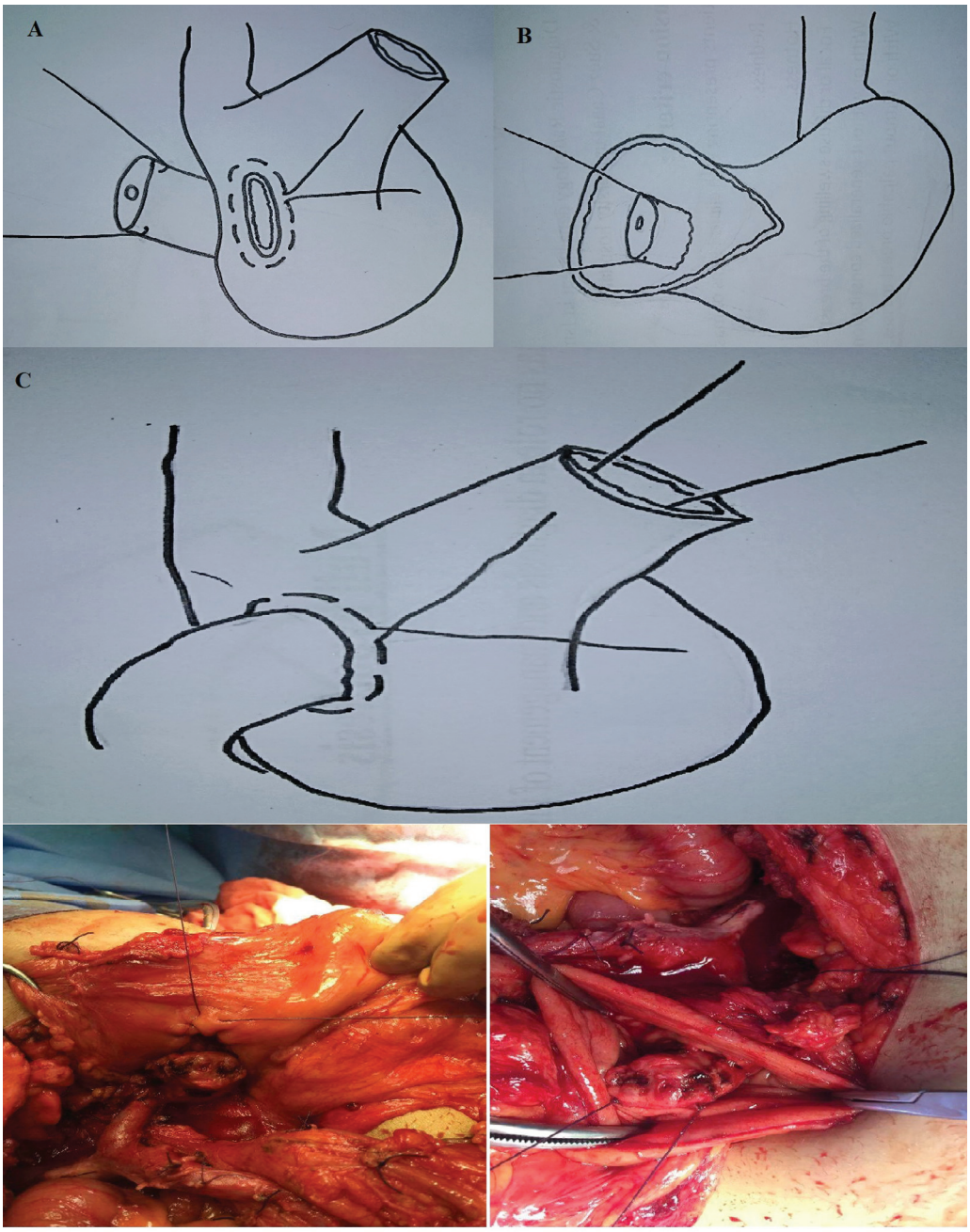
A transversal full-thickness incision was made on the posterior gastric wall with a length of 2 cm at the most

Figure 1



First technique using transfixing suture. Showed the 4 steps : (A, B,C, D) of the techniques which illustrated in detail in methods part.

Figure 2



Second technique using single purse-string. Showed a real picture (D) of the ended technique.

to ensure tight adherence to the posterior wall of the stomach and the pancreatic stump after completion of the anastomosis. The relevant place for the incision was selected so that the pancreatic stump could enter the opening without tension. A continuous seromuscular circular suture (3-0 PDS) was placed around the gastric incision 1 cm away from the cut edge. The pancreatic remnant was pulled with slide tension on the holding sutures through the hole in the posterior gastric wall into the stomach. Ideally, the pancreatic remnant should protrude from the posterior gastric wall by 2 cm. Then, the seromuscular continuous circular suture was tied to the lowest part of the pancreatic stump (Fig. 2). This ensured submucosal hemostasis and water-tight anastomosis.

After the completion of the anastomosis in both groups, the permeability of the main pancreatic duct was checked with a catheter probe (intravenous catheter, 20 G). Two abdominal drains were placed close to the PG through the foramen of Winslow (right drain) and the lesser sac (left drain). Drain output was checked daily for amylase levels until the seventh postoperative day. Drains were then removed in the absence of a PF according to the International Study Group for Pancreatic Fistula definition.

The collected data were coded and entered into the statistical package of social sciences (version 21.00; SPSS Inc., Chicago, IL, USA) program for statistical analysis. Descriptive data were managed according to its type: mean, SD, and range, whereas qualitative data were summarized as frequencies. For the analytical data, the χ^2 test and the Fisher test were used to detect the difference between qualitative data, whereas the Student *t* test was used to detect differences between continuous data.

Results

Forty pancreatic cancer patients who were undergoing the Whipple operation were enrolled in the study; 20 were candidates for pancreas-transfixing suture (group 1) and 20 for purse-string seromuscular nonpancreatic suture (group 2) for performing PG. The difference between the two groups in terms of age, sex, and history of diabetes was not statistically significant as shown in Table 1.

In terms of tumor location, 85% of the patients in group 1 and 95% of the patients in group 2 had tumors that were located in the head of the pancreas and the rest were located in the neck of the pancreas. In terms of tumor size, 45% of the tumors in group 1 and 40% of the tumors in group 2 were less than 3 cm. More than half of the patients in each group (55% of group 1 vs. 60% of group 2) had high-grade tumors, followed by moderate-grade tumors (45 and 30% in the two groups, respectively), and only minority of group 2 (10%) had low-grade tumors as shown in Table 2.

Pancreatic texture was soft in 45% of the patients of group 1 and 60% of the patients in group 2. In terms of Wirsung duct diameter, it was less than or equal to 4 cm in 70% of the patients in group 1 and in 75% of the patients in group 2. In terms of the operative blood loss, 90% of the patients in group 1 versus 75% of the patients in group 2 lost less than or equal to 1500 ml and 10% of the patients in group 1 and 25% of the patients in group 2 lost more than 1500 ml of blood intraoperatively. The mean duration of the operation was 5.5±0.8 in group 1 compared with 5±0.6 in group 2 and there was a statistically significant difference as shown in Table 3.

The duration of PG was higher among the patients in group 1 compared with the patients in group 2 (34±7.7

Table 1 Sociodemographic data

Characteristic	Group 1 [*n* (%)]	Group 2 [*n* (%)]	*P* value
Age (years)			
<50	4 (20)	3 (15)	0.815[a]
50–60	12 (60)	14 (70)	
> 60	4 (20)	3 (15)	
Mean±SD	55.3±6.8	55.9±5.1	0.450[b]
Sex			
Male	11 (55)	12 (60)	0.749[c]
Female	9 (45)	8 (40)	
Diabetes			
No	7 (35)	9 (45)	0.519[c]
Yes	13 (65)	11 (55)	

[a]Fisher's exact test. [b]Student's *t* test. [c]Chi square test. Steps of technique; step 1 , 2 , 3 . . . etc.

Table 2 Tumor characteristics

	Group 1 [*n* (%)]	Group 2 [*n* (%)]	*P* value
Tumor location			
Head	17 (85)	19 (95)	0.605[a]
Neck and body	3 (15)	1 (5)	
Tumor size (cm)			
<3	9 (45)	8 (40)	0.749[b]
≥3	11 (55)	12 (60)	
Pathological grade			
High	11 (55)	12 (60)	0.348[a]
Moderate	9 (45)	6 (30)	
Low	0	2 (10)	
TNM staging			
I/II	4 (20)	8 (40)	0.168[b]
III	16 (80)	12 (60)	
Blood vessel invasion			
No	4 (20)	6 (30)	0.465[b]
Yes	16 (80)	14 (70)	
Perineural invasion			
No	16 (80)	19 (95)	0.342[a]
Yes	4 (20)	1 (5)	

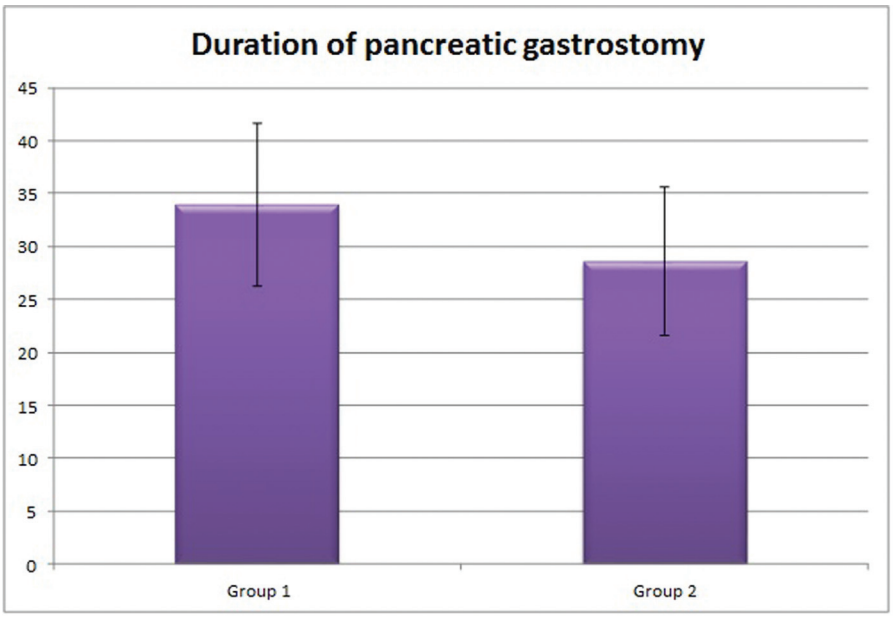
[a]Fisher's exact test. [b]Chi square test.

Table 3 Pancreatic texture, Wirsung duct diameter, and duration of operation among the two groups studied

	Group 1 [*n* (%)]	Group 2 [*n* (%)]	*P* value
Pancreatic texture			
Soft	9 (45)	12 (60)	0.342[a]
Hard	11 (55)	8 (40)	
Wirsung duct diameter			
≤4	14 (70)	15 (75)	0.723[a]
>4	6 (30)	5 (25)	
Duration of operation	5.5±0.8	5±0.6	0.003[a,*]

[a]Chi square test.

Figure 3



Duration of pancreaticogastrostomy among the groups studied.

Table 4 Postoperative pancreatic fistula among the patients studied

POPF	Group 1 [*n* (%)]	Group 2 [*n* (%)]	*P* value
Yes			
No	17 (85)	20 (100)	0.231[a]
Grade A	2 (10)	0	
Grade B	1 (5)	0	

POPF, postoperative pancreatic fistula. [a]Fisher's exact test.

vs. 28.6±7, respectively), and the difference was statistically significant as shown in Fig. 3.

Postoperative complications were assessed in the two groups. Table 4 shows that three (15%) patients in group 1 developed postoperative pancreatic fistula (POPF); two (10%) of them were grade A and were treated conservatively, whereas one (5%) was grade B and was treated by ultrasound-guided drainage and antibiotics. No patients in group 2 developed POPF. The rest of the postoperative complications are shown in Table 5.

Table 5 Postoperative complications among the groups studied

	Group 1 [*n* (%)]	Group 2 [*n* (%)]	*P* value
Bile leakage			
No	19 (95)	20 (100)	1[a]
Yes	1 (5)	0	
Intestinal anastomotic leakage			
No	19 (95)	18 (90)	1[a]
Yes	1 (5)	2 (10)	
Intraabdominal abscess			
No	19 (95)	20 (100)	1[a]
Yes	1 (5)	0	
Hematemesis			
No	16 (80)	14 (70)	0.465[b]
Yes	4 (20)	6 (30)	
Wound infection			
No	15 (75)	17 (85)	0.695[a]
Yes	5 (25)	3 (15)	

[a]Fisher's exact test. [b]Student's *t* test.

Discussion

PD is the standard procedure for the treatment of patients with pancreatic cancer and other periampullary diseases. However, postoperative complications of PD are still common [9]. POPF and delayed gastric emptying are the principal complications of PD and may sometimes be fatal. Other complications such as postoperative wound infections, intraabdominal fluid collection, and hemorrhage are also common after PD [10]. In clinical practice, various techniques or modifications of PG are carried out to minimize the complications of PD.

In 45% of group 1 and 40% of group 2 patients; the mean tumor size by computed tomography was less than 3.5 cm in maximum diameter, whereas in the rest of the patients, the tumor size was larger than 3.5 cm. These are closely related to Zhan *et al.* [11], who found that the mean tumor size was 4.6±2.2 cm (range, 0.5–14 cm), with 12 (16%) patients having tumors smaller than 3 cm, whereas in 70 (84%) patients, tumors were larger than

3 cm. This may be justified in the light of late presentation or aggressiveness of tumor behavior. Capello *et.al*. [12] found that tumor size less than 3 cm is an independent predictive factor for resectability.

In the present study, 17 (85%) patients of group 1 and 19 (95%) patients of group 2 had tumors that were located at the head of the pancreas, whereas the rest of the tumors were located at the body and the tail of the pancreas. These findings are in agreement with the data of Ryan *et al.* [13], who reported that ~75% of all pancreatic carcinomas occur within the head or neck of the pancreas, 15–20% occur in the body of the pancreas, and 5–10% occur in the tail.

Intraoperatively, pancreatic parenchyma was considered hard in 11 (55%) patients of group 1 and eight (40%) patients of group 2. Like group 1, Hiroaki *et al*. [7], who performed PG using mattress sutures, found that 10 (52.9%) out of 17 of his patients had a hard pancreas. This may be explained by the fact that both studies had the same inclusion criteria. Similarly, Wang *et al*. [14], who used a single purse-string duct to mucosa PG, found that 40% of their studied patients had firm or fibrosed pancreatic texture close to the group 2 results.

In our study, 70% of the patients of group 1 and 75% of the patients of group 2 were found to have Wirsung duct diameter less than 3 mm. Similar results have been obtained by Wang *et al*. [14], who found that 45 (61.5%) patients had pancreatic duct diameter less than 3 mm. Also, Addeo *et al*. [15] found that the mean size of the pancreatic duct was 4±2 mm (median, 3 mm; range, 2–9 mm), with 28 out of 40 patients having a Wirsung diameter less than 3 mm. The size of the pancreatic duct has been implicated as a major predictor of fistula. This is particularly important because when a small nondilated pancreatic duct, typically defined as less than or equal to 3 mm in diameter, is found, patients are more likely to be predisposed to PF compared with patients with dilated ducts.

The mean time for PG anastomosis in the trans-pancreatic suture group, from the incision of the posterior gastric wall to completion of the inner layer, was 34±7.7 min. This is similar to the results reported by Jeong *et al*. [16], who took a mean of 32 ±7 min for the completion of PG anastomosis, and also to Hiroaki *et al*. [7], who used trans-pancreatic mattress sutures and found that the mean duration for the anastomosis was 36±6 min.

The mean time for PG anastomosis in the purse-string suture group (from the incision of the posterior gastric wall till ligation of the inner layer) was 25.6±7 min; this is close to Addeo *et al*. [15], who found that the median time for the PG anastomosis was 21 min (range, 18–30 min). Daniel *et al*. [17], who performed PG using a single continuous circular suture, reported a mean operative time for PG of 22±9 min and a median of 9 min. However, Feng *et al*. [18] reported a much shorter time of 12 min for the PG (range, 8–24 min). The difference between these results and ours may be attributed to the fact that the former study was carried out in a high-volume center.

In group 1, three (15%) patients had POPF; two (10%) of them were grade A and one (5%) was grade B. The two patients with type A fistula had spontaneous regression of elevated drain amylase levels by POD seven, and all drains were eventually removed by POD 10. One patient with a type B PF underwent ultrasound-guided drainage of a peripancreatic collection and was managed on an outpatient basis by leaving the operative drain until POD 20. Similar results were obtained by Aranha *et al*. [19], who found that 15% (20 patients) of the patients developed grade A POPF among the 152 cases studied. They used pancreas-transfixing suture for the PG anastomosis as we did. Jeong *et al*. [16] found relatively similar results; they found that among the 63 patients studied, 22% (13 patients) had grade A POPF and 3% (two patients) had grade B POPF.In our work, none of the patients in group 2 developed POPF. Similar results were obtained by Addeo *et al*. [15], who used a similar technique for the PG anastomosis and found that the overall PF rate was 4% (two out of 50 patients) according to the International Study Group for Pancreatic Fistula definition. In the two patients, one PF was graded as type A and the second as type B, and both were treated conservatively. There were no type C PFs. All fistulas occurred in patients with a soft pancreatic parenchyma. Meanwhile, Feng *et al*. [18], who adopted a similar PG technique, found that POPF was encountered in two (1.7%) patients. According to the international clinical grading system, one patient had grade A POPF. This case was treated conservatively and fed orally without any additional intervention. One patient had grade B POPF and underwent an interventional drainage procedure with B-mode ultrasonic guidance.

In our study, it was found that postoperative biliary leakage occurred only in one (5%) patient in group 1, whereas none was encountered in group 2 and intestinal anastomotic leakage was found only in

group 2 in 5% (1 patient) of the patients, but did not occur in group 1. Similarly, Han *et al*. [20] reported biliary leak in one (1%) patient, with no reported enteric leak following PD. Aranha *et al*. [19] also detected 1% (one patient) biliary leak with 0% intestinal anastomotic leakage.

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Conflicts of interest
There are no conflicts of interest.

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