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Pancreaticogastrostomy .... Seven years tertiary hospital experience

Deena Hadedeya, Hanaa Al-Hashemy, Saud Al-Muhammadi

ABSTRACT

Aims: Pancreaticoduodenectomy (PD) is the treatment of choice for periampullary tumors. However, this procedure carries significant risk and potential morbidity, mostly related to pancreatic anastomotic failure. Many techniques have been described in an attempt to decrease the anastomotic leak rate and related complications. Pancreaticogastrostomy (PG) is one of the techniques utilized to restore pancreatic continuity after pancreatic head resection. The aim of this study is to share our experience with the pancreaticogastrostomy technique. Methods: Retrospective review of all those patients who underwent pancreaticoduodenectomy between 2008 to August 2015 at King Faisal Specialist Hospital and Research Center (Gen. Org.), Jeddah, Kingdom of Saudi Arabia. A total of 36 patients underwent a pancreaticoduodenectomy with a pancreaticogastrostomy using our modified technique. Variables studied included indications for surgery, intraoperative and postoperative factors and postoperative complications. Results: At King Faisal Specialist Hospital and Research Center (Gen. Org.), Jeddah in group of patients who underwent pancreaticogastrostomy (n=36) including 21 males and 15 females, the mean age was 58.44 years (SD 15.76). Total 62% of patients had BMI ≥ 25 (7 are missing). Intraoperatively, the pancreatic stump was soft and friable in 31.6% of the cases. The histopathology review postoperatively showed seven benign cases and 29 malignant cases. The indications for pancreaticoduodenectomy based on the histopathology have been divided into seven main categories: adenocarcinomas, neuroendocrine tumors, intraductal tumors, pseudopapillary tumors, cystic lesions of the pancreas, trauma and others including inflammations and fibrosis. The mean tumor size was 3.29 cm in diameter (range, 0–11 cm) with (0–6) number of lymph node involvement. The mean tumor size for malignant lesions was 3.57 cm in diameter while in benign lesions the mean tumor size was 2.66 cm in diameter. There was a vascular invasion in 23.5% of the cases. Fibrosis presented in 41.7% of the specimens. The highest morbidity in our series following pancreaticoduodenectomy was, wound infection 22.2%, atelectasis 13.9%, delayed gastric emptying and postoperative bleeding 8.3%. Others include Intraoperative and postoperative hemorrhage, abscesses and collections, wound dehiscence and pulmonary embolism (PE) counted for 5.6% of the complications. Intraoperative bleeding, pancreatic fistula, biliary fistulas, lymphatic duct injury and deep venous thrombosis (DVT) occurred in 2.8% of the patients. Conclusion: Pancreatic stump invagination into the gastric lumen with a two layers fixation of the ventral surface of the pancreas might be associated with a lower risk of pancreatic anastomosis failure compared with other techniques. Further

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prospective validation with a larger number of cases is needed to support our results.

Keywords: Anastomotic leak, Pancreatic fistula, Pancreaticogastrostomy, Pancreaticojujenostomy, Periambullary tumors, Whipple procedure

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INTRODUCTION

The five-year survival rate of pancreatic cancer is the lowest among all cancer types. Early diagnosis is essential and the only chance for cure is resection [1, 2]. Up to 85% of patients with pancreatic cancer are already in advanced stage at the time of the diagnosis and in those patients curative resection is possible in only 10–15 % [1]. Pancreaticoduodenectomy is the procedure of choice for all periampullary tumors and pancreatic head tumors, specifically [1, 3]. Although the mortality rate following PD is reported to be around 3–5% only [1], postoperative morbidity is still relatively high (20–30%) despite improvements over recent years [4]. Pancreaticoduodenectomy is an invasive and potentially risky procedure and a key step is anastomoses of the pancreatic remnant to the intestine. [5]. Various techniques for managing the pancreatic remnant have been reported including simple ligation of the pancreatic duct [6, 7], occlusion of the pancreatic duct using a synthetic rubber injection or fibrin glue [8, 9], optimization of the blood supply of the edge of the pancreatic remnant and meticulous placement of sutures using magnification [10], application of fibrin glue sealant around the pancreaticojejunal (PJ) anastomosis [11], various modifications of the PJ (either end-to-end or end-to-side anastomosis) [12, 13] or isolated Roux-en-Y pancreaticojejunostomy [14, 15]. Results following PG have been inconsistently reported in numerous studies [16, 17]. Bassi et al. showed that biliary fistula, postoperative collections and delayed gastric emptying were significantly reduced in patients treated by PG compared with alternative anastomoses [18]. In addition, PG is associated with lower frequency of multiple surgical complications. The purpose of the present study is to describe and evaluate our modified PG technique on 36 patients in a retrospective manner to determine whether this is a safe procedure for managing restoration of pancreatic remnant.

MATERIALS AND METHODS

We conducted a retrospective review of 36 patients who underwent PG after PD at King Faisal Specialist Hospital & Research Center (Gen. Org.), Jeddah, KSA between 2008 and August 2015. All procedures were conducted by a single surgeon (Dr. Saud Al-Muhammadi (Saudi Arabia).

All patients were investigated preoperatively to confirm their diagnosis and to evaluate their general and nutritional health statistics. Blood work, electrocardiogram (ECG), Chest X-ray and an abdomen and pelvis computed tomography (CT) scan were performed for all patients.

Clinical and pathological data were obtained from the hospital data base and medical records. Data obtained for each patient included demographics, preoperative laboratory values, preoperative intervention, intraoperative data such as the use of prophylactic antibiotics, the use of intravenous octreotide before the anastomosis, the length of the operation and the blood loss.

Postoperative data included complications, pathological findings, and survival outcomes. Analyses were performed using statistical software (IBM SPSS statistics 21 for windows) with the t-test used where appropriate. Statistical significance was set at $p = 0.05$.

SURGICAL TECHNIQUE

The abdominal cavity was accessed via a longitudinal upper midline incision and, after stepwise mobilization, the PD was performed. The pancreatic parenchymal transection was performed using cutting electrocautery after controlling the blood supply originating from two arterial arcades in front of and behind the pancreatic head using a 4-0 PDS suture (Video 1).

Reconstruction of the PG was done using the most common technique described by Mackie and Rhoads involving a simple invagination technique with a few modifications. A $2–2^{-1/2}$ cm centimeters length of the remnant pancreas was mobilized from the surrounding tissues using ligature ties (almost always one to two splenic vein and arterial branches need to be ligated). Excessive mobilization of the pancreas was avoided to reduce the risk of pancreatic necrosis/pancreatitis.

Video 1: Pancreaticogastrostomy procedure.

Video URL: http://www.ijhpd.com/archive/2016-archive/100049IJHPDDH2016-hadedeya/100049IJHPDDH2016-hadedeya-full-text.php

A small incision was then made in the posterior surface of the stomach (the diameter of the gastric incision is calibrated to 1 cm less than the diameter of the pancreatic stump) and two invaginating sutures fixed to each corner of the gastrectomy incision. These two sutures are responsible for invaginating the pancreas into the stomach and are an important step during this procedure (Figure 1).

A row of interrupted 4-0 monofilament sutures is then placed between the gastric seromuscular layer and the anterior wall of the pancreatic parenchyma 2 cm from the cut edge of the pancreas. The suture is passed proximal to distal to improve invagination of 1–2 cm of pancreatic parenchyma when tying these sutures (Figure 2). Sutures are then placed from the posteroinferior gastric wall to the posterior body of the pancreas, using the same technique of proximal to distal passage of the suture through the pancreas (Figure 3).

A second continuous layer of sutures is then added to the posterior body of the pancreas and the inferior cut edge of the gastrostomy (Figure 4).

The hepaticojejunostomy and gastrojejunostomy are performed using a Roux-en-Y technique with an

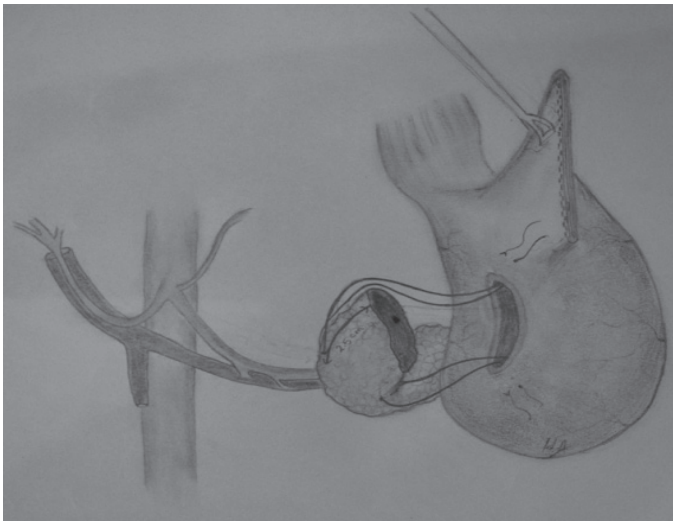

Figure 1: Gastro-pancreatic corner mattress stitch, notice the stitch out-in 2 cm above both gastrostomy corners and anterior-posterior through both superior and inferior edge of the pancreas 2 cm below the cut edge of the pancreas.

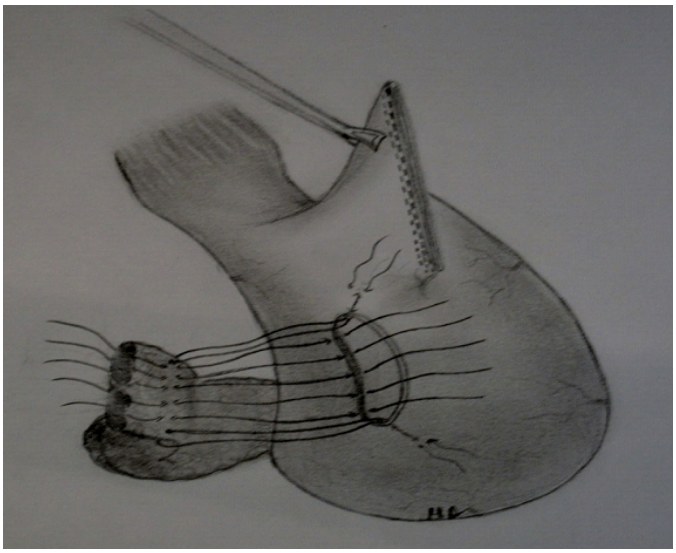

Figure 2: Simple suture between superior edge of gastrostomy and dorsal service of pancreas, notice the stitch are taken through pancreatic service distal 2 cm below the cut edge of the pancreas.

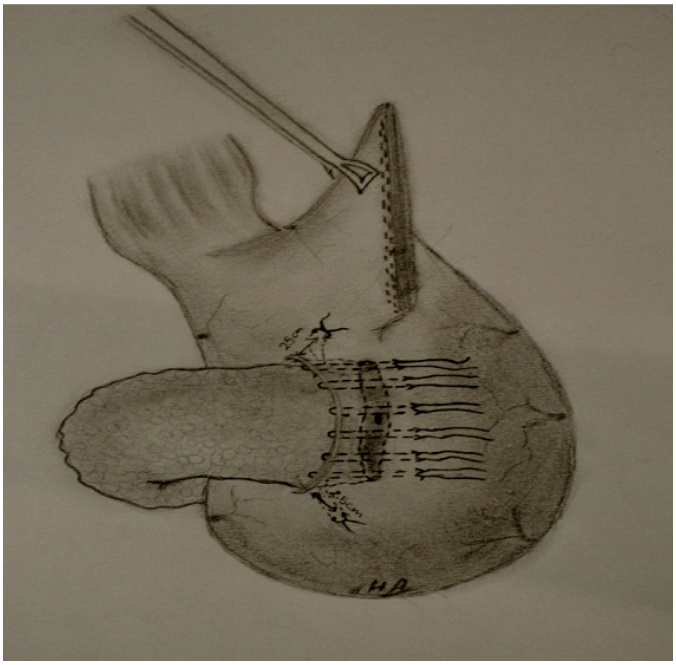

Figure 3: Mattress suture out-in through the inferior edge of the gastrostomy and the ventral surface of the pancreas. Note, sutures are passed proximal to distal through the pancreas, 2 cm away from the cut edge.

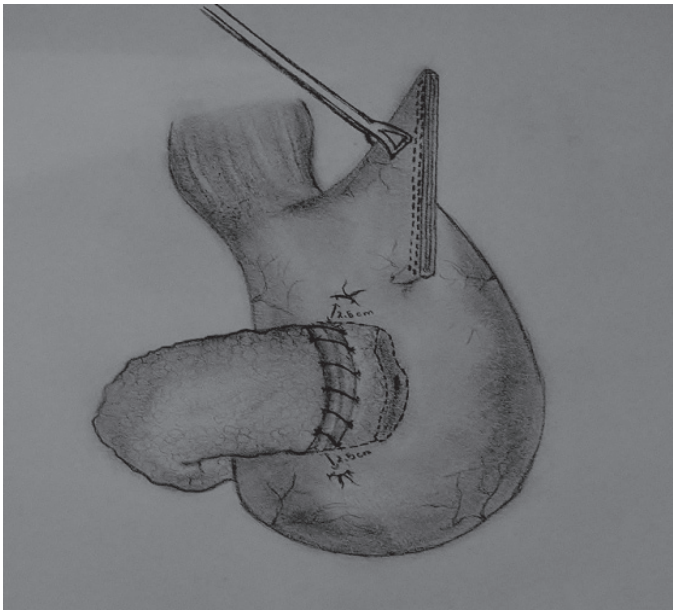

Figure 4: A continuous suture is placed between the inferior edge of the gastrotomy and the pancreatic tissue at the ventral surface to reinforce the posterior layer (after invaginating the pancreas into the stomach.

interrupted single layer of PDS for the H-J and a stapled anastomosis for both the gastrojejunostomy and the enteroenterostomy.

Two drains are left in place, one in the sub hepatic area and one below the pancreatic anastomosis. The abdominal cavity was closed using a running suture of loop #1 PDS. The skin was closed using a stapler. The median operation time was 6 hours, ranging between 2–11 hours. The median estimated blood loss 400 ml, ranging between 100–1500 ml.

POSTOPERATIVE CARE

All patients were transferred to the surgical intensive care unit (SICU) for 24 hours postoperatively. Prophylactic intravenous (IV) cefazolin (Kefazol®) 1 g every 8 hours and metronidazole (Flazol®) 500 mg every 6 hours was given for seven days, metoclopramide (Primperan®) 10 mg every 8 hours PRN for nausea and vomiting, omeprazole (Losec®) 20 mg every 12 hours, all our patients received either patient controlled analgesia (PCA Fentanyl) (Sublimaz®) or epidural anesthesia for 3 days maximum. Acetaminophen (Perfalgan®) 500-1000 mg every 6 hours and tramadol (Tramal®) 50–100 mg every 6 hours were used when the PCA or epidural anesthesia was removed, octreotide (Sandostatin®) 100 mcg every 8 hours was given for 5 days. Patients received unfractionated heparin 5000 IU TID via a subcutaneous (SC) route as DVT prophylaxis.

Oral fluids were reintroduced on day-2 and then progressed to full diet, as tolerated. Delayed gastric emptying was defined following the definition of the international study group for pancreatic fistulas (ISGPF) as the inability to return to a standard diet by the end of the first postoperative week and includes prolonged nasogastric intubation of the patient [19].

Both intra-abdominal drains were attached to vacuum containers and were monitored daily for volume output. Amylase levels from the serum and drainage fluid were measured on day-5. Any external fistula with a drain output of any measurable volume after postoperative day-3 with an amylase level greater than three times the upper limit of the normal serum value is defined as a postoperative PF according to the international study group for pancreatic fistulas (ISGPF) [20]. Bile leak according to the international study group of liver surgery was suspected if bilirubin concentration in the drain fluid at least three times the serum bilirubin concentration on or after postoperative day 3 or as the need for radiologic or operative intervention resulting from biliary collections or bile peritonitis (ISGLS) [21].

RESULTS

In total, 36 patients underwent PG including 21 males and 15 females. The mean age of this cohort was 58.44 years (SD 15.76). 62% of Patients had BMI ≥ 25 (7 are missing). 30.6% of patients had been diagnosed with diabetes mellitus preoperatively and already started on treatment.

Thirty six percent of patients had biliary stents placed pre-operatively via endoscopic retrograde cholangiopancreatography (ERCP) or percutaneous drainage (PTC) of the biliary system under radiological guidance. Intraoperatively the pancreatic stump was soft and friable in 31.6% of the cases. Histopathological analysis confirmed 7 benign cases and 29 malignant cases as given in Table 1. In this cohort, the mean tumor size was 3.29 cm (range, 0–11 cm)-malignant 3.57 cm in diameter vs. 2.66 cm for benign lesions, of the malignant cases vascular invasion was seen in 23.5% of specimens, for that patients received chemotherapy as per multidisciplinary meeting decision. Fibrosis presented in 41.7% of specimens. R0 resection achieved successfully in 52.8%, R1 resection in 19.4% and R2 resection in 5.6% of patients. The mean operating time was 5.6 hours (SD 1.74), the mean intraoperative blood loss was 676.39 ml (SD 1222.96). The mean hospital stay was 11.86 days (SD 6.05). The mean survival rate was 9.5 months (SD11.68).

During the follow-up period, four patients (11.1%) died 9 months to 4 years after the procedure. One patient was lost to follow up. In hospital mortality (define – is this 90 days) occurred in two patients (5.5%). One patient

Table 1: Patient characteristics

Age (years)	58.44±15	
Sex		
Male	21	(58.3%)
Female	15	(41.6%)
Histopathological result		
Adenocarcinoma	25	(69.4%)
Other	3	(8.3%)
Neuroendocrine tumour	2	(5.5%)
Cystic lesion	2	(5.5%)
Intraductal lesion	2	(5.5%)
Trauma	1	(2.7%)
Pseudo-papillary tumor	1	(2.7%)
Tumour size (cm)	3.29±(SD2.28)	
Vascular invasion		
Present	8	(23.5%)
Absent	28	(77.7%)
Operating time (hours)	5.6±1.74	
Intra operative blood loss (ml)	676.39±1222.96	
Hospital stay (days)	11.86±6.05	
Survival (months)	9.5±11.68	

died from intraoperative bleeding as a result of a porta hepatis injury and the other died on day-1 due to DIC as a result of massive blood transfusion for intraoperative bleeding. Two patients were excluded from the final survival analysis.

The overall morbidity was 83.3% which included wound infections (22.2%), atelectasis (13.9%) and delayed gastric emptying and postoperative hemorrhage (8.3%). Abscesses and collections, wound dehiscence and PE occurred in a total of (5.6%) of the cases. Intraoperative hemorrhage, pancreatic and biliary fistulas, lymphatic duct injury and DVT account for 2.8% of the complications. The lowest rate was (0%) in major complications such as cholangitis and acute pancreatitis (Table 2). In this cohort, we noticed that there was no correlation between the pancreatic fistula and the development of intra-abdominal abscess or collection. Re-admission was needed in three patients, first patient readmitted after two weeks with recurrent vomiting, upper gastrointestinal scope was done for him and it was normal-no mechanical causes of obstruction. He improved with diet modification within few weeks. The second patient presented after three weeks from the discharge with hematemesis, upper gastrointestinal scope and CT angiogram were obtained for him and both of them were negative. Patient admitted for observation, his bleeding stopped spontaneously and patient discharged home. In the third case, patient readmitted within few days from the discharge with wound infection and sepsis, which needed frequent dressing and IV antibiotic. Steatorrhea was noticed in 13.9% of patients postoperatively in the first few visits which treated with recombinant pancreatic enzymes. On the long-term follow-up four of our patients died after 2–3 years from the operation and one of them lost his follow-up.

Table 2: Postoperative complications

Wound infection	8	(22.2%)
Atelectasis	5	(13.9%)
Steatorrhea	5	(13.9%)
Delayed gastric emptying	3	(8.3%)
Postoperative hemorrhage	3	(8.3%)
Wound dehiscence	2	(5.6%)
Abscess or collection	2	(5.9%)
Pulmonary embolism	2	(5.6%)
Intraoperative hemorrhage	1	(2.8%)
Pancreatic fistula	1	(2.8%)
Biliary fistula	1	(2.8%)
Lymphatic duct injury	1	(2.8%)
DVT	1	(2.8%)
Cholangitis	0	(0%)
Acute pancreatitis	0	(0%)

DISCUSSION

Periampullary tumors are defined as those arising from the head of the pancreas, the distal common bile duct and the duodenum. Overall they have a high mortality rate compared with other cancer types, and account for >30,000 cancer related deaths per year in the U.S. [22]. The most definite treatment for periampullary tumors is PD although this is still considered as a relatively risky procedure with a high morbidity and mortality rate. Post-operative morbidity occurs in up to 45.1% of cases [23]. The most significant complication is a pancreaticoenteric anastomotic leak which is reported to occur in 5–20% of cases [15]. The presence of a pancreatic leak increases the mortality rate, Lerut et al. reported that pancreatic fistula accounted for 55% of postoperative deaths [24]. PJ is the most commonly used technique for managing the pancreatic remnant. However, when using this technique anastomotic leaks and pancreatic fistulas have been reported in up to 11–40% of cases [25]. Pancreaticoenteric anastomotic failure often results in delayed gastric emptying, pancreatic fistula, and wound infection. The consequences of a pancreatic fistula may be dire sometimes, leading to intraabdominal hemorrhage, intraabdominal infection, wound dehiscence and even death [26]. Yeo et al. reported on outcomes after 650 consecutive PDs [27]. They noted that four percent of patients required repeat surgery and that one third of these patients died after the second operation as a result mostly related to leakage from the PJ anastomosis. The modified technique of PG used in the present series resulted in zero leaks and numerous other groups have similar good results using this technique, Miyagawa et al. [28] in a retrospective comparative study found that PG was superior to PJ in terms of anastomotic breakdown. Bartoli, [29] undertook a meta-analysis of pancreatic fistula and relative mortality in malignant disease after PD. They compared data on PG versus PJ anastomosis performed in three different ways, i.e., PJ end to side, PJ end to end, and Wirsung duct to jejunal end to side anastomosis. In all cases, PG was associated with lower morbidity and mortality rates compared with a PJ anastomosis. In a retrospective study on 214 patients Aranha GV et al. showed a significant difference in mortality between the two groups in favor of the PG group [27]. Anastomosies of the pancreas was first described theoretically by Tripodi and Sherwin in 1934 [30]. The technique was further evaluated in the laboratory by Person and Glenn [31]. The first successful PG in a patient was performed by Waugh and Clagett in 1946 [32]. In a review done from 1946 to

1997 by Mason, pancreaticogastrostomy sees to be safe procedure . A total of 199 cases using the PG technique were described in the literature. A mortality of 4.5% (9/199) and a leakage rate of 1% (2/199) were reported. None of the nine deaths described in this review were attributed to PG. During the time period 1991 to 1997, the number of PGs described in the literature was 614. The incidence of leakage for this period when compared with the previous period rose to 4.7% (29/614), with an overall mortality of 3.3% (20/614). In this mortality group only 15% of deaths were related to the PG anastomosis [33]. Numerous theories have been proposed as to why a PG might be more favorable in terms of the risk of an anastomotic leak compared with PJ. Firstly, the stomach is known to have a rich blood supply which might decrease the risk of ischemic complications. Secondly, the thick wall of the stomach makes the sutures hold better than in the jejunum. Thirdly, the pancreas lies immediately behind the stomach and anastomosing it in the posterior wall allows a tension free anastomosis which may reduce the risk of leakage. Fourthly, there is no accumulation of pancreaticobiliary secretions as presumably occurs in a long loop of the jejunum which can add tension to the anastomosis. Fifthly, the relatively acidic media of the stomach do not activate the pancreatic proteolytic enzymes which may also help protect the anastomosis. Lastly, the alkaline pancreatic secretions neutralize the gastric acidity which protects against potential marginal ulceration [23, 34].

In addition to these, there are other controllable factors which can affect the anastomosis and the general outcome. These can be divided into: pancreatic factors, patient factors and operative factors. Pancreatic factors include [1] the pancreatic texture where the fibrotic pancreatic remnant is less likely to leak after an anastomosis compared with a soft and fragile pancreatic remnant; [2] the original pathology; [3] the blood supply to the pancreatic remnant; [4] and the pancreatic duct size. Patient related factors include: age, gender, level of preoperative jaundice, and comorbid diseases. Operative factors include operation time, blood loss, type of anastomosis and stenting of the pancreatic duct [34, 35].

Numerous pharmacological agents have been described to decrease or prevent pancreatic anastomotic leaks. The most commonly used medication is octreotide. A recent meta-analysis by Connor et al., showed that octreotide usage reduces the incidence of postoperative complications in pancreatic surgery [24].

CONCLUSION

Pancreatic stump invagination into the gastric lumen for about 2 cm with a two layer fixation of the ventral surface of the pancreas was associated with low risk of pancreatic anastomosis failure in our study. The limitations of this include the small sample size and the range of different pathologies in this series. Larger multi-centric studies are needed to establish whether pancreaticogastrostomy reconstruction following pancreaticoduodenectomy is superior to pancreaticojejunal reconstruction.

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Author Contributions
Deena Hadedeya – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published
Hanaa Al-Hashemy – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published
Saud Al-Muhammadi – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Guarantor
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Conflict of Interest
Authors declare no conflict of interest.

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