Study of early follow-up of pancreatojejunostomy (duct to mucosa) after pancreaticoduodenectomy: a retrospective study from January 2017 to November 2020

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Introduction
There is a great debate for the best technique of pancreatic reconstruction following pancreaticoduodenectomy (PD). The aim of the study was to follow-up early complications and outcomes regarding pancreatojejunostomy (PJ) (duct to mucosa) for pancreatic anastomosis performed at our center regarding postoperative morbidity and mortality.
Patients and methods
In this study, we reviewed the data of the patients who were treated by PD with pancreatic reconstruction by PJ (duct to mucosa) at the Gastroenterology Surgical Center, Mansoura, Egypt, during the period from January 2017 to November 2020. The primary outcome measure was the rate of postoperative pancreatic fistula, delayed gastric emptying, bile leak, and postoperative morbidity and mortality.
Results
A total of 44 patients treated by PD were included in the study and followed up. The median age of study patients was 57 years. Regarding preoperative biliary drainage endoscopic retrograde cholangiopancreatography (ERCP), 43% of cases were stented within 1 month preoperatively. The median operative time for reconstruction was 39 min. Postoperative pancreatic fistula developed in 8/44 patients, whereas hospital mortality was 2/44 patients.
Conclusion
Duct-to-mucosa PJ was relatively effective, particularly in small-sized pancreatic duct and soft friable consistency of pancreatic tissue, which can be difficult in other anastomotic types owing to parenchymal laceration, especially in comparison with other types of pancreaticoenteric anastomotic methods.

Keywords:
pancreaticoduodenectomy, pancreatojejunostomy, postoperative pancreatic fistula

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Introduction

Pancreatic cancer is a disturbing disease that rapidly robs patients of both quality and quantity of life.

Pancreaticoduodenectomy (PD) or Whipple operation is considered the standard treatment for various benign and malignant conditions of the pancreatic head and periampullary region.

It is the only potential line of radical cure. PD safety has been greatly improved with the advances in surgical technique and perioperative care since the introduction of the procedure by Allen Whipple in 1935 [1].

PD has moved from a high mortality rate procedure in the late 19th century to a relatively low mortality surgery with 2% mortality in high-volume centers; however, the incidence of postoperative morbidity remains high, from 20 to 50% [2].

Postoperative pancreatic fistula (POPF) remains a difficult and uncontrollable complication of PD. POPF can result in abdominal abscess, hemorrhage, and sepsis, which are related to higher mortality and longer postoperative hospital stay.

Several factors, including the surgeon's experience, the texture of the pancreas, the diameter of pancreatic duct, and the techniques/drugs used can influence the risk and severity of POPF [3].

Many surgical techniques have been anticipated to reduce POPF rates such as pancreaticoenteric reconstruction.

Pancreatojejunostomy (PJ) which is one of these techniques and the most commonly employed in the management of the pancreatic remnant after PD involves a pancreatic anastomosis [4].

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It was originally described by Warren and Cattell [5]. PJ is a safe reconstruction procedure that consists of an end-to-side PJ. This technique has enabled the patients to start oral feeding earlier than others and oral feeding can be continued even if with pancreatic fistula, which improves healing and reduces complications. The duct-to-mucosa anastomosis is a theoretically superior anastomotic technique, and if it is performed carefully, it can be used for any size duct and any consistency of pancreas [6,7].

Patients and methods

Patients

We retrospectively reviewed the data of patients who underwent PD PJ (duct to mucosa) at the Gastroenterology Surgical Center, Mansoura, Egypt, during the period from January 2017 to November 2020, who were eligible for the study. Exclusion criteria included patients with locally advanced periampullary tumor, patients with metastases, patients who received neoadjuvant chemoradiotherapy, patients who underwent pancreaticogastrostomy and invagination PJ, and patients with advanced liver cirrhosis (Child B or C), malnutrition, or coagulopathy.

Patients' reports were revised for data collection from a prospectively maintained database for all patients, including history, clinical examination, routine laboratory investigation, tumor markers such as carcinoembryonic antigen (CEA) and carbohydrate antigen 19-9 (CA19-9), abdominal ultrasound, magnetic resonance cholangiopancreatography, and abdominal computed tomography.

Operative techniques

Laparotomy was done through an extended right subcostal incision. First, exclusion of distant metastasis, for example, liver metastasis, and peritoneal nodules and assessment of resectability (by exclusion of mesenteric vascular involvement) were done. Once resectability was confirmed, standard PD was performed in all patients.

The gall bladder, distal common bile duct, gastric antrum, duodenum, pancreatic head, and the proximal 10 cm of the jejunum were included in the resected specimen. Regional lymphadenectomy was performed in all patients, which included resection of lymph nodes within the hepatoduodenal ligament, right side of the superior mesentric vien (SMVs), and inferior vena cava (IVC).

Pancreatic duct diameter was measured precisely with the help of a ruler. Evaluation of the pancreatic texture from soft to firm was done by the operating surgeon or the senior assisting surgeon.

Pancreatic anastomosis is performed first in an end-to-side fashion followed by an end-to-side hepaticojejunostomy, and finally, an antecolic gastrojejunal anastomosis.

Reconstruction technique (pancreatojejunostomy duct to mucosa)

A duct to mucosa PJ was performed in two layers. A posterior row of 3/0 nonabsorbable suture was performed between the jejunal serosa and the pancreatic parenchyma and capsule. A small full-thickness jejunotomy is then followed opposite to the pancreatic duct. Then, the duct-to-mucosa anastomosis was carried out using 5/0 or 6/0 vicryl or PDS sutures placed radially taking bites of the duct with the adjacent parenchyma and the full thickness of the jejunal opening without stenting. After completion of the duct-to-mucosa anastomosis, an anterior row of 3/0 nonabsorbable sutures is placed between the jejunal serosa and the pancreatic parenchyma and capsule.

Data collected

Patient data were reviewed from a prospectively maintained database for all patients undergoing PD (PJ duct to mucosa).

The data collection for all patients included preoperative data, which included age, sex, BMI, laboratory tests, tumor markers, and preoperative biliary drainage.

Intraoperative data included liver status, tumor size, pancreatic duct diameter, texture of the pancreas, operative time, blood loss, and blood transfusion.

Postoperative data included postoperative complications [POPF, delayed gastric emptying (DGE), bile leak, internal hemorrhage, relaparotomy, wound infection, pulmonary complications, and hospital mortality], drain output, start of oral feeding, hospital stay, and postoperative pathology.

Evaluation

The main evaluation and assessment of the outcome was the POPF rate. POPF was defined by the International Study Group of Pancreatic Fistula as any measurable volume of fluid on or after the third day postoperatively with amylase content greater than three times the serum amylase activity.

A pancreatic fistula was graded according to the International Study Group of Pancreatic Fistula into grades BL (grade A), B, and C according to the clinical course.

BL which was previously termed as 'grade A POPF' is no longer regarded a real pancreatic fistula or a serious consequence. It is also known as a 'biochemical fistula' in the literature which has no absolute clinical effect by definition. However, grade B POPF is a well-defined fistula with increased amylase activity in the fluid from any drain in combination with a clinically significant disease, which demands a change in the intended postoperative pathway's care. Unlike the BL, the pancreatic drains may be kept in place for up to 3 weeks after surgery, or there may be a need to relocate the operatively inserted drains using interventional, image-guided methods to decompress an undrained intra-abdominal fluid collection.

Cases are classified into grade C POPF as follows: if a grade B POPF results to organ failure or clinical instability that necessitates reoperation, the POPF is upgraded to a grade C. Moreover, ICU hospitalization is required, and the hospital stay becomes abnormally extended. Postoperative organ failure is defined as the need for reintubation, hemodialysis, and/or the use of inotropic medications for more than 24 h owing to respiratory, renal, or cardiac insufficiency [8].

The other outcomes were postoperative morbidities (DGE, pancreatitis, and biliary leakage), operative time, operative time needed for reconstruction, and length of postoperative hospital stay. Complications were graded according to their severity on a validated five-point scale using Dindo-Clavien complication classification system into grades I, II, III, IV, and V. The complications that were higher than Dindo-Clavien grade III were considered to be major complications.

Follow-up was performed three weeks postoperatively.

Statistical analysis

Statistical analysis in this study was performed using SPSS software, version 23 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were calculated and described as median (range) for continuous variables. Categorical variables were represented using percentages.

Results

Patients' characteristics

The study included 44 patients [17 (39%) females and 27 (61%) males] with various benign and malignant diseases of the ampulla and the periampullary region, who presented to the Gastroenterology Surgical Center, Mansoura University, for a variety of indications during the study period and underwent PD (PJ duct to mucosa). Their demographic data are presented in Tables 1 and 2.

Preoperative data

According to our study, Tables 1 and 2 show that the median age of study patients was 56 years (13–70). Approximately 61% of them were males.

Regarding our views, obesity, high BMI, and smoking are relative risk factors for POPF. In our study, 73% of patient had BMI above 25, whereas 36% of patient were smokers.

Table 1 Demographic data

Variables	Results [*n* (%)]
Age (years)	56 (13–70)
<60	28 (63)
>60	16 (36)
Sex	
Male	27 (61)
Female	17 (39)
BMI	
≤25	12 (27)
>25	32 (73)
Smoking	16 (36)
ASA score	
I	20 (45.4)
II	23 (52.3)
III	1 (2.3)
IV	0

ASA, American Society of Anesthesiology.

Table 2 Preoperative symptoms, comorbidities, and laboratory data

Variables	Results [*n* (%)]
Symptoms	
Jaundice	30 (68)
Abdominal pain	32 (72)
Weight loss	28 (63)
Comorbidities	
DM	28 (64)
HTN	17 (38)
Cardiac complications	1 (2.3)
Laboratory data	
Preoperative HB	11.5 (9–15)
Preoperative albumin (g%)	3.8 (3–5)
Preoperative SGPT (u/ml)	117 (20–110)
Preoperative alkaline (K.A.U.)	18 (5–75)
Preoperative bilirubin (mg%)	8.6 (1–30)
CEA (μg/l)	
≤5	31 (70)
>5	13 (30)
CA19-9 (μ/ml)	
≤37	17 (39)
>37	27 (61)
Preoperative biliary drainage (ERCP)	19 (43)

DM, diabetes mellitus; HB, hemoglobin; HTN, hypertension.

American Society of Anesthesiology physical status classification system to assesses and communicates a patient's pre-anesthesia medical comorbidities. The classification system predicts the perioperative risks. It can be helpful in predicting perioperative risks. Overall, 52% of our study patients are American Society of Anesthesiology II.

The most common presenting symptoms in the study was abdominal pain in 72% of cases followed by jaundice in 68%, and 28 (63%) cases presented with weight loss.

The median hemoglobin and albumin levels were 11.5 g/dl (range, 9–15 g/dl) and 3.8 g/dl (range, 3–5 g), respectively.

Preoperative bilirubin and alkaline phosphatase were 8.3 mg/dl (1–30 mg/dl) and 18 K.A.U. (5–75 K.A.U.), respectively.

Regarding tumor markers, CEA was within the normal range in 70% of patients, whereas 61% of patient had high levels of CA19-9 above the normal range. On the subject of preoperative drainage (ERCP), 43% of cases were stented within 1 month preoperatively.

Table 3 Intraoperative data

Variables	Results [*n* (%)]
Cirrhotic liver	6 (14)
Pancreas	
Soft	29 (66)
Firm	15 (34)
Pancreatic duct diameter (mm)	4.4 (1–15)
≤3	18 (41)
>3	26 (59)
Pancreatic duct to posterior border (mm)	3 (1–9)
≤3	21 (48)
>3	23 (52)
CBD diameter mean (mm)	14 (5–30)
Mass size (cm)	
≤2	20 (45)
>2	24 (55)
Operative time (min)	350 (180–540)
Operative time for PJ anastomosis (median) (min)	39 (20–75)
Blood loss (ml)	750 (200–2500)
Cases needed blood transfusion	13 (29)

CBD, common bile duct; PJ, pancreatojejunostomy.

Intraoperative data

Regarding pancreatic texture, soft pancreatic consistency is a well-known risk factor for POPF after PD, whereas evaluation of the pancreatic texture is usually performed intraoperatively and subjectively by surgeons. In our study, pancreas appeared soft in most cases (66%). However, pancreatic duct was of small diameter in 41% of the cases, making the PJ stitches technically difficult to perform.

Tumor size also has an important effect on prognosis, as noted by its involvement into the American Joint Committee on Cancer staging system for pancreatic cancer. Actually, in the American Joint Committee on Cancer staging system, the difference between a T1 and T2 tumor is defined by the size of the tumor (≤2 cm vs. >2 cm). The effect of tumor size on outcome is noted, although it remains contentious. Concerning our study, the tumor size was more than 2 cm in 55% of cases. Regarding operative time, longer operative time was associated with negative outcomes in various surgical procedures, but its role in pancreatic resection is not yet well defined. However, longer operative time is independently associated with worse perioperative outcomes after pancreatic resection and should be considered a relevant parameter in risk-adjustment processes for outcome evaluation. According to our results, Table 3 shows the operative time for our cases ranged from 180 to 540 min, whereas the median was 350 min. However, regarding the PJ anastomosis time, the median time was 39 min. With respect to intraoperative blood loss, elevated intraoperative blood loss during PD cannot be a significant indicator of poor perioperative outcomes. By choosing certain approaches, surgeons may be able to actively control intraoperative blood loss, reduce unnecessary transfusions, and alleviate the risk of suboptimal outcomes. In our study, the median amount of blood loss was 750 ml, ranging from 200 to 2500 ml.

Postoperative data

The common practice of admitting all patients to an ICU after a complex operation is based upon concern for timely identification of adverse events, whereas admission of patient to intensive care postoperatively has increased our ability to monitor, diagnose, and treat any sudden events.

Routinely at our center, all cases were administrated to ICU postoperatively for follow-up. The median duration for ICU stay was 3 days.

The early detection and routine drainage of anastomotic fistulas, pancreatic fistulas, bleeding, or other intra-abdominal fluid collections after pancreatic resections are considered as important and effective ways to reduce postoperative complications and the mortality rate, which makes inserting drains after pancreatic resections to be a routine procedure. In most of our cases, we put right-sided drain in Morrison.

Table 4 shows the total median amount of drains postoperatively was 1500 ml (range, 200–7000 ml).

The drain discharge mainly was serosanguinous in nature in 71%. Most drains were removed between the eighth and ninth day at the median level.

Regarding the time to start oral feeding postoperatively, the median time among our cases to start oral feeding was the fourth day (range, 3–42 days).

Early oral feeding regardless of the presence or absence of POPF is considered one of the advantages of PJ (duct to mucosa), which also improves healing of any fistula.

Regarding patients with complication, 47% of patients experienced different levels of complications ranging from minor to major level, according to grading: 9% of patients experienced grade I complications as well as grade II complications, 13.5% of patients experienced grade III complications, and 4.5% experienced grade V complications.

Complications following PD included POPF, which remains the most problematic and feared common complication after PD and is associated with a greater number of other complications and prolonged hospital stay. Overall, 16.5% of cases were classified into BL, grade B, and grade C. Postoperative bile leak occurred in 13.6% of cases, and the postoperative DGE rate was 13.6%. Wound infection occurred in 18% of cases, whereas chest infection occurred in 11% of cases. Hospital mortality occurred in two of 44 patients.

Pancreatic head mass represented most of our cases (59%), as shown in Table 5.

Table 4 Postoperative follow-up

Variables	Result [*n* (%)]
ICU stay (day)	3 (1–20)
Hospital stay (day)	10 (4–45)
Total amount of drainage (ml)	1500 (200–7000)
Drain removal (days)	8.5 (4–28)
Drain nature	
Serous	31 (71)
Bile	3 (6.5)
Pancreatic	5 (11)
Combined bile+pancreatic	3 (6.5)
Bloody	2 (5)
Time start oral (days)	4 (3–42)
Total patients with complications	21 (47)
Complication grade	
I	4 (9)
II	4 (9)
III	6 (13.5)
IV	0
V	2 (4.5)
Severity of complications ≥IIIb	
Minor	14 (31.8)
Major	2 (4.5)
POPF (ISGPF 2016)	8 (16.5)
BL	3 (6)
Grade B	3 (6)
Grade C	2 (4.5)
DGE	6 (13.6)
Bile leak	6 (13.6)
Pancreatitis	3 (6.5)
Wound infection	8 (18)
Pulmonary complications	5 (11)
Collection	6 (13.6)
Internal hemorrhage	2 (4.5)
Re-exploration	2 (4.5)
Hospital mortality (30-day mortality)	2 (4.5)

DGE, delayed gastric emptying; ISGPF, International Study Group of Pancreatic Fistula; POPF, postoperative pancreatic fistula.

Table 5 Indication of pancreaticoduodenectomy

Variables	Results [*n* (%)]
Site of origin	
Pancreas	27 (61.5)
Ampullary mass	11 (25)
Duodenum	3 (6.8)
Distal 1/3 of CBD	3 (6.8)
Pathological type	
Pancreatic adenocarcinoma	22 (50)
Ampullary carcinoma	11 (25)
Duodenal carcinoma	3 (6.8)
Distal cholangiocarcinoma	3 (6.8)
Chronic pancreatitis	1 (2)
Solid pseudopapillary tumor	1 (2)
Primary pancreatic lymphoma	1 (2)
Pancreatic neuroendocrine tumor	1 (2)
Tumor differentiation	
Well differentiated	9 (20.5)
Moderate differentiated	30 (68.2)
Poor differentiated	3 (6.8)
Benign nature	2 (4.5)
Mass size (cm)	
≤2	20 (45.5)
>2	24 (54.5)
Dissected lymph node number (mean)	10 (2–22)
Dissected lymph node status	
Positive	29 (66)
Negative	15 (34)
Safety margin status	
Free	40 (91)
Infiltrated	4 (9)
Perineal invasion	
Positive	10 (22.7)
Negative	34 (77.3)
Vascular invasion	
Positive	2 (4.5)
Negative	42 (95.5)

CBD, common bile duct.

Although adenocarcinoma was the most common pathology in our study (91%), unusual pathologies were also represented in our study population (neuroendocrinal tumor in one case, chronic pancreatitis in one case, non-hodgkin lymphoma (NHL) in one case, and solid pseudopapillary tumor in one case).

Relevant risk factors for POPF identified by us and others were balanced between the three groups regarding age, sex, BMI, prevalence of diabetes mellitus, histopathology, small pancreatic duct diameter less than 3 mm, and intraoperative blood transfusions. However, soft pancreatic texture which is considered an important risk factor for POPF was significantly high (29/44 of cases).

Several factors have been noted to affect survival follow surgical resection of pancreatic adenocarcinoma. Specifically, lymph node status, perineural/vascular invasion, histological tumor grade, and margin status have all been reported to affect outcome.

Discussion

PD is a precisely thought-provoking operation performed to treat neoplastic diseases of the pancreatic head and periampullary region. Among potential complications, POPF is the most common which has a significant influence on the postoperative course, possibly leading to life-threatening complications such as hemorrhage and intra-abdominal abscess, which are major causes of death after PD [4,9].

Many randomized control trials (RCTs) showed that pancreatojejunal anastomosis is commonly used as a reconstruction method in multiple pancreatic centers, and duct-to-mucosa, which was originally described by Warren and Cattell, is a widely practiced procedure [10]. The development of POPF after PD appears to be a multifactorial. Many studies demonstrated that many factors significantly associated with POPF, including obesity, cirrhotic liver, soft pancreas, small pancreatic duct diameter, location of pancreatic duct, and the technique and type of pancreatic reconstruction [11,12].

According to our study, the median age of study patients was 57 years. With respect to preoperative biliary drainage (ERCP), 43% of cases were stented within 1 month preoperatively. The median operative time for reconstruction was 39 min. POPF developed in 18% of patients, whereas hospital mortality was seen 4% of patients. Concerning the site of origin of the tumor, pancreatic head mass represented most of our cases (59%) and pancreatic adenocarcinoma was the most common pathology in our study (91%). According to McMillan and colleagues, in the study entitled 'Defining the practice of PD around the world,' which included surveys distributed to members of 22 international gastrointestinal surgical societies, representing six continents, eight languages, and 897 patients, there was significant variability in the practice of PD. One of these several variable was type the type of pancreatic anastomosis.

Table 6 shows that approximately a third of surgeons across the world use the same pancreatoenteric reconstruction in every case. PJ end to side duct to mucosa was the preferred anastomotic technique in 67.6% of cases [13].

Duct-to-mucosa PJ may be a reasonable choice because it has a lower rate of clinically relevant POPF. PJ technique with duct-to-mucosa anastomosis has the following advantages: it is easy to grasp, is applicable to other anastomoses such as hepaticojejunostomy, has a long history, and many surgeons are familiar with it.

However, the Cattell-Warren PJ can be technically challenging when the pancreatic duct has a small diameter, but this can be easily overcome by wide experiences of many surgeons in this type of anastomosis to the extent making it the most familiar type.

A meta-analysis by Zhang and colleagues, reviewed many RCTs that discussed duct to mucosa type of PJ and compared it with other types of PJ and revealed that seven studies were included at different times from different countries including 421 patients of PJ duct to mucosa (244 men and 177 women) who underwent PJ duct to mucosa after PD from five different countries

Table 6 Utilization of operative strategies for pancreatoenteric reconstruction, stratified by region [13]

Preferred anastomotic reconstruction	Europe/Africa/Middle East [*n* (%)]	North America [*n* (%)]	South/Central America [*n* (%)]	Asia/Australia [*n* (%)]	Overall [*n* (%)]
Pancreatojejunostomy end-to-side duct-to-mucosa	169 (61.9)	220 (79.1)	76 (60.8)	133 (63.6)	598 (67.6)
Pancreatojejunostomy end-to-side invagination/dunking	35 (12.8)	29 (10.4)	10 (8.0)	32 (15.3)	106 (12.0)
Pancreatogastrostomy	45 (16.5)	9 (3.2)	11 (8.8)	21 (10.0)	86 (9.7)
No reconstruction (ductal occlusion)	2 (0.7)	1 (0.4)	0	0	3 (0.3)
Others	22 (8.1)	23 (6.9)	30 (22.4)	23 (11.1)	98 (10.4)

Table 7 Results of main randomized control trials discussing duct to mucosa type of pancreatojejunostomy [14]

References	Number of patients	Year of study	Age, mean (range by year)	Operative time (min)	Estimated blood loss (ml)	Soft pancreas (%)
El Nakeeb *et al.* [3]	53	2011–2013	54	330	500	79
Bai *et al.* [18]	64	2012–2015	62	360	300	60.60
Han *et al.* [19]	32	2006–2008	59	NA	NA	100
Berger *et al.* [20]	97	2006–2008	68	379	500	51
Langrehr *et al.* [21]	56	1999–2000	59	346	560	25
Bassi *et al.* [22]	72	1999–2001	62	379	NA	100
Chou *et al.* [23]	47	1984–1996	60	390	884	N/A

including three studies from China and the rest from Egypt, Germany, Italy, and United States. This is in contrast to this study, which included 44 patients (27 men and 17 women), who underwent procedures done by more than one surgeon. The mean age of these studies was 60.5 years, whereas in our present study, the mean age was 56 years (Tables 7 and 8).

The mean operative durations were ~364 min, whereas in this study, the mean operative durations were 350 min. However, regarding other parameters including total blood, which has wide variations and cannot be accurately calculated, although the mean in these RCTs was 548 ml, the mean in our study was 750 ml.

A soft pancreatic consistency is a well-known risk factor for POPF after PD. Evaluation of the pancreatic texture is usually performed intraoperatively and subjectively by a senior surgeon, as it is usually associated with a small main pancreatic duct (MPD) (making the PJ stitches technically difficult to perform). In these RCTs, the percentage of soft pancreas ranged from 60.6% to reach 100% in two studies, which makes the mean of soft pancreas in the studies as 69.2%, whereas it was 66% in our study. All seven RCTs reported POPF rates. The overall POPF rate after PD was 15.9% (67/421), whereas in this study, the POPF was 16.9% (8/44); '6% of them were biochemical leak, which by definition has no clinical effect.' In particular, BL implies no deviation in the normal postoperative pathway and therefore, does not affect the normal postoperative duration of stay.

The postoperative mortality rates were reported in all the seven RCTs. The overall mortality rate was 2.38%, whereas in this study, the postoperative mortality rate was 2%.

In most of the RCTs, postoperative DGE was defined as gastric stasis for more than a week. Among the seven RCTs, only one did not report the postoperative DGE rate. The DGE rate in the duct-to-mucosa group was 6.2% (20/324), whereas in this study, the DGE rate was 13.6% (6/44); '6.5% of them were grade A and resolved spontaneously in less than 7 days.' Five reported the length of hospital stay with useful data for analysis; the mean hospital stay of these patients was 15.6 days, whereas in our study, the mean hospital stay was 10 days.

Table 8 Results of main randomized control trials discuss duct to mucosa type of pancreatojejunostomy [14]

References	POPF	DGE	Reoperation	Hospital mortality	Mean hospital stay
El Nakeeb *et al.* [3]	11	3	8	3	8
Bai *et al.* [18]	18	0	1	0	14.7
Han *et al.* [19]	2	1	0	1	18
Berger *et al.* [20]	2	2	0	2	18
Langrehr *et al.* [21]	2	0	10	0	15
Bassi *et al.* [22]	9	1	1	1	16
Chou *et al.* [23]	2	0	1	3	20

DGE, delayed gastric emptying; POPF, postoperative pancreatic fistula.

No pancreatic reconstruction procedure has been shown to work for all forms of pancreatic stumps. The best method to avoid difficulties associated with pancreas reconstruction is to tailor pancreatic reconstruction in a way to overcome the complications related to the type of reconstruction.

Pancreatic reconstruction is difficult in pancreases with small duct and a soft fragile pancreas even in experienced hand. The small pancreatic duct makes PJ duct to mucosa difficult and liable to inaccurate suture placement and obstruction with possibility of jejunal-fold edema around the pancreatic duct opening, leading to development of pancreatitis and anastomotic stenosis. Many studies have shown that obesity, cirrhosis of the liver, soft pancreas, short pancreatic duct diameter, pancreatic duct position within 3 mm of the posterior edge, and the technique and type of pancreatic reconstruction are all associated with POPF. PJ has become the commonly preferred method of reconstruction after PD at our center nowadays owing to the reduced risk of POPF and owing to its progressive

learning curve. A duct-to-mucosa anastomosis is preferred over other methods [15,16].

It has been the most commonly employed method for pancreatic reconstruction aiming for a more physiological anastomosis to preserve the normal exocrine and endocrine functions [1,17].

Conclusion

Although many studies revealed no difference between different types of pancreatoenteric anastomosis regarding the rate and severity of POPF and other postoperative complications, PJ technique with duct-to-mucosa anastomosis has the following advantages: it is easy to grasp, is applicable to other anastomoses such as hepaticojejunostomy, has a long history, and many surgeons are familiar with it and more efficient in soft pancreas with reduced rates of POPF in comparison with other techniques.

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Conflicts of interest

There are no conflicts of interest.

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