Asian Journal of Surgery (2018) 41, 250–256

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-asianjournalsurgery.com

ORIGINAL ARTICLE

A modified technique of pancreaticogastrostomy with short internal stent: A single surgeon's experience

Pei Yi Yap [a], Jung Shan Hwang [b], Jan Jin Bong [b,c,*]

[a] Department of Biological Sciences, Faculty of Science and Technology, Sunway University, Bandar Sunway, Selangor, Malaysia
[b] Sunway Institute for Healthcare Development, Sunway University, Bandar Sunway, Selangor, Malaysia
[c] Department of Surgery, Sunway Medical Centre, Selangor, Malaysia

Received 31 October 2016; received in revised form 5 December 2016; accepted 25 January 2017
Available online 10 March 2017

KEYWORDS
pancreatico-duodenectomy;
pancreatico-gastrostomy;
postoperative pancreatic fistula

Summary *Background/Objective:* Postoperative pancreatic fistula (POPF) remains an important cause of morbidity and mortality after pancreaticoduodenectomy. Pancreaticogastrostomy (PG) as a reconstruction method after pancreaticoduodenectomy is a safe and optional surgical technique in decreasing the risk of POPF. In this study, a retrospective analysis was carried out to evaluate a new modification of PG technique that uses a two-layer anastomoses with an internal stent.
Methods: Forty-seven patients underwent this newly modified PG technique between February 2012 and August 2016. Demographics, histopathological findings, type of surgery performed, perioperative parameters, postoperative length of stay, postoperative complications and interventional procedures, follow-up, and mortality data were collected and analyzed. Clavien–Dindo classification was used to grade the complications' severity.
Results: Postoperative mortality was 4.25%, unrelated to POPF, and postoperative morbidity was 44.68%. Thirteen patients had severe (>Grade IIIa) complications, according to Clavien–Dindo classification. As classified in accordance to the International Study Group of Pancreatic Fistula, 24 (51.06%) patients developed Grade A POPF, and no occurrence of Grade B/C POPF was noted. All patients recovered uneventfully with successful treatment interventions.
Conclusion: The reported PG anastomotic technique is a safe and dependable reconstruction procedure with acceptable morbidity and mortality.

Conflicts of interest: The authors declare that there are no conflicts of interest.

* Corresponding author. Hepatobiliary–Pancreatic Surgical Unit, Department of Surgery, Sunway Medical Centre, Number 5, Jalan Lagoon Selatan, Bandar Sunway, Selangor Darul Ehsan 47500, Malaysia.
E-mail address: bongjj@gmail.com (J.J. Bong).

http://dx.doi.org/10.1016/j.asjsur.2017.01.003

1. Introduction

Pancreaticoduodenectomy (PD) or Whipple's procedure is a complex surgery performed for various benign and malignant diseases on the pancreatic head, duodenum, periampullary region, and the distal part of the common bile duct.[1] The development of postoperative pancreatic fistula (POPF) after PD could potentially contribute to severe complications such as intra-abdominal abscess,[2] intraperitoneal bleeding, delayed gastric emptying (DGE),[3] postoperative pancreatic hemorrhage, wound infection, and/or peritonitis.[4,5] Hence, this would contribute to longer hospital stays, increased healthcare costs, severe morbidity, or even surgical mortality.[6,7] The occurrence rate of POPF was reported to be between 0% and 17%.[8,9] Despite advancements in perioperative management and reconstructive surgical techniques, the overall postoperative morbidity remains high, even at high volume centers, ranging from 30% to 50%,[10–12] whereas the mortality rate has been reduced to less than 5%.[13]

To date, there has been no consensus between the common methods for pancreatic-enteric anastomosis—pancreaticojejunostomy (PJ) and pancreaticogastrostomy (PG), as to which is the superior surgical reconstruction method after PD.[14,15] Recent retrospective studies proposed that PG reduced the POPF rate more compared with PJ.[16,17] However, one recent meta-analysis of six randomized controlled trials indicated that there were no differences in the postoperative complications and mortality rates between PJ and PG.[18] Despite this, PG is still an alternative for pancreatic anastomosis for many surgeons, with some theoretical physiologic and technical advantages over PJ,[2,19] such as excellent anastomotic healing, which is facilitated by the abundant gastric blood supply to the stomach wall, and the ability of the stomach wall to hold sutures well.[14,15,20]

Several PG anastomotic technical modifications have been reported to reduce PF, including twin square wrapping with duct-to-mucosa anastomosis,[21] single purse-string suture duct-to-mucosa anastomosis,[22] full-thickness suture,[23] and double-binding continuous hemstitch sutures.[24] Nevertheless, a "gold standard" surgical technique has yet to be established. The objective of this retrospective, noncomparative study was to evaluate a newly modified PG anastomotic technique—a two-layer anastomosis (an external interrupted suture and an internal continuous suture) with an internal stent.

2. Patients and methods

The medical records of 47 patients who had undergone PD followed by PG between February 2012 and August 2016 at Sunway Medical Centre, Selangor, Malaysia, were retrospectively reviewed. Ethical approval was obtained from Sunway Medical Centre Independent Research Ethics Committee. Patients' data collected included demographics (age and sex), histopathological findings, types of surgery performed [classic Whipple or pylorus-preserving pancreaticoduodenectomy (PPPD)], perioperative parameters (operating time, blood loss, and blood transfusion), postoperative length of stay, postoperative complications and interventional procedures, follow-up, and mortality. The severity of the complications was scored using the Clavien—Dindo classification of surgical complications,[25,26] where Grade I and Grade II indicate no or nonsevere complications, Grade IIIa to Grade IVb indicate severe complications to multiorgan dysfunction, and Grade V indicates death. Patients routinely received total parenteral nutrition until Postoperative Day (POD) 5. The volume and concentration of fluid amylase in the surgical drains were measured on POD 3 and POD 5 to identify the presence of POPF. The upper limit of normal serum amylase value in our hospital was 160 U/L. According to the International Study Group of Pancreatic Fistula (ISGPF), POPF is defined as a drain output of any measurable volume of fluid and more than three times the serum amylase concentration in drainage fluid on or after POD 3. POPF was then classified as follows: Grade A, fistula without any clinical impact; Grade B, fistula which required persistent drainage of more than 3 weeks and presented signs of infections; and Grade C, fistula which necessitated aggressive clinical interventions.[13] DGE was defined as the incapability of tolerating normal diet by POD 7 and required prolonged nasogastric intubation.[27] A bile leak was defined as an increase of drainage bilirubin levels on or after POD 3 based on International Study Group for Liver Surgery.[28] Chylous ascites was denoted as the lipid-rich lymph collection in the peritoneal cavity.[29] Operative mortality referred to the occurrence of death postoperatively within 30 days.

2.1. Surgical technique

After PD was performed (either the classic Whipple's resection or duodenal-preserving resection), the restoration of pancreatic remnant to gastrointestinal continuity was via PG.

After transection of the neck or body of the pancreas, the distal pancreatic stump was mobilized for 2 cm off the splenic vein and the surrounding structures. Two traction sutures were applied to the superior and inferior borders of the pancreas close to the cut edge. Some tributaries of splenic veins joining the posterior surface of the pancreatic stump were carefully cauterized or ligated. The stomach was mobilized distally, and all posterior adhesion was divided. The stomach was positioned to sit naturally in its original position but ensuring that the distal part was mobile.

Next, a small infant feeding tube (6F or 8F) was inserted into the pancreatic duct and secured to the pancreatic parenchyma with 4/0 polydioxanone (PDS) sutures. The protruding end of the tube was cut approximately 3—4 cm away from the pancreatic stump, thus forming an internal stent (Figure 1).

The pancreatic stump was brought to the posterior surface of the stomach, and a series of full-thickness suturings (4/0 Prolene, Prolene, Ethicon, USA) was passed through the pancreatic parenchyma (Figure 1). These sutures were then passed through the posterior layer of the stomach and ligated, thus securely anchoring the pancreatic stump to the stomach. The presence of the pancreatic stent prevented the inadvertent incorporation of the main pancreatic duct with the full-thickness sutures.

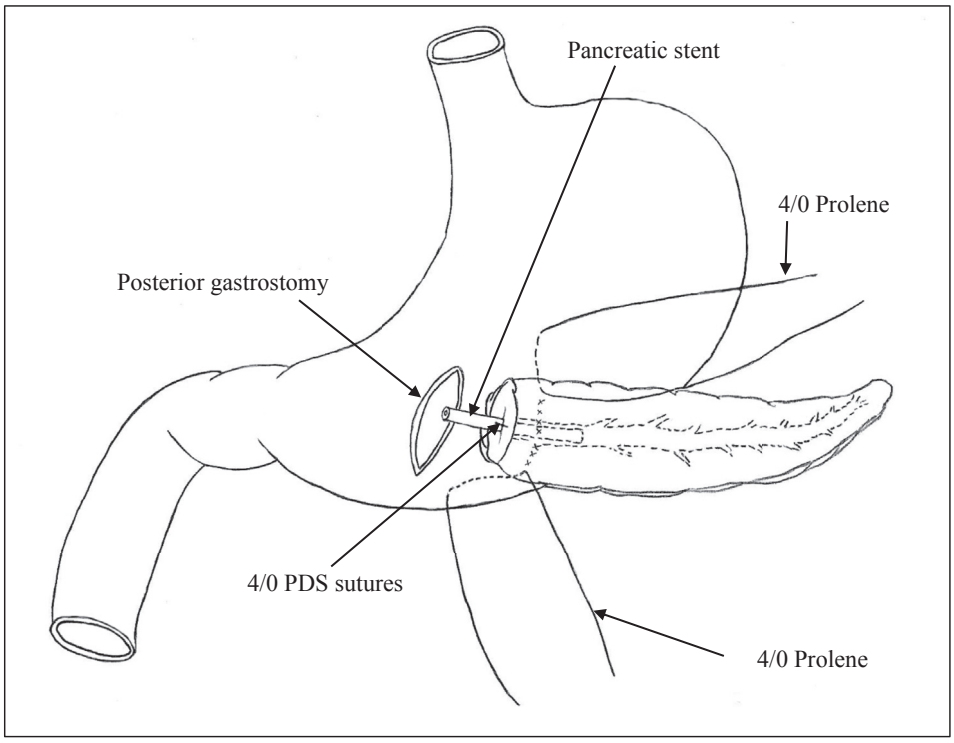

Figure 1 Schematic drawing shows the technique of pancreaticogastrostomy. The pancreatic stent was secured with a 4/0 polydioxanone (PDS) suture. A series of 4/0 Prolene sutures was passed through the pancreatic parenchyma, away from the cutting edge, to anchor the pancreatic stump to the posterior wall of the stomach. An incision was made at the posterior gastrostomy, next to the pancreatic stump.

A posterior gastrostomy incision was then made next to the pancreatic stump (Figure 1) to allow for the traction sutures to pass into the stomach. An anterior, longitudinal gastrostomy incision was then made to retract the traction sutures, and to bring the pancreatic stump through the gastric wall, and to protrude into the stomach lumen. The pancreatic stump was then sutured to the seromuscular layer of the stomach in a continuous running fashion using 4/0 PDS suture. Once internal suturing was completed, the external part of the pancreas was anchored to the posterior wall of the stomach in interrupted, full-thickness fashion using a series of 4/0 Prolene sutures (Figure 2). The anterior gastrostomy was then closed with running suture.

Hepaticojejunostomy was completed by performing an end-to-side, retrocolic, hepaticojejunostomy using 4/0 PDS sutures. The gastrostomy was fashioned in two-layer anastomosis, using 4/0 PDS suture. Two surgical drains were placed next to the hepaticojejunostomy and PG, respectively.

2.2. Statistical analysis

Statistical analysis of the data was performed using Microsoft Excel program for data collection and SPSS Statistics (Version 21.0; SPSS, Inc., Chicago, IL, USA) for data entry and analysis. The description of the data is in the form of median and range for quantitative data. For qualitative data, the data description is in the form of frequency, proportion, or percentage.

3. Results

There were 30 females and 17 males included in this study, with a median age of 60 years (range 26—77 years) (Table 1). The histopathological diagnoses were as follows: 18 pancreatic adenocarcinomas, eight ampullary adenocarcinomas, six cholangiocarcinomas, three chronic pancreatitis, three neoplastic pancreatic cysts, two pancreatic cystic lesions, two neuroendocrine tumors, two duodenal gastrointestinal stromal tumor, one ampullary tubulovillous adenoma with high grade dysplasia, one intraductal tubular carcinoma, and one adenocarcinoma of the distal, extrahepatic common bile duct (Table 1). The median size of the tumors was 30 mm (range, 8—130 mm). Positive resection margins (R1) were observed in three (6.8%) of the specimens whereas 44 (93.6%) were of negative resection margins (R0).

The classic Whipple's resection was performed in 41 (80.85%) patients, and two (4.25%) patients underwent PPPD (Table 2). In another three (12.76%) cases, classic Whipple's resection was combined with other procedures such as wedge segmentectomy for neuroendocrine liver metastasis, left hepatectomy, and total abdominal hysterectomy. One (2.12%) patient underwent PPPD with salpingo-oophorectomy. The median operative time was 351 minutes (range, 243—553 minutes). The median blood loss was 563.8 mL (range, 200—5000 mL); 20 (42.55%) out of 47 patients received perioperative blood transfusion, with the median amount transfused being 2 units of packed red blood cells.

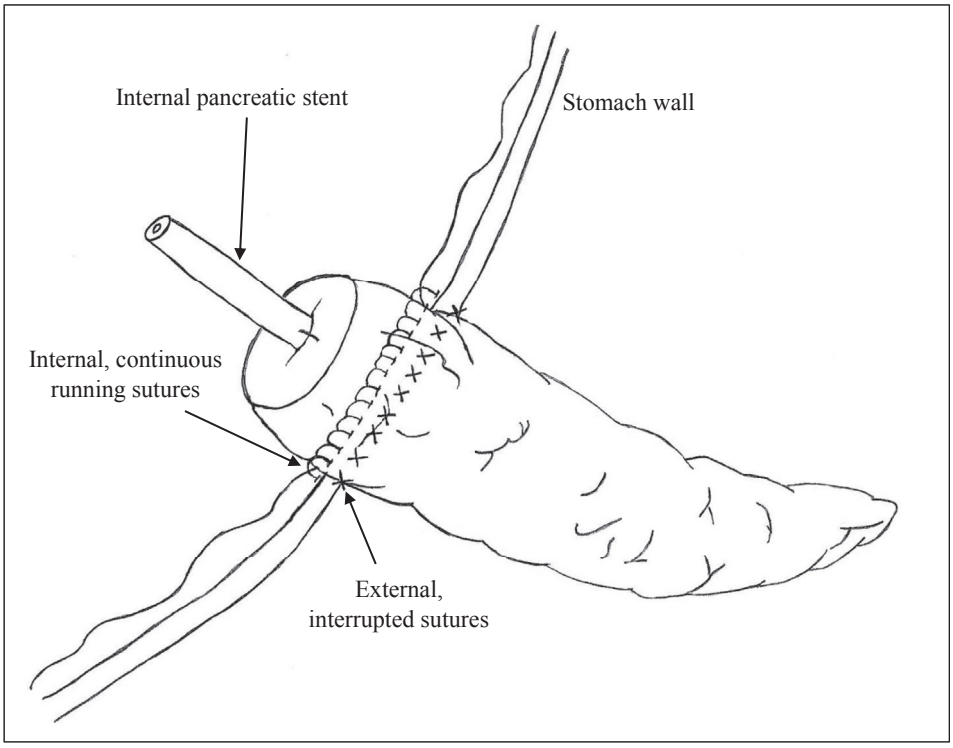

Figure 2 Schematic drawing shows the pancreatic stump protruding the stomach lumen. The pancreatic stump was sutured to the seromuscular layer of the stomach with 4/0 polydioxanone (PDS) sutures, in a continuous running fashion. The external part of the pancreas was sutured to the posterior wall of the stomach with 4/0 Prolene sutures, in an interrupted, full-thickness fashion.

The median fluid amylase concentrations were 578 U/L from the left abdominal drain near the hepaticojejunostomy anastomosis (range, 3—54,879 U/L) and 232.5 U/L (range, 3—7617 U/L) from the right abdominal drain near the PG anastomosis on POD 3. On POD 5, the median amylase concentration for the left abdominal drain was 116 U/L (range, 5—24,043 U/L), and for the right abdominal drain it was 68 U/L (range, 6—1672 U/L). Meanwhile, the median fluid volumes were 140 mL (range, 3—1200 mL) for the left abdominal drain and 79.5 mL (range, 1—1400 mL) for the right abdominal drain on POD 3. On POD 5, the median drain volumes were 102.5 mL (range, 2—1280 mL; left abdomen) and 110 mL (range, 5—1002 mL; right abdomen).

The overall postoperative morbidity was 44.68%. According to the Clavien—Dindo classification of surgical

Table 1 Patients' demographic data and histopathological diagnoses.

Variable	Patients (n = 47)
Sex (M/F)	17/30
Age (y)	60 (26—77)
Histopathological diagnoses	
Pancreatic adenocarcinoma	18
Ampullary adenocarcinoma	8
Cholangiocarcinoma	6
Chronic pancreatitis	3
Neoplastic pancreatic cysts	3
Pancreatic cystic lesions	2
Neuroendocrine tumor	2
Duodenal gastrointestinal stromal tumor	2
Ampullary tubulovillous adenoma with high grade dysplasia	1
Intraductal tubular carcinoma	1
Adenocarcinoma of the distal, extrahepatic common bile duct	1
Tumor size (mm)	30 (8—130)
Surgical resections	
Positive resection margin (R1)	3 (6.8%)
Negative resection margin (R0)	4 (93.6%)

Table 2 Operative details.

	Patients (n = 47)
Type of surgery	
Classic Whipple's	41
Classic Whipple's + wedge segmentectomy	1
Classic Whipple's + left hepatectomy	1
Classic Whipple's + TAHBSO	1
PPPD	2
PPPD + salpingo-oophorectomy	1
Operative time (min)	351 (243—553)
Blood loss (mL)	563.8 (200—5000)
Perioperative blood transfusion	20/47 (42.55%)
No. of packed red blood cell units	2

PPPD = pylorus-preserving pancreaticoduodenectomy; TAHBSO = total abdominal hysterectomy bilateral salpingo-oophorectomy.

complications, nine were Grade I, one was Grade II, nine were Grade IIIa, two were Grade IIIb, and two were Grade V. There were two (4.25%) postoperative mortalities. Surgical complications (Table 3) included bile leak ($n = 1$), DGE ($n = 2$), chylous ascites ($n = 7$), intra-abdominal fluid collection ($n = 4$), gastric outlet obstruction and dehiscence of gastrostomy ($n = 2$), liver abscess ($n = 1$), liver abscess and narrowed hepaticojejunal anastomosis ($n = 1$), PG ulcer ($n = 1$), upper gastrointestinal bleeding ($n = 1$), and wound infection ($n = 1$). According to the ISGPF classification system, there were 24 patients with Grade A POPF (nonclinical significant), and none of the patients had Grade B/C POPF (clinically significant). All patients with POPF recovered uneventfully. The median length of stay was 12 days (range, 6–35 days). The most frequent complication was chylous ascites, which was treated with laparotomy ($n = 1$) or conservatively with total parenteral nutrition ($n = 6$; Table 3). One patient with bile leak was treated with exploratory laparotomy, and hepaticojejunostomy was redone. Two patients with DGE were treated with the insertion of nasojejunal feeding tube and were conservatively managed. Intra-abdominal fluid collection, which occurred in four cases, were successfully treated with ultrasound-guided drainage and antibiotics. Two cases with gastric outlet obstruction and dehiscence of gastrostomy were treated with relaparotomy. A case with liver abscess was treated with percutaneous drainage and antibiotics. One case that was complicated with liver abscess and narrowed hepaticojejunal anastomosis was treated with abscess drainage, percutaneous transhepatic biliary stenting. Two patients with upper gastrointestinal bleeding from gastrojejunal stromal ulcers were treated with adrenaline injection and hemoclip application. Lastly, one case with wound infection was treated with wound dressing. All patients with complications recovered uneventfully.

Table 3 Postoperative outcomes and interventions.

Postoperative morbidity	44.68%
Clavien–Dindo	
Grade I	9
Grade II	1
Grade IIIa	9
Grade IIIb	2
Grade IV	0
Grade V	2
Postoperative mortality	2 (4.25%)
Surgical complication	
Bile leak	1
Delayed gastric emptying	2
Chylous ascites	7
Intra-abdominal fluid collection	4
Gastric outlet obstruction and dehiscence of gastrostomy	2
Liver abscess	1
Liver abscess and narrowed hepaticojejunal anastomosis	1
Upper gastrointestinal bleeding from gastrojejunal stromal ulcers	2
Wound infection	1
POPF	
Grade A	24 (51.06%)
Grade B/C	0
Interventions	
Laparotomy	1
Conservatively with total parenteral nutrition	6
Exploratory laparotomy repair of bile leak and redo hepaticojejunostomy	1
Insertion of nasojejunal feeding tube and conservatively managed	2
Ultrasound-guided drainage and antibiotics	4
Relaparotomy	2
Percutaneous drainage and antibiotics	1
Abscess drainage, PTBD, and stenting	1
OGDS	2
Wound dressing	1
Length of stay (d)	12 (6–35)

OGDS = esophagogastricduodenoscopy; POPF = postoperative pancreatic fistula; PTBD = percutaneous transhepatic biliary drainage.

The two cases of postoperative mortalities in this series involved portal vein injury and had no correlation with the PG reconstructive technique. The first case involved portal vein tear close to the hepatic bifurcation and was injured during hilar lymphadenectomy. The injury was repaired, but the patient subsequently succumbed to postoperative liver failure and ensuing multiple-organ failure on POD 6. The second case involved resection of a large tumor with elective portal vein resection and reconstruction using saphenous vein graft. Postoperative ischemic hepatitis was observed with poor portal flow and hepatic artery thrombosis. The patient gradually deteriorated with sepsis and multiorgan failure, and died on POD 8.

4. Discussion

As PD becomes a more standardized surgical procedure, controversy regarding the reconstructive method for pancreatic–enteric anastomosis continues to persist. Although PG was first reported by Waugh and Clagett[30] in 1946, PJ is still the most commonly performed procedure in comparison to PG. PG has been reestablished as an alternative secure reconstructive method in the past decade. It is favored by several surgeons lately because of its many theoretical advantages compared to PJ. First, pancreatic enzymatic secretions are deactivated by the acidic gastric fluid, and the deficiency of enterokinase, which is necessitated for converting trypsinogen to trypsin and consequently activating other proteolytic enzymes, may help in preventing the autodigestion of the pancreatic anastomosis. Moreover, the alkaline pancreatic secretions may assist in preventing marginal ulceration. The close proximity between the posterior gastric wall and the pancreatic remnant permits for the possibility of less tension on the pancreatic anastomosis. The nasogastric decompression also allows for the continuous stomach emptying, thus reducing the tension on the anastomosis. Lastly, PG decreases the anatomoses amount in a single loop of retained jejunum and averts the creation of a long jejunal limb between the biliary and pancreatic anastomoses, wherein

an accumulation of both pancreatic and biliary secretions could induce more pressure, which could potentially lead to tension at both anastomoses.[31,32] Even so, pancreatic surgeons continue to be challenged in managing the pancreatic remnant after PD, thus, many modified techniques have been used in order to further decrease the occurrence rate of POPF.

In this study, PG is the reconstructive method of choice after PD. Many authors endorsed this practice. Guerrini et al[16] presented a lower fistula rate (15.1%) after PG compared to after PJ (22.1%). We reported a newly modified PG technique utilizing two-layer anastomoses (internal continuous and external interrupted), which were performed using 4/0 PDS sutures, with a short internal stenting of the pancreatic duct. In comparison to other modified PG techniques, this method of reconstruction was beneficial because the full-thickness bites of sutures on the stomach wall and the pancreatic parenchyma were more secure irrespective of the thickness and consistency of the pancreatic parenchyma. In other words, cheese-wire or cut-through of the sutures were less likely to occur. Furthermore, the internal, short pancreatic stent diverted the pancreatic juice away from the PG anastomosis, thus lessening the risk of autodigestion and dehiscence on the anastomosis.

POPF refers to a drain output of any measurable volume of fluid on or after POD 3 with an amylase content greater than three times the serum amylase activity based on ISPGF.[13] POPF was identified based on both drainage amylase concentration and volume on POD 3 and POD 5. Out of 47 patients, only 24 patients were diagnosed with Grade A, but none of the patients were unwell clinically and no patient required any specific intervention. None of the patients were diagnosed with Grade B/C POPF. Grade A POPF is also known as a "transient fistula" or "chemical leakage," which has no clinical impact. Various reports have analyzed the utilization of particular concentrations of drain amylase during the postoperative period as a predictor of POPF with diverging results, in spite of the international consensus.[13] For instance, drain amylase greater than 5000 U/L on POD 1 or more than 200 mL/d output with amylase greater than five times the serum amylase concentration on POD 5 have been proposed as clinically useful predictors of POPF.[33,34] Although the data in our study aligned with these proposed predictors, no clinical evidence for clinical POPF (Grade B/C) was observed. Accordingly, there are limitations in using the fistula classification.[35,36] This is because amylase-rich drainage cannot be solely used in identifying clinical POPF.[37] From the results obtained, both left and right abdominal drainage concentrations and volumes decreased on POD 5 from POD 3. Additionally, in some cases, the surgical drainage volume increased owing to the resumption of normal diet, which in turn induced exocrine stimulation causing more pancreatic juice to move through the leaking pancreatic anastomosis. Thus, measurement of surgical drainage volume alone might be useful, but it was insufficient to identify clinical POPF. Therefore, the severity of POPF was further determined and graded by the clinical outcomes of patients.[34] Because there are differences in the description of POPF, it is conceived that the well-defined Clavien—Dindo classification of surgical complications[25,26] has more merit in scoring postoperative complications. The rate of severe postoperative complication was 27.7% in this study, which was similar to the rates (16.7—27.1%) in other studies.[38—40] Patient-related risk factors such as age,[41] sex,[42] duration of jaundice, clearance of creatinine, and intraoperative blood loss[43] were not taken into account because they have been shown equivocally to have no association with POPF.

In conclusion, the acceptable morbidity and low mortality rates in this series demonstrated that this modified PG anastomotic technique was safe and reliable in comparison with other PG or PJ methods. This work has several limitations. As this is a retrospective study, it may be prone to recall bias; other limitations include unavailability of important data[44] and the small sample size. Future prospective, large-volume trials are crucial to corroborate these preliminary results and elucidate the advantages of this modified technique.

References

1. Winter JM, Cameron JL, Campbell KA, et al. 1423 Pancreaticoduodenectomies for pancreatic cancer: a single-institution experience. *J Gastrointest Surg*. 2006;10:1199—1211.
2. Osada S, Imai H, Sasaki Y, Tanaka Y, Nonaka K, Yoshida K. Reconstruction method after pancreaticoduodenectomy. Idea to prevent serious complications. *JOP*. 2012;13:1—6.
3. Callery MP, Pratt WB, Kent TS, Chaikof EL, Vollmer Jr CM. A prospectively validated clinical risk score accurately predicts pancreatic fistula after pancreatoduodenectomy. *J Am Coll Surg*. 2013;216:1—14.
4. Callery MP, Pratt WB, Vollmer Jr CM. Prevention and management of pancreatic fistula. *J Gastrointest Surg*. 2008;13:163—173.
5. Lai EC, Lau SH, Lau WY. Measures to prevent pancreatic fistula after pancreatoduodenectomy: a comprehensive review. *Arch Surg*. 2009;144:1074—1080.
6. Aranha GV, Aaron JM, Shoup M, Pickleman J. Current management of pancreatic fistula after pancreaticoduodenectomy. *Surgery*. 2006;140:561—569.
7. Schmidt CM, Choi J, Powell ES, et al. Pancreatic fistula following pancreaticoduodenectomy: clinical predictors and patient outcomes. *HPB Surg*. 2009:1—8.
8. Kazanjian KK, Hines OJ, Eibl G, Reber HA. Management of pancreatic fistulas after pancreaticoduodenectomy: results in 437 consecutive patients. *Arch Surg*. 2005;140:849—856.
9. Veillette G, Dominguez I, Ferrone C, et al. Implications and management of pancreatic fistulas following pancreaticoduodenectomy. *Arch Surg*. 2008;143:476—481.
10. Muscari F, Suc B, Kirzin S, et al. Risk factors for mortality and intra-abdominal complications after pancreatoduodenectomy: multivariate analysis in 300 patients. *Surgery*. 2006;139:591—598.
11. Rosso E, Bachellier P, Oussoultzoglou E, et al. Toward zero pancreatic fistula after pancreaticoduodenectomy with pancreaticogastrostomy. *Am J Surg*. 2006;191:726—732.
12. Tewari M, Hazrah P, Kumar V, Shukla HS. Options of restorative pancreaticoenteric anastomosis following pancreaticoduodenectomy: a review. *Surg Oncol*. 2010;19:17—26.
13. Bassi C, Dervenis C, Butturini G, et al. Postoperative pancreatic fistula: an international study group (ISGPF) definition. *Surgery*. 2005;138:8—13.
14. Bassi C, Falconi M, Molinari E, et al. Reconstruction by pancreaticojejunostomy versus pancreaticogastrostomy following pancreatectomy. *Ann Surg*. 2005;242:767—773.
15. McKay A, Mackenzie S, Sutherland FR, et al. Meta-analysis of pancreaticojejunostomy versus pancreaticogastrostomy

reconstruction after pancreaticoduodenectomy. *Br J Surg*. 2006;93:929—936.
16. Guerrini GP, Soliani P, D'Amico G, et al. Pancreatico-jejunostomy versus pancreaticogastrostomy after pancreaticoduodenectomy: an up-to-date meta-analysis. *J Investig Surg*. 2016;29:175—184.
17. Hallet J, Zih FS, Deobald RG, et al. The impact of pancreaticojejunostomy versus pancreaticogastrostomy reconstruction on pancreatic fistula after pancreaticoduodenectomy: meta-analysis of randomized controlled trials. *HPB*. 2015;17:113—122.
18. Zhang X, Ma L, Gao X, et al. Pancreaticogastrostomy versus pancreaticojejunostomy reconstruction after pancreaticoduodenectomy: a meta-analysis of randomized controlled trials. *Surg Today*. 2014;45:585—594.
19. Shen YF, Jin WY. Reconstruction by pancreaticogastrostomy versus pancreaticojejunostomy following pancreaticoduodenectomy: a meta-analysis of randomized controlled trials. *Gastroenterol Res Pract*. 2011;91(42):2990—2994.
20. Wente MN, Shrikhande SV, Müller MW, et al. Pancreaticojejunostomy versus pancreaticogastrostomy: systematic review and meta-analysis. *Am J Surg*. 2007;193:171—183.
21. Maemura K, Mataki Y, Kurahara H, et al. Pancreaticogastrostomy after pancreaticoduodenectomy using twin square wrapping with duct-to-mucosa anastomosis. *Eur Surg Res*. 2015;55:109—118.
22. Wang XA, Wu XS, Cai Y, et al. Single purse-string duct to mucosa pancreaticogastrostomy: a safe, easy, and useful technique after pancreaticoduodenectomy. *J Am Coll Surg*. 2015;220:e41—e48.
23. Fatih O, Adil B, Cengiz A, et al. No mortality or pancreatic fistula after full-thickness suture pancreaticogastrostomy in 39 patients who underwent pancreaticoduodenectomy. *Int Surg*. 2015;100:275—280.
24. Zhu F, Wang M, Wang X, et al. Modified technique of pancreaticogastrostomy for soft pancreas with two continuous hemstitch sutures: a single-center prospective study. *J Gastrointest Surg*. 2013;17:1306—1311.
25. Clavien PA, Barkun J, de Oliveira ML, et al. The Clavien—Dindo classification of surgical complications: five-year experience. *Ann Surg*. 2009;250:187—196.
26. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg*. 2004;240:205—213.
27. Wente MN, Bassi C, Dervenis C, et al. Delayed gastric emptying (DGE) after pancreatic surgery: a suggested definition by the International Study Group of Pancreatic Surgery (ISGPS). *Surgery*. 2007;142:761—768.
28. Brooke-Smith M, Figueras J, Ullah S, et al. Prospective evaluation of the International Study Group for Liver Surgery definition of bile leak after a liver resection and the role of routine operative drainage: an international multicentre study. *HPB*. 2015;17:46—51.
29. Al-Busafi SA, Ghali P, Deschênes M, Wong P. Chylous ascites: evaluation and management. *ISRN Hepatol*. 2014:1—10.
30. Waugh JM, Clagett OT. Resection of the duodenum and head of the pancreas for carcinoma. *Surgery*. 1946;20:224—232.
31. Fragulidis GP, Arkadopoulos N, Vassiliou I, et al. Pancreatic leakage after pancreaticoduodenectomy: the impact of the isolated jejunal loop length and anastomotic technique of the pancreatic stump. *Pancreas*. 2009;38:e177—e182.
32. Shrikhande SV, Qureshi SV, Rajneesh N, Shukla PJ. Pancreatic anastomoses after pancreaticoduodenectomy: do we need further studies? *World J Surg*. 2005;29:1642—1649.
33. Molinari E, Bassi C, Salvia R, et al. Amylase value in drains after pancreatic resection as predictive factor of postoperative pancreatic fistula. *Ann Surg*. 2007;246:281—287.
34. Shinchi H, Wada K, Traverso LW. The usefulness of drain data to identify a clinically relevant pancreatic anastomotic leak after pancreaticoduodenectomy? *J Gastrointest Surg*. 2006;10:490—498.
35. Gebauer F, Kloth K, Tachezy M, et al. Options and limitations in applying the fistula classification by the International Study Group for Pancreatic Fistula. *Ann Surg*. 2012;256:130—138.
36. Tan WJ, Kow AW, Liau KH. Moving towards the New International Study Group for Pancreatic Surgery (ISGPS) definitions in pancreaticoduodenectomy: a comparison between the old and new. *HPB*. 2011;13:566—572.
37. Shyr YM, Su CH, Wu CW, Lui WY. Does drainage fluid amylase reflect pancreatic leakage after pancreaticoduodenectomy? *World J Surg*. 2003;27:606—610.
38. Braga M, Capretti G, Pecorelli N, et al. A prognostic score to predict major complications after pancreaticoduodenectomy. *Ann Surg*. 2011;254:702—708.
39. Greenblatt DY, Kelly KJ, Rajamanickam V, et al. Preoperative factors predict perioperative morbidity and mortality after pancreaticoduodenectomy. *Ann Surg Oncol*. 2011;18:2126—2135.
40. McAuliffe JC, Parks K, Kumar P, McNeal SF, Morgan DE, Christein JD. Computed tomography attenuation and patient characteristics as predictors of complications after pancreaticoduodenectomy. *HPB*. 2013;15:709—715.
41. Matsusue S, Takeda H, Nakamura Y, Nishimura S, Koizumi S. A prospective analysis of the factors influencing pancreaticojejunostomy performed using a single method, in 100 consecutive pancreaticoduodenectomies. *Surg Today*. 1998;28:719—726.
42. Suzuki Y, Kuroda Y, Morita A, Pujino Y, Ykawamura T, Saitoh Y. Fibrin glue sealing for the prevention of pancreatic fistulas following distal pancreatectomy. *Arch Surg*. 1995;130:952—955.
43. Yeh TS, Jan YY, Jeng LB, et al. Pancreaticojejunal anastomotic leak after pancreaticoduodenectomy—multivariate analysis of perioperative risk factors. *J Surg Res*. 1997;67:119—125.
44. Hess DR. Retrospective studies and chart reviews. *Respir Care*. 2004;49:1171—1174.