

ORIGINAL ARTICLE

Isolated Roux loop pancreaticojejunostomy versus pancreaticogastrostomy after pancreaticoduodenectomy: a prospective randomized study

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Abstract

Objectives: The optimal strategy for the reconstruction of the pancreas following pancreaticoduodenectomy (PD) is still debated. The aim of this study was to compare the outcomes of isolated Roux loop pancreaticojejunostomy (IRPJ) with those of pancreaticogastrostomy (PG) after PD.

Methods: Consecutive patients submitted to PD were randomized to either method of reconstruction. The primary outcome measure was the rate of postoperative pancreatic fistula (POPF). Secondary outcomes included operative time, day to resumption of oral feeding, postoperative morbidity and mortality, and exocrine and endocrine pancreatic functions.

Results: Ninety patients treated by PD were included in the study. The median total operative time was significantly longer in the IRPJ group (320 min versus 300 min; $P = 0.047$). Postoperative pancreatic fistula developed in nine of 45 patients in the IRPJ group and 10 of 45 patients in the PG group ($P = 0.796$). Seven IRPJ patients and four PG patients had POPF of type B or C ($P = 0.710$). Time to resumption of oral feeding was shorter in the IRPJ group ($P = 0.03$). Steatorrhea at 1 year was reported in nine of 42 IRPJ patients and 18 of 41 PG patients ($P = 0.029$). Albumin levels at 1 year were 3.6 g/dl in the IRPJ group and 3.3 g/dl in the PG group ($P = 0.001$).

Conclusions: Isolated Roux loop PJ was not associated with a lower rate of POPF, but was associated with a decrease in the incidence of postoperative steatorrhea. The technique allowed for early oral feeding and the maintenance of oral feeding even if POPF developed.

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Introduction

Although operative mortality in patients undergoing pancreaticoduodenectomy (PD) has fallen to <5%, incidences of postoperative morbidity remain high at 40–50%.^{1–4} The occurrence of postoperative pancreatic fistula (POPF) remains challenging, even at high-volume centres, and contributes significantly to increases in hospital stay, costs and mortality. Intra-abdominal collection, delayed gastric emptying, postoperative haemorrhage and sepsis are common sequelae of pancreatic leakage.^{3–5} Incidences of POPF after PD range from 5% to 30%.^{3–7}

Many technical modifications of the pancreatic anastomosis have been proposed and evaluated in attempts to prevent POPF. The best type of pancreatic reconstruction and anastomotic technique are still debated.^{2,4–6} The two most common methods of pancreatic anastomosis are pancreaticojejunostomy (PJ) and pancreaticogastrostomy (PG). Comparisons of the short-term outcomes of these two methods of reconstruction show mixed results.^{2–5,8–10} Longterm outcomes, including morphological outcomes and exocrine and endocrine functions of the remaining pancreas, have yet to be determined.^{9,11–13}

The concept of isolated Roux loop PJ (IRPJ) is based on the theory that reducing the activation of pancreatic juice by biliary secretion will decrease the incidence and severity of POPF.^{14–17}

ClinicalTrials.gov ID: NCT01859806.

Recent prospective randomized studies have compared the outcomes of IRPJ with those of conventional PJ,^{14–17} but not with those of PG.

Hence, the purpose of this study was to compare the outcomes of IRPJ with those of PG after PD with regard to the rate of occurrence of POPF, postoperative morbidity and mortality, and exocrine and endocrine pancreatic functions in a prospective randomized study.

Materials and methods

Patients

Consecutive patients undergoing PD for periampullary tumours at the Gastroenterology Surgical Centre, Mansoura, Egypt, during the period from January 2011 to May 2013 were eligible for the study. Exclusion criteria denied the inclusion of patients with locally advanced periampullary tumours or metastases, patients undergoing bilioenteric or gastroenteric bypass or total pancreatectomy, and patients with advanced liver cirrhosis (Child–Pugh class B or C) with portal hypertension, malnutrition or coagulopathy.

Informed consent was obtained from all patients included in the study after the nature of the disease and possible treatments and potential complications had been carefully explained. The study was approved by the local ethics committee.

Preoperative endoscopic retrograde cholangiopancreatography (ERCP) was performed in patients with serum bilirubin levels of >10 mg/dl or when biliary obstruction was associated with high liver enzymes (more than three-fold the normal level (i.e. >120 IU/ml)).⁴

Randomization

Patients enrolled in the study were randomized into two groups using the closed envelope method. Envelopes were drawn and opened by a nurse not otherwise engaged in the study in the operating room after resection. Patients in one group underwent IRPJ with isolated pancreatic drainage and patients in the other underwent PG. No patient was excluded after resection of the tumour. The same surgeons, who had equivalent levels of experience, performed PD in both groups.

Operative techniques

Standard PD was performed after the pancreatic head and duodenum had been mobilized. The pancreas was divided anteriorly and to the left of the superior mesenteric vein and portal vein. Antrectomy was performed in all patients.

Isolated Roux loop PJ group

Pancreaticojejunostomy was constructed in two layers after the performance of a small jejunostomy in the isolated jejunal loop equal to the diameter of the pancreatic duct. The duct and the entire thickness of the pancreatic parenchyma were sutured to the full thickness of the jejunum using 5/0 vicryl interrupted sutures in a radial manner and 3/0 silk interrupted sutures to attach the

outer seromuscular layer to the pancreatic capsule without pancreatic stenting. A separate Roux loop was created for the end-to-side hepaticojejunostomy (HJ) and the end-to-side antecolic gastrojejunostomy (GJ). The PJ loop was anastomosed to the main loop (Fig. 1).

Pancreaticogastrostomy group

The proximal part of the pancreatic remnant was mobilized from the splenic vessels and the retroperitoneum for subsequent anastomosis to the posterior gastric wall. The PG was constructed in two layers. A seromuscular suture was performed between the posterior wall of the stomach and pancreatic capsule using either interrupted or continuous 3/0 silk. A 2.5–3.0-cm gastrostomy was performed and the pancreatic parenchyma with the duct were sutured to the full thickness of the stomach using interrupted or continuous 5/0 vicryl sutures. The outer seromuscular layer between the stomach and pancreatic capsule was sutured using 3/0 silk interrupted sutures without pancreatic stenting.

Biliary drainage was achieved by end-to-side HJ (retrocolic). Gastric drainage was achieved by an antecolic end-to-side GJ 30 cm caudal to the HJ.

Postoperative management

All patients were admitted to the intensive care unit (ICU) for at least 1 day before transfer to the ward. Octreotide was given to all patients routinely for 4 days. Outputs from operatively placed drains and nasogastric tubes were recorded daily. Patients resumed oral feeding on a fluid diet followed by a regular diet once bowel sounds were present and patients were able to tolerate oral feeding.

Serum and drainage fluid amylase was measured on postoperative days (PoDs) 1 and 5. Abdominal ultrasound was performed routinely in all patients. Ultrasound-guided percutaneous drainage was performed in patients who demonstrated an abdominal collection.

Follow-up was conducted at 1 week, 3 months and 6 months postoperatively, and then at 1 year. Patients were also seen at outpatient clinics if symptoms developed between follow-up visits.

Assessments

The primary outcome was the rate of POPF. Postoperative pancreatic fistula was defined according to the International Study Group on Pancreatic Fistula (ISGPF) definition as any measurable volume of fluid on or after PoD 3 with amylase content greater than three times serum amylase activity.^{18,19} The severity of POPF was assessed using the Dindo–Clavien system of classification as Grade I (no need for specific intervention), Grade II (need for drug therapy such as antibiotics, blood transfusion, total parenteral nutrition), Grades IIIa and IIIb (need for invasive radiological, endoscopic or surgical therapy), Grades IVa and IVb (organ dysfunction requiring an ICU stay and management), and Grade V (death).²⁰ Complications of severity higher than Clavien–Dindo

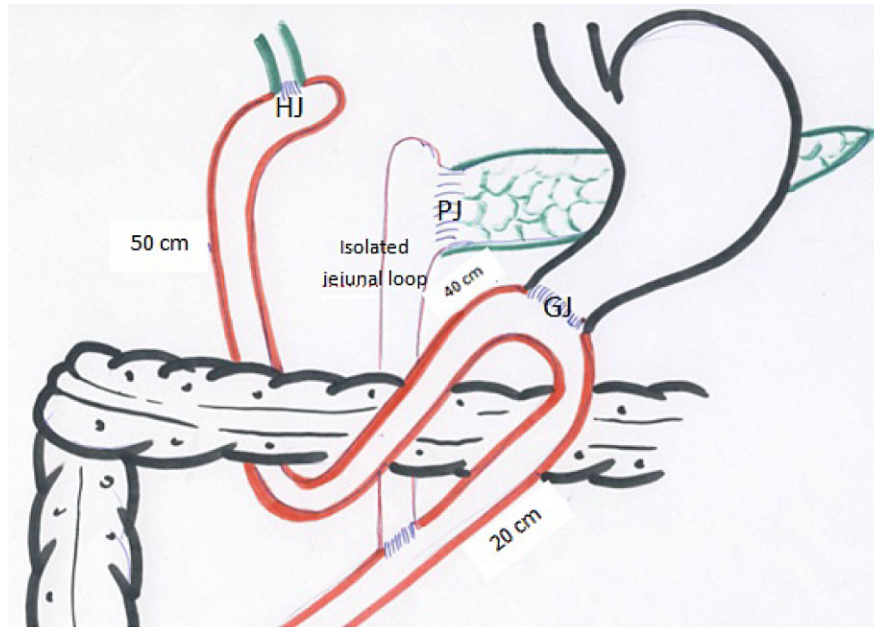


Figure 1 Graphic representation of isolated Roux loop pancreaticojejunostomy (PJ) carried out using a 40-cm isolated loop of jejunum for PJ, and a Roux loop for hepaticojejunostomy (HJ) and gastrojejunostomy (GJ) (50 cm caudal to the HJ). The PJ loop was anastomosed to the main loop (20 cm caudal to the GJ)

Grade III were considered to be major complications. Pancreatic fistulae were graded according to ISGPF criteria into Grades A, B and C according to their clinical course.^{18,19}

Secondary outcomes included total operative time, operative time for reconstruction, length of postoperative stay, postoperative complications (including delayed gastric emptying, biliary leakage, bleeding PG, bleeding GJ, internal haemorrhage and pulmonary complications), endocrine and exocrine functions, need for re-exploration, and survival rate. Biliary leak was defined according to ISGPF criteria as the presence of bile in drainage fluid persisting to PoD 4. Delayed gastric emptying was defined as output from a nasogastric tube of >500 ml per day persisting beyond PoD 10, failure to maintain oral intake by PoD 14, or need for the reinsertion of a nasogastric tube.^{18,19}

Complications were graded according to severity on a validated 5-point scale using the Dindo–Clavien complication classification system into Grades I, II, IIIa and IIIb, IVa and IVb, and V.²⁰

To assess endocrine function, fasting blood glucose level was measured without the administration of oral hypoglycaemic drugs or insulin (normal level: <110 mg/dl). Any diagnosis of diabetes mellitus (DM) was based on criteria established by the World Health Organization study group on DM.²¹

Pancreatic exocrine function was evaluated. Patients who were taking pancreatic enzyme supplements were asked to stop this treatment at least 10 days before the clinical evaluation. Patients were asked about the presence of steatorrhea (more than three stools per day, faecal output of >200 g/day for at least 3 days, pale or yellow stools, and stools with a pasty or greasy appearance).

Severe steatorrhea was defined by the presence of at least three of these criteria, need for pancreatic enzyme supplements, and pre- and postoperative variation in body weight.²²

Data collected

Preoperative and intraoperative variables included patient demographics, liver status, tumour size, pancreatic duct diameter, texture of the pancreas, operative time, blood loss and blood transfusion.

Postoperative variables included postoperative complications, drain output and nature, drain amylase, liver function, days to resumption of oral feeding, postoperative stay, re-exploration, hospital mortality, postoperative pathology, fasting blood sugar at 1 year, postoperative weight compared with preoperative weight, and presence or absence of steatorrhea.

A sample size for each group was calculated to set the level of power for the study at 80% with a 5% significance level supposing POPF rates of 17% after PG^{4–6} and 0% after IRPJ.^{14–16} Based on these parameters, a sample size of 45 subjects in each group was deemed to be sufficient.

Statistical analysis in this study was performed using spss Version 17 (SPSS, Inc., Chicago, IL, USA). Data were analysed on an intention-to-treat basis. For continuous variables, descriptive statistics were calculated and described as medians and ranges. Categorical variables were reported using percentages of the total number of patients ($n = 90$) and of the number of patients in each group ($n = 45$). Student's *t*-test was used to detect differences in the means of continuous variables. The chi-squared test was used

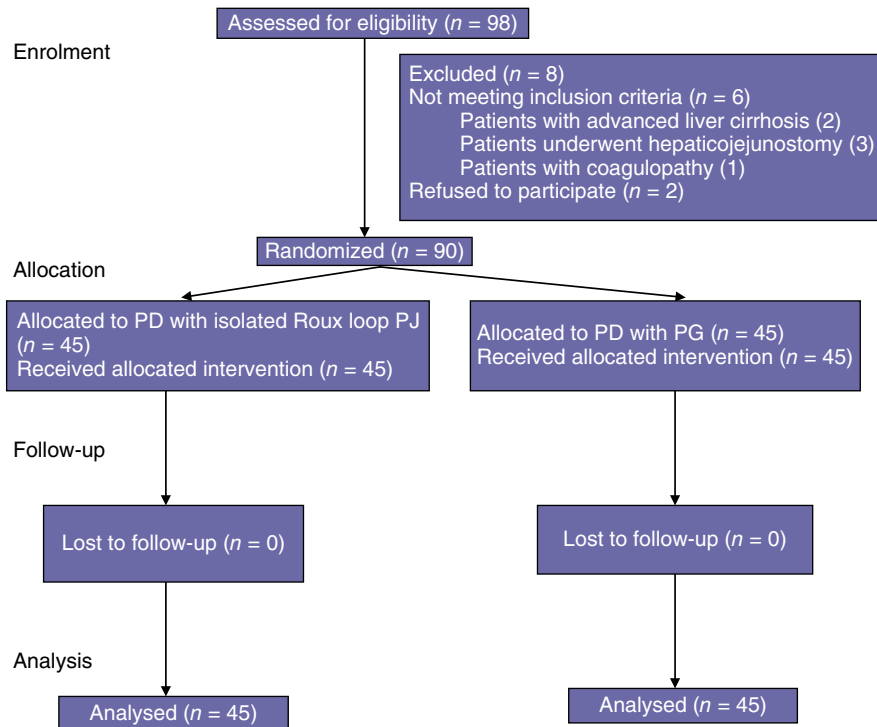


Figure 2 Flow diagram showing progress through the phases of this randomized trial (i.e. enrolment, intervention allocation, follow-up and data analysis). PD, pancreaticoduodenectomy; PG, pancreaticogastrostomy; PJ, pancreaticojejunostomy

Table 1 Demographic data for patients submitted to isolated Roux loop pancreaticojejunostomy (IRPJ) or pancreaticogastrostomy (PG)

Variable	All patients (n = 90)	IRPJ group (n = 45)	PG group (n = 45)	P-value
Patient age, years, median (range)	55.5 (12–73)	54 (15–73)	58 (12–73)	0.105
Sex, n (%)				
Female	40 (44.4%)	18	22	0.396
Male	50 (55.6%)	27	23	
Symptoms, n (%)				
Jaundice	83 (92.2%)	41	42	0.694
Abdominal pain	69 (76.7%)	34	35	0.803
Loss of weight	19 (21.1%)	12	7	0.197
Body mass index, kg/m ² , median (range)	21 (17–34)	21 (17–34)	22 (17–32)	0.321
Preoperative bilirubin, mg/dl, median (range)	3.2 (0.4–36.0)	4.4 (0.5–25.7)	2.7 (0.4–36.0)	0.325
Preoperative biliary drainage (ERCP), n (%)	54 (60.0%)	23	31	0.089

ERCP, endoscopic retrograde cholangiopancreatography.

for categorical variables. *P*-values of <0.05 were considered to indicate statistical significance. Significance was two-tailed.

Results

Patient characteristics

The study flow chart is shown in Fig. 2. The characteristics of the two randomized groups are presented in Table 1. Intraoperative data are shown in Table 2. Postoperative data are shown in Table 3.

Ultrasound-guided tubal drainage to resolve an intra-abdominal collection was required in four patients in the IRPJ group and six patients in the PG group (*P* = 0.502).

Longterm outcomes are shown in Table 4.

Discussion

The safe reconstruction of the pancreatic anatomy after PD continues to challenge pancreatic surgeons.^{1–3} Ideally, the

Table 2 Operative data for patients submitted to isolated Roux loop pancreaticojejunostomy (IRPJ) or pancreaticogastrostomy (PG)

Variable	All patients (n = 90)	IRPJ group (n = 45)	PG group (n = 45)	P-value
Cirrhotic liver, n (%)	12 (13.3%)	7	5	0.535
Size of mass, cm, median (range)	2 (0.5–6.0)	2 (0.5–6.0 cm)	3 (1.0–4.0)	0.477
<2 cm, n (%)	46 (51.5%)	26	20	0.206
>2 cm, n (%)	44 (48.5%)	19	25	
Ampullary site, n (%)	36 (40.0%)	19	17	
Pancreatic head mass	46 (51.1%)	20	26	0.313
Duodenal tumour	6 (6.7%)	4	2	
Lower CBD tumour	2 (2.2%)	2	0	
Indication for resection, n (%)				
Malignant	75 (83.4%)	38	37	0.466
Benign	13 (14.4%)	6	7	
Borderline	2 (2.2%)	1	1	
Pancreatic duct diameter, mm, median (range)	3.5 (1–12)	3 (1–12)	4 (2–10)	0.632
<3 mm, n (%)	43 (47.8%)	21	22	0.833
>3 mm, n (%)	47 (52.2%)	24	23	
Pancreatic duct to posterior border, mm, median (range)	3 (1–15)	3 (1–15)	3 (1–15)	0.537
<3 mm, n (%)	46 (51.1%)	23	23	1
>3 mm, n (%)	44 (48.9%)	22	22	
Pancreatic consistency, n (%)				
Firm	42 (46.7%)	23	19	0.398
Soft	48 (53.3%)	22	26	
Pancreatic remnant mobilization, cm, median (range)	2 (1–3)	2 (1–2)	2 (1–3)	0.039
Total operative time, min, median (range)	300 (210–480)	320 (240–480)	300 (210–420)	0.047
Operative time for reconstruction, min, median (range)	110 (90–125)	115 (95–125)	100 (90–120)	<0.001
Blood loss, ml, median (range)	500 (50–3000)	500 (50–2500)	400 (100–3000)	0.732

CBD, common bile duct.

reconstructive technique should not only minimize the risk for POPE, but should decrease its severity if POPF does occur and should also maintain exocrine and endocrine pancreatic functions. Pancreaticogastrostomy has several potential advantages over PJ. The PG anastomosis is technically feasible and easy to perform, and contributes towards a lower tendency for ischaemia and less tension as a result of anatomical factors. The gastric acid environment is thought to inhibit the activation of pancreatic enzymes and prevent the breakdown effect of proteolytic enzymes on the anastomosis.^{2,23–25}

Incidences of POPF after PD using PG reconstruction range from 3% to 14.3%.^{4,6–10} Several studies have reported low rates of POPF after PD using IRPJ reconstruction in the range of 0–10.9%, and related decreases in morbidity and mortality^{15,16,26–32} (Table 5). Hence, the aim of this study was to compare the outcomes of IRPJ with those of PG after PD.

Isolated Roux loop PJ was first reported in 1976 by Machado *et al.*³⁰ In many studies, IRPJ did not avoid POPF but did decrease leak-related morbidity and mortality.^{14–17} In a prospective

randomized study of 216 patients, Ke *et al.*¹⁷ found similar rates of POPF in patients undergoing conventional loop PJ and IRPJ, but the ratio of Grade B POPF was much higher in the conventional PJ group than the IRPJ group. Other studies have reported lower leak rates and no leak-related mortality after IRPJ.^{16,28,29,32–38} In the current study, the isolated Roux loop did not decrease the incidence or severity of POPF.

These findings conform with those of a recently published survey conducted in Japanese centres, which revealed no difference between conventional PJ and PG in rates of POPF, bleeding, abdominal collection and mortality after pancreatic head resection in 3109 patients.^{39,40} All prospective randomized studies have failed to show significant differences, which suggests that PJ and PG provide equally good results.^{2,23,41,42}

Sutton *et al.* have previously reported the obstruction of the distal enteroenterostomy secondary to oedema leading to luminal pressure-induced POPF as a theoretical danger of IRPJ reconstruction.¹⁶ This problem was not observed in the current study,

Table 3 Postoperative data for patients submitted to isolated Roux loop pancreaticojejunostomy (IRPJ) or pancreaticogastrostomy (PG)

Variable	All patients (n = 90)	IRPJ group (n = 45)	PG group (n = 45)	P-value
Hospital stay, days, median (range)	8 (4–41)	8 (5–41)	9 (4–34)	0.448
Time to drain removal, days, median (range)	8 (4–35)	7.5 (5–35)	9 (4–34)	0.118
Amount of draining, ml, median (range)	900 (65–17000)	850 (70–15000)	950 (65–17000)	0.705
Time to oral feeding, days, median (range)	6 (4–30)	5 (4–20)	6 (4–30)	0.029
Patients with complications, n (%)	31 (34.4%)	14	17	0.506
Complication grade, n (%)				
I	3 (3.3%)	2	1	0.724
II	10 (11.1%)	5	5	
IIIa	5 (5.6%)	2	3	
IIIb	6 (6.7%)	2	4	
IV	7 (7.8%)	3	4	
V	7 (7.8%)	3	4	
Severity of complications, n (%)				
Minor (<IIIb)	14 (15.5%)	8	6	0.385
Major (>IIIb)	17 (18.9%)	6	11	
Pancreatic leakage (POPF), n (%)	19 (21.1%)	9	10	0.796
POPF Grade A, n (%)	8 (8.9%)	5	3	0.710
POPF Grade B, n (%)	5 (5.6%)	2	3	
POPF Grade C, n (%)	6 (6.7%)	2	4	
Pancreatitis, n (%)	3 (3.3%)	2	1	0.557
Biliary leakage, n (%)	10 (11.1%)	4	6	0.502
Delayed gastric emptying, n (%)	13 (14.4%)	4	9	0.134
Obstructed GJ, n (%)	2 (2.2%)	1	1	1
Bleeding GJ, n (%)	2 (2.2%)	1	1	1
Bleeding PG, n (%)	2 (2.2%)	0	2	0.153
Internal haemorrhage, n (%)	2 (2.2%)	1	1	1
Wound infection, n (%)	5 (5.6%)	3	2	0.645
Liver failure, n (%)	1 (1.1%)	1	0	
Pulmonary complications, n (%)	4 (4.4%)	2	2	1
Re-exploration, n (%)	7 (7.8%)	3	4	0.694
Readmission rate at 3 months, n (%)	6 (6.7%)	2	4	0.398
Mortality, n (%)	7 (7.8%)	3	4	0.694
Pulmonary embolism, n (%)	1 (1.1%)	1	0	
SIRS secondary to POPF, n (%)	5 (5.6%)	2	3	
Liver failure, n (%)	1 (1.1%)	0	1	

POPF, postoperative pancreatic fistula; GJ, gastrojejunostomy; PG, pancreaticogastrostomy; SIRS, systemic inflammatory response syndrome.

possibly because a wide enteroenterostomy was performed in all patients.

A possible disadvantage of IRPJ is that it requires an additional enteroenterostomy, which increases operative time.^{14,17} Median total and reconstructive operative times in the current study were longer in the IRPJ group.

In the current study, oral feeding commenced 1 day earlier in the IRPJ group than in the PG group. Patients with POPF after

IRPJ resumed oral feeding without any increase in the amount of leak and demonstrated a principal advantage in the absence of delayed gastric emptying. However, some studies have found no significant difference in either of these factors.^{14–17}

In the current study, the frequency of severe steatorrhea at 1 year post-surgery was significantly higher in the PG than in the IRPJ group ($P = 0.029$). Correspondingly, median albumin at 1 year was significantly higher in the IRPJ group than in the PG

Table 4 Functional changes in patients submitted to isolated Roux loop pancreaticojejunostomy (IRPJ) or pancreaticogastrostomy (PG)

Variable	IRPJ group (n = 45)	PG group (n = 45)	P-value
Preoperative steatorrhea, n	8/45	10/45	0.598
Postoperative steatorrhea, n	9/42	18/41	0.029
P-value	0.157	0.005	
Need for pancreatic enzyme supplements, n	9/42	18/41	0.029
Preoperative albumin, g/dl, median (range)	4 (3.2–5)	4 (3.3–4.8)	0.915
Postoperative albumin, g/dl, median (range)	3.6 (3.1–4.5)	3.3 (2.5–4.1)	<0.001
P-value	<0.001	<0.001	
Preoperative weight, kg, median (range)	71 (54–121)	72 (54–72)	0.596
Postoperative weight, kg, median (range)	71 (52–99)	70 (50–105)	0.789
P-value	<0.001	<0.001	
Preoperative body mass index, n			
<25 kg/m ²	30/45	26/45	0.384
>25 kg/m ²	15/45	19/45	
Postoperative body mass index, n			
<25 kg/m ²	34/42	34/41	0.815
>25 kg/m ²	8/42	7/41	
P-value	0.025	0.002	
Preoperative diabetes mellitus, n	11/45	13/45	0.634
Postoperative diabetes mellitus, n	12/42	20/41	0.059
P-value	0.157	0.008	
Preoperative fasting blood sugar, mg/dl, median (range)	114 (71–275)	102 (79–217)	0.477
Postoperative fasting blood sugar, mg/dl, median (range)	102 (70–210)	132 (90–299)	0.022
P-value	0.004	<0.001	

group (3.6 g/dl versus 3.3 g/dl; $P \leq 0.001$). Several published series have reported that exocrine function after PD depends on various complex factors, including pre-existing obstructive pancreatitis by tumour, the degree of fibrosis in the pancreatic remnant, the volume of resected pancreatic parenchyma, impairment of pancreatic juice flow as a result of anastomotic stricture or swelling of the gastric mucosa, and possibly the type of pancreatic reconstruction.^{13,43–46} Some retrospective studies have reported higher rates of suggested pancreatic exocrine insufficiency in patients with longterm follow-up who have undergone PG rather than PJ reconstruction.^{11–13,29} There is, however, no evidence that impaired pancreatic endocrine function would be associated more often with a certain type of reconstruction.⁴³ Pancreaticogastrostomy may cause more morphological and functional derangement because the reflux of gastric juice causes the inactivation of pancreatic enzymes and early pancreatic insufficiency.^{11,12,22}

The present study is subject to two limitations. Firstly, the sample size was calculated to set the level of power for the study at 80% with a 5% significance level, presupposing POPF rates of 17% after PG^{4–6} and 0% after IRPJ.^{14–16} The calculation of the

sample size in relation to the 4–14% incidence of POPF after IRPJ^{15,17,36} yielded large numbers in excess of 100 patients per group, which exceeded the proposed duration of the trial. Secondly, the operations were performed by eight surgeons, which may have represented a source of bias. However, the fact that these surgeons had almost equal levels of experience within the trial helps to overcome this. Nonetheless, further prospective randomized studies with larger sample sizes are required to confirm these results.

Conclusions

The results of this study contribute to evidence indicating that IRPJ is not associated with a lower rate of POPF, but is associated with a decrease in the incidence of postoperative steatorrhea. Isolated Roux loop PJ allowed for early oral feeding and facilitated the maintenance of oral feeding even if POPF developed.

Conflicts of interest

None declared.

Table 5 Results of Roux-en-Y pancreaticojejunostomy reported in different studies

		Type of study	Patients, n	POPF, n (%)	Steatorrhea, n (%)	DGE, n (%)	Duration of surgery, median	Hospital stay, days, median	HM, n (%)
Kingsnorth ²⁹	1994	Single group	52	0	10/41 (24.4%)			18	3 (5.8%)
Papadimitriou <i>et al.</i> ³²	1999	Retrospective Single group	105	0				7.6	1 (0.9%)
Khan <i>et al.</i> ²⁸	2002	Retrospective Single group	41	0		5 (12.2%)	8.0 h	16	1 (2.4%)
Ma <i>et al.</i> ³⁸	2002	Retrospective Single group	26	0	1 (3.8%)			10–14	0
Sutton <i>et al.</i> ¹⁶	2004	Retrospective Single group	61	0			5.5 h	16	3 (5%)
Casadei <i>et al.</i> ²⁷	2008	Prospective	18 IRPJ	2/18 (11.1%)					2.6%
		Non-randomized	20 CPJ	3/20 (15%)					26.3%
Grobmyer ⁴⁷	2008	Retrospective	112 RYR	14.8%		10.1%	5.8 h	18	0.9
		Two group	588 CPJ	5.7%		10.3%	5.1 h	19	2.6%
Kaman <i>et al.</i> ¹⁴	2008	Retrospective	60 IRPJ	10%		12 (20%)		17.5	5 (8%)
		Two group	51 CL	12%		6 (12%)		17.25 d	4 (8%)
Wayne <i>et al.</i> ³⁷	2008	Retrospective Single group	13	0		0			0
Fragulidis <i>et al.</i> ³⁵	2009	Retrospective	69 LIPJ	4.3%		11	255 min	10.2	1
		Two groups	63 SIPJ	14.2%		11	245 min	16.3	1
Perwaiz <i>et al.</i> ¹⁵	2009	Retrospective	53 IRPJ	5 (9.4%)		5 (9.4%)	442 min	10.1	2 (3.7%)
		Single group	55 CPJ	6 (10.9%)		4 (7.2%)	370 min	9.5	2 (3.6%)
Ballas <i>et al.</i> ³⁶	2010	Two groups	46 IRPJ	2 (4.3%)		7 (15.2%)	366.1 min	14.6 d	1 (2.2%)
			42 CPJ	3 (7.1%)		4 (9.5%)	338.8 min	19.5	1(2.3%)
Pozzo <i>et al.</i> ⁴⁸	2010	Single group	27	0				18	
Ke <i>et al.</i> ¹⁷	2013	Prospective	107 IRPJ	17 (15.7%)		25 (23%)	5.7 h	18.7	0
		Randomized	109 CPJ	19 (17.6%)		27 (25%)	5.6 h	19.1	0

POPF, postoperative pancreatic fistula; DGE, delayed gastric emptying; HM, hospital mortality; IRPJ, isolated Roux loop pancreaticojejunostomy; CPJ, conventional pancreaticojejunostomy; RYR-PJ, Roux-en-Y pancreaticojejunostomy; JPJ, conventional pancreaticojejunostomy; LIPJ, long loop isolated pancreaticojejunostomy; SIPJ, short loop isolated pancreaticojejunostomy.

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