ORIGINAL ARTICLE

Comparison Between Pancreaticojejunostomy and Pancreaticogastrostomy After Pancreaticoduodenectomy

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Background/Purpose: Pancreatic leakage is a leading cause of morbidity and mortality after pancreaticoduodenectomy (PD). Pancreaticogastrostomy (PG) has been reported to be associated with a lower pancreatic leakage rate and morbidity rate than pancreaticojejunostomy (PJ). This study compared the preoperative characteristics, surgical risk factors, intraoperative parameters, and postoperative outcome between PJ and PG.

Methods: From March 1992 to March 2005, a comparative study between PJ and PG for patients with periampullary lesions undergoing PD was conducted. A total of 377 consecutive patients underwent PD. Among them, 188 patients underwent PJ and 189 underwent PG.

Results: The overall mortality, morbidity and pancreatic leakage following PD were 5%, 45.1% and 10.6%, respectively. The mortality, morbidity and pancreatic leakage were 8.9%, 56.4% and 17.6% in the PJ group, and 2.1%, 33.9% and 3.7% in the PG group ($p < 0.001$). Mean operative time was 9.3 hours versus 6.7 hours ($p < 0.001$), mean blood loss was 1032 mL versus 891 mL ($p = 0.064$) and mean hospital stay was 34.8 days versus 26.1 days ($p < 0.001$) in the PJ and PG groups, respectively. PJ, soft pancreas, pancreatic duct stenting, low surgical volume (< 20) and age (> 65 years) were identified as risk factors for pancreatic leakage, while PJ, soft pancreas, pancreatic duct stenting and low surgical volume (< 20) were four significant risk factors for surgical morbidity. Further, PJ, pancreatic leakage, low surgical volume (< 20) and age (> 65 years) were identified to be surgical risk factors for mortality.

Conclusion: PG is a safer method than PJ following PD as a significantly lower rate of pancreatic leakage, surgical morbidity and mortality, shorter operation time, and shorter postoperative hospital stay are reported.
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Key Words: pancreaticojejunostomy, pancreaticogastrostomy

Pancreaticoduodenectomy (PD) has become increasingly accepted as a safe and appropriate surgical technique for patients with either malignant or benign diseases of the pancreas and periampullary region. Nonetheless, the incidence of postoperative morbidity remains high and is currently estimated at 46–59%.[1–12] In most reports, the leading cause of morbidity after PD is attributable to pancreatic leakage,[1,2,8,13–15] due to failure of the pancreatic–enteric anastomosis to heal. The incidence of pancreatic anastomosis leakages ranges from 6% to 24%, with an average

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of 13.6%,[16–19] resulting in mortality rates of approximately 8–40% (mean, 12.5%).[16–19]

Attempts to minimize anastomotic leakage and minimize complications following PD have included both pharmacologic prophylactic approaches as well as various surgical techniques. For example, simple closure of the pancreatic duct, use of rubber or fibrin glue to occlude the main duct, pancreaticoenterostomy with the jejunum or stomach, PD with or without external pancreatic duct drainage, pancreatic duct stenting, invaginating end-to-end or end-to-side anastomoses, using an isolated Roux-en-Y limb, one- versus two-layer suture or duct-to-mucosa anastomosis, and even total pancreatectomy have been attempted.[20–31] Despite the introduction of these techniques, universal agreement has yet to be reached regarding the selection or endorsement of any particular variation of pancreaticojejunostomy (PJ) as a safer surgical technique that is less prone to fistula formation.

The recently repopularized option for enteric drainage of the pancreatic remnant is pancreaticogastrostomy (PG), a technique first reported in dogs in 1934,[31] and initially described clinically by Waugh and Clagett in 1946.[32] Although a few randomized controlled trials revealed no difference in the incidence of pancreatic leakage between PJ and PG,[33–35] most retrospective reports suggest that PG is associated with lower pancreatic leakage and surgical morbidity compared to PJ.

Since the reconstruction method of choice remains controversial, this study was designed to retrospectively compare patients receiving PJ or PG following PD to determine whether or not PG is a safer alternative for pancreatic reconstruction than PJ.

Methods

Patients and outcome measures

Medical data from 377 patients in Taipei Veterans General Hospital who underwent PJ or PG following PD between March 1992 and March 2005 inclusive were analyzed. Surgical technique (PJ versus PG) was selected according to the surgeon's preference.

Surgical risks in terms of surgical mortality, morbidity, and pancreatic leakage were assessed and compared by a variety of factors including surgical technique, patient age, stenting status for pancreatic anastomosis, consistency of pancreatic parenchyma and the surgeon volume in performing PD.

Surgeon volume was according to the total volume of each surgeon and stratified into three groups: low (< 10), medium (10–20), and high (> 20). Surgical mortality was defined as any death occurring during hospitalization or within 30 days postoperatively. Delayed gastric emptying was defined as the inability to resume oral intake after postoperative day 14. To provide direct evidence of pancreatic anastomosis leakage, upper gastrointestinal studies (oral intake of 2 mL methylene blue dye plus 200 mL water) or fistulogram were performed in any patient in whom pancreatic leakage was suspected. Thus, pancreatic leakage was defined as leak of methylene blue dye into a drain or positive fistulogram findings at any time during the postoperative period.

Surgical technique

PD was performed with either the pylorus-preserving modification or classic resection including antrectomy. For reconstruction of PG, a 3–4 cm stump of the pancreatic remnant was freed from the splenic vein and retroperitoneum. The pancreatic stump was anastomosed and invaginated into the mid-body posterior wall of the stomach with interrupted two-layer sutures employing 3-0 silk for the outer layer placed between the pancreatic capsule and seromuscular layer of the posterior gastric wall, and 3-0 polyglactin (Vicryl; Ethicon, Somerville, NJ, USA) for the inner layer placed between the cut edge of the pancreas and the full thickness of the posterior gastric wall. No duct-to-mucosa anastomosis was used for PG.

For reconstruction of PJ, end-to-side or end-to-end anastomosis, duct-to-mucosa, two-layer sutures were performed with the same suture

materials as described for PG. Two latex closed-suction tubes were used to drain the areas near the pancreatic anastomosis. In patients with pancreatic duct stents, a 5F or 8F pediatric feeding tube was used. After pancreatic reconstruction, an end-to-side hepaticojejunostomy and an end-to-side antecolic duodenojejunostomy or gastrojejunostomy completed the reconstruction. No vagotomy was performed in any procedure. A nasogastric tube was routinely used to decompress the stomach posteriorly, which was subsequently removed when gastric output from the nasogastric tube was less than 500 mL.

Statistical analysis

Statistical analysis was performed using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA). Data are presented as mean ± standard deviation (SD). Categorical data were compared using χ^2 test. The independent samples *t* test was employed to compare the means of two groups. Logistic regression multivariate analysis was carried out to determine the independent risk factors after PD. A *p* value < 0.05 was considered statistically significant.

Results

A total of 377 patients underwent PG or PJ following PD. As illustrated in Table 1, 189 patients received PG and 188 PJ. In the PG group, 132 patients were male and 57 were female with a mean age of 66 years. In the PJ group, 129 patients were male and 59 were female with a mean age of 65.1 years. There was no difference in age and sex distribution between the two groups. In the PJ group, a significant higher incidence of ampulla Vater adenocarcinoma and distal common bile duct adenocarcinoma were observed, while duodenal adenocarcinoma and other malignant lesions were more common in the PG group. Patients receiving PJ presented with significantly more symptoms of fever and chills, while jaundice was more common in PG.

Surgical mortality was lower in the PG group than in the PJ group ($p = 0.000$) (Table 2). Surgical morbidity was also significantly lower in the PG group regarding overall complications ($p = 0.000$), pancreatic leakage ($p = 0.000$), intra-abdominal abscess ($p = 0.000$), and sepsis ($p = 0.004$). The mean length of hospital stay was statistically different between the two groups, with 26.1 days in the PG group and 34.8 days in the PJ group ($p = 0.000$). Operative time was significantly less in the PG group (PG, 6.7 ± 1.2 hours; PJ, 9.3 ± 2.0 hours). The PG group had a significantly higher proportion of patients with small PD diameter ($p = 0.002$), and no stenting of the pancreatic duct ($p = 0.000$). There was no significant difference in pancreatic texture between the two groups ($p = 0.098$).

Table 3 demonstrates a statistically significant relationship between pancreatic leakage and each of: type of anastomosis ($p = 0.000$); pancreatic texture ($p = 0.032$); pancreatic duct stenting ($p = 0.000$); surgeon volume ($p = 0.000$); and age ($p = 0.031$). Multivariate analysis (Table 4) revealed that the independent risk factors for pancreatic leakage included type of anastomosis ($p = 0.020$; odds ratio [OR], 4.35) and age ($p = 0.031$; OR, 2.54).

Surgical morbidity was significantly associated with type of anastomosis ($p = 0.000$), pancreatic texture ($p = 0.001$), pancreatic duct stenting ($p = 0.002$), and surgeon volume ($p = 0.034$) (Table 5). The independent risk factors for surgical morbidity by multivariate analysis included type of anastomosis ($p = 0.001$; OR, 3.18) and pancreatic texture ($p = 0.003$; OR, 2.01) (Table 6). As shown in Table 7, surgical mortality was significantly associated with the type of anastomosis ($p = 0.009$), pancreatic leakage ($p = 0.000$), surgeon volume ($p = 0.000$), and age ($p = 0.039$).

Most (87.0%) of the patients were operated on by experienced surgeons (surgeon volume > 20). These surgeons had significantly lower surgical mortality rates (2.7%) compared with the medium-count surgeons (19%) and low-count surgeons (21.4%) ($p = 0.000$). Independent risk factors of surgical mortality included pancreatic leakage ($p = 0.010$; OR, 4.21) and surgeon volume ($p = 0.001$), with OR of 4.59 for medium

Table 1. Demographic characteristics and clinical presentation of patients undergoing pancreaticoduodenectomy*

	Overall ($n=377$)	PJ ($n=188$)	PG ($n=189$)	p
Periampullary lesions				
Ampulla Vater adenocarcinoma	133 (35.3)	80 (42.6)	53 (28.0)	0.003
Pancreatic head adenocarcinoma	18 (13.1)	11 (5.9)	7 (3.7)	0.328
Distal CBD adenocarcinoma	34 (9.0)	27 (14.4)	7 (3.7)	0.000
Duodenal adenocarcinoma	114 (30.2)	40 (21.3)	74 (39.2)	0.000
Chronic pancreatitis	46 (12.2)	25 (13.3)	21 (11.1)	0.517
Other malignancy	20 (5.3)	2 (1.1)	18 (9.5)	0.000
Other benign lesion	12 (3.2)	3 (1.6)	9 (4.8)	0.080
Age (yr)				0.456
Median (range)	68 (15–89)	68 (15–89)	69 (16–85)	
Mean ± SD	65.6	65.1 ± 11.6	66.0 ± 12.1	
Sex				0.824
Male	261 (69.2)	129 (68.6)	132 (69.8)	
Female	116 (30.8)	59 (31.4)	57 (30.2)	
Clinical presentation				
Jaundice	267 (70.8)	122 (64.9)	145 (76.7)	0.012
Epigastralgia	153 (40.6)	83 (44.1)	70 (37.0)	0.160
Body weight loss	126 (33.4)	71 (37.8)	55 (29.1)	0.075
Diabetes mellitus	63 (16.7)	29 (15.4)	34 (18.0)	0.505
Anorexia/nausea/vomiting	48 (12.7)	22 (11.7)	26 (13.8)	0.550
Upper gastrointestinal bleeding	24 (6.4)	16 (8.5)	8 (4.2)	0.089
Diarrhea/steatorrhea	23 (6.1)	13 (6.9)	10 (5.3)	0.510
Others	141 (37.4)	78 (41.5)	63 (33.3)	0.102
Preoperative serum albumin (mg/dL)				0.064
Median (range)	3.7 (2.5–4.9)	3.7 (2.5–4.9)	3.8 (2.7–4.6)	
Mean ± SD	3.7 ± 0.4	3.7 ± 0.4	3.7 ± 0.4	
Duration of symptoms (mo)				0.070
Median (range)	1 (0–120)	1 (0–31)	1 (0–120)	
Mean ± SD	3.0 ± 9.2	2.1 ± 3.8	3.8 ± 12.4	

**Data are presented as n (%) unless otherwise indicated. PJ = pancreaticojejunostomy; PG = pancreaticogastrostomy; CBD = common bile duct; SD = standard deviation.*

surgeon volume and 7.27 for low surgeon volume (Table 8).

Discussion

Since pancreatic leakage is a leading cause of morbidity and mortality after PD, this study was performed in order to compare preoperative characteristics, surgical risk factors, intraoperative parameters, and postoperative outcomes between PJ and PG in patients who had previously undergone PD. The data presented herein identified a significantly lower rate of pancreatic leakage in patients who had PG following PD compared to patients who had PJ after PD (3.7% *vs.* 17.6%).

These results are different from those cited in the literature. While only a few controlled randomized studies dealing with the comparison of PG and PJ following PD have been published,[33–35] no significant difference in pancreatic leakage between PJ and PG was reported. Specifically,

Table 2. Observed morbidity and mortality following pancreaticoduodenectomy

	Overall ($n=377$)	PJ ($n=188$)	PG ($n=189$)	p
Surgical mortality	19 (5.0)	15 (7.9)	4 (2.1)	0.000
Complications				
Patients with complications	170 (45.1)	106 (56.4)	64 (33.9)	0.000
Pancreatic leakage	40 (10.6)	33 (17.6)	7 (3.7)	0.000
Wound infection	33 (8.8)	20 (10.6)	13 (6.9)	0.196
Delayed gastric emptying	43 (11.4)	22 (11.7)	21 (11.1)	0.857
Intra-abdominal abscess	35 (9.3)	29 (15.4)	6 (3.2)	0.000
Intra-abdominal bleeding	19 (5.0)	12 (6.4)	7 (3.7)	0.234
Upper gastrointestinal bleeding	21 (5.6)	12 (6.4)	9 (4.8)	0.493
Sepsis	15 (4.0)	13 (6.9)	2 (1.1)	0.004
Gastrojejunostomy leakage	2 (0.5)	2 (1.1)	0	0.248
Others	37 (9.8)	24 (12.8)	13 (6.9)	0.055
Postoperative hospital stay (d)				0.000
Median (range)	26 (1–134)	28 (1–134)	23 (4–106)	
Mean ± SD	30.4 ± 18.8	34.8 ± 21.9	26.1 ± 13.7	
Blood loss (mL)				0.064
Median (range)	800 (100–5540)	800 (100–5540)	800 (100–4500)	
Mean ± SD	955 ± 684	1032 ± 798	891 ± 566	
Operation time (hr)				0.000
Median (range)	7.5 (4–16)	9.0 (5–16)	6.5 (4–11)	
Mean ± SD	8.0 ± 2.1	9.3 ± 2.0	6.7 ± 1.2	

**Data are presented as n (%) unless otherwise indicated. PJ = pancreaticojejunostomy; PG = pancreaticogastrostomy; SD = standard deviation.*

Bassi et al,[33] Yeo et al[34] and Duffas et al[35] reported pancreatic leakage in 13%, 12.3% and 16% of patients who had PG, and 16%, 11.1% and 20% of patients who had PJ following PD. One meta-analysis found that PG was associated with a significantly lower pancreatic leakage rate than PJ.[36] Interestingly, in most retrospective studies,[37–43] the pancreatic leakage rate of PG is approximately 0–5%, which is significantly lower than the rate of pancreatic leakage in patients who had PJ (13–20%). No significant difference between the two procedures in terms of pancreatic leakage, however, has been reported.[44–47] It is interesting that the rate of pancreatic leakage associated with PG varies so remarkably between different institutions. Two possible causes of this disparity might be differences in surgeons' learning curves and differences in surgical technique between surgeons. While PJ has been performed for more than 100 years, PG has only been introduced more recently. As a result, it may be too soon to make solid conclusions regarding the best technique.

A number of theoretical advantages have been made regarding factors that apparently contribute to the low leakage rate of PG. These include: anastomosis protection against enzymatic attack by inactivating the pancreatic proteolytic enzymes in the relatively acid milieu of the stomach and in the absence of enterokinase which is present only in the small bowel; protection against marginal ulceration by neutralizing gastric acidity with alkaline pancreatic secretions; tension-free anastomosis as the pancreas lies immediately adjacent to the posterior wall of the stomach and the two organs naturally opposed; absence of a long jejunal loop which may cause tension on the anastomosis by accumulation of pancreaticobiliary

Table 3. Univariate analysis of risk factors for pancreatic leakage

Risk factor	Pancreatic leakage		*p*
	Yes	No	
Type of anastomosis			0.000
PJ (*n* = 188)	33 (17.6)	155 (82.4)	
PG (*n* = 189)	7 (3.7)	182 (96.3)	
Pancreas texture			0.032
Soft (*n* = 224)	29 (12.9)	195 (87.1)	
Hard (*n* = 136)	8 (5.9)	128 (94.1)	
Pancreatic duct stenting			0.000
With (*n* = 185)	30 (16.2)	155 (83.8)	
Without (*n* = 175)	8 (4.6)	167 (95.4)	
Surgeon volume			0.000
Low (< 10) (*n* = 28)	9 (32.1)	19 (67.9)	
Medium (10–20) (*n* = 21)	3 (14.3)	18 (85.7)	
High (> 20) (*n* = 328)	27 (8.2)	301 (91.8)	
Age			0.031
≤ 65 yr (*n* = 144)	9 (6.3)	135 (93.7)	
> 65 yr (*n* = 223)	31 (13.9)	202 (86.1)	

**Data are presented as n (%). PJ = pancreaticojejunostomy; PG = pancreaticogastrostomy.*

Table 4. Multivariate analysis of risk factors for pancreatic leakage

Risk factor	*p*	OR	95% CI
Type of anastomosis			
PJ	0.020	4.35	0.07–0.80
PG		1.00	
Pancreas texture			
Soft	0.085	2.11	0.90–4.94
Hard		1.00	
Pancreatic duct stenting			
With	0.830	1.14	0.26–2.92
Without		1.00	
Surgeon volume			
Low (< 10)	0.289	1.74	0.62–4.86
Medium (10–20)	0.535	1.54	
High (> 20)		1.00	
Age			
≤ 65 yr		1.00	
> 65 yr	0.031	2.54	1.09–5.92

OR = odds ratio; CI = confidence interval; PJ = pancreaticojejunostomy; PG = pancreaticogastrostomy.

Table 5. Univariate analysis of risk factors for surgical morbidity

Risk factor	Surgical morbidity		*p*
	Yes	No	
Type of anastomosis			0.000
PJ ($n=188$)	106 (56.4)	82 (43.6)	
PG ($n=189$)	64 (33.9)	125 (66.1)	
Pancreas texture			0.001
Soft ($n=224$)	115 (51.3)	109 (48.7)	
Hard ($n=136$)	46 (33.8)	90 (66.2)	
Pancreatic duct stenting			0.002
With ($n=185$)	97 (52.4)	88 (47.6)	
Without ($n=175$)	64 (36.6)	111 (63.4)	
Surgeon volume			0.034
Low (< 10) ($n=28$)	18 (64.3)	10 (35.7)	
Medium (10–20) ($n=21$)	9 (42.9)	12 (57.1)	
High (> 20) ($n=328$)	142 (43.3)	186 (56.7)	
Age			0.514
≤ 65 yr ($n=144$)	68 (47.2)	76 (52.8)	
> 65 yr ($n=223$)	102 (43.8)	131 (56.2)	

**Data are presented as n (%). PJ = pancreaticojejunostomy; PG = pancreaticogastrostomy.*

Table 6. Multivariate analysis of risk factors for surgical morbidity

Risk factor	*p*	OR	95% CI
Type of anastomosis			
PJ	0.001	3.18	0.16–0.63
PG		1.00	
Pancreas texture			
Soft	0.003	2.01	1.27–3.19
Hard		1.00	
Pancreatic duct stenting			
With	0.291	1.44	0.73–2.86
Without		1.00	
Surgeon volume			
Low (< 10)	0.591	1.28	0.52–3.13
Medium (10–20)	0.521	0.73	0.28–1.92
High (> 20)		1.00	

OR = odds ratio; CI = confidence interval; PJ = pancreaticojejunostomy; PG = pancreaticogastrostomy.

secretions and the weight of the loop itself; excellent blood supply and the thick stomach wall is less likely to develop ischemic complications and holds sutures better than the jejunum loop; early detection of bleeding from the pancreatic remnant or the anastomosis by routine postoperative gastric decompression (which also provides constant removal of pancreatic and gastric secretions ensuring that a buildup of secretions will not cause tension on the anastomosis); direct

Table 7. Univariate analysis of risk factors for surgical mortality

Risk factor	Surgical mortality		*p*
	Yes	No	
Type of anastomosis			0.009
PJ (*n* = 188)	15 (8.0)	173 (92.0)	
PG (*n* = 189)	4 (2.1)	185 (97.9)	
Pancreas texture			0.058
Soft (*n* = 224)	15 (6.7)	209 (93.3)	
Hard (*n* = 136)	3 (2.2)	133 (97.8)	
Pancreatic duct stenting			0.183
With (*n* = 185)	12 (6.4)	173 (93.6)	
Without (*n* = 175)	6 (3.4)	196 (96.6)	
Pancreatic leakage			0.000
Yes (*n* = 40)	8 (20)	32 (80)	
No (*n* = 337)	11 (3.3)	326 (96.7)	
Surgeon volume			0.000
Low (< 10) (*n* = 28)	6 (21.4)	22 (78.6)	
Medium (10–20) (*n* = 21)	4 (19.0)	17 (81.0)	
High (> 20) (*n* = 328)	9 (2.7)	319 (97.3)	
Age			0.039
≤ 65 yr (*n* = 144)	3 (2.1)	141 (97.9)	
> 65 yr (*n* = 223)	16 (6.9)	217 (93.1)	

**Data are presented as n (%). PJ = pancreaticojejunostomy; PG = pancreaticogastrostomy.*

Table 8. Multivariate analysis of risk factors for surgical mortality

Risk factor	*p*	OR	95% CI
Type of anastomosis			
PJ	0.306	1.93	0.15–1.83
PG		1.00	
Pancreatic leakage			
Yes	0.010	4.21	1.41–12.57
No		1.00	
Surgeon volume			
Low (< 10)	0.004	7.27	1.87–28.29
Medium (10–20)	0.019	4.59	1.28–16.42
High (> 20)		1.00	
Age			
≤ 65 yr		1.00	
> 65 yr	0.142	2.66	0.72–9.83

OR = odds ratio; CI = confidence interval; PJ = pancreaticojejunostomy; PG = pancreaticogastrostomy.

examination of the anastomosis by endoscopy or roentgenography if necessary; and easy exploration of the anastomosis without disassembling the pancreatic anastomosis by opening the anterior wall of the stomach if bleeding occurs.[16,46,68]

Some reports associated delayed gastric emptying with intra-abdominal complication rather than the type of reconstruction.[49,50] In this study, no significant difference in delayed gastric emptying between PJ and PG was identified. Thus, reconstruction method did not play an important role in delayed gastric emptying. Our data indicated that soft pancreas was associated with significantly higher pancreatic leakage by univariate analysis, and higher surgical morbidity by both univariate and multivariate analyses. Thus, these results were similar with a number of studies,[51–53] which reported that a soft pancreatic remnant is more likely to develop pancreatic leakage, thereby contributing to higher surgical morbidity.

In an attempt to prevent pancreatic leakage and occlusion of the pancreatic duct, some studies advocate pancreatic stenting.[54–57] In the present trial, however, pancreatic duct stenting was associated with a significantly higher pancreatic leakage rate and surgical morbidity rate by our univariate analysis (but not by multivariate analysis). It should be noted, however, that pancreatic duct stenting was performed in the majority of PJ (90.6%), while only 15.9% of PG involved stenting. It therefore appears that pancreatic duct stenting does not play an important role in the prevention of pancreatic leakage in the PG group.

Our data demonstrated a longer operation time in the PJ than in the PG group. The possible explanation is that most of the patients in the PJ group underwent duct-to-mucosa, which was not performed in the PG group. Another reason is that pylorus-preserving pancreaticoduodenectomy (PPPD) was performed in 93.7% (177/189) of our PG patients while it was only performed in 8.5% (16/188) of our PJ patients. One meta-analysis found that PPPD was associated with shorter operation time and less blood loss.[58] These two reasons might be the cause of the longer operation time in the PJ group than in the PG group.

In the study reported here, surgeons with higher volume had lower pancreatic leakage rate. This supports previous study results that reported significantly lower rates of surgical mortality, pancreatic leakage and bile leakage in surgeries performed by more experienced surgeons.[59] Overall, there was a higher pancreatic leakage rate in PJ (17.6%) than in PG (3.7%) in the present study. Pancreatic leakage-related mortality was higher in PJ (8/33, 24.2%) than in PG (0%). The cause of pancreatic leakage-related death in the PJ group included intra-abdominal bleeding, intra-abdominal abscess and sepsis. Other research groups' findings support these results. For example, Takano et al reported that the mortality rate related to pancreatic leakage was higher in PJ than in PG (22.2% *vs.* 0%).[43] One clear disadvantage of PJ is that once pancreatic leakage occurs, the activated pancreatic enzymes may lead to massive bleeding and, thus, to a life-threatening condition.

In conclusion, this study clearly demonstrated that PG was associated with a lower surgical risk than PJ in patients who had previously been treated with PD in terms of pancreatic leakage, surgical morbidity, mortality, operation time and length of hospital stay. For the reconstruction of pancreatic remnant after PD, we conclude that PG is a safer procedure than PJ and should therefore be the technique of choice amongst surgeons.

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