Al-Azhar International Medical Journal

Volume 4 | Issue 10 Article 33

2023
Section: General Surgery

Modalities of Pancreatic Duct Drainage after Whipple Procedure

Magdy Salah El-Din Hussain
Department of General surgery, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt.

Mahmoud Abd-El-Hady Abd-El-Aziz
Department of General surgery, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt.

Ahmed Alsayed Mohamed Abd Elrahman
Department of General surgery, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt.

Al Sayed FottohAbd El Wanis El Garhy
Department of General surgery, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt., drelsayedelgarhey1984@gmail.com

How to Cite This Article

Hussain, Magdy Salah El-Din; Abd-El-Aziz, Mahmoud Abd-El-Hady; Elrahman, Ahmed Alsayed Mohamed Abd; and Garhy, Al Sayed FottohAbd El Wanis El (2023) "Modalities of Pancreatic Duct Drainage after Whipple Procedure," *Al-Azhar International Medical Journal*: Vol. 4: Iss. 10, Article 33.
DOI: https://doi.org/10.58675/2682-339X.1976

ORIGINAL ARTICLE

Modalities of Pancreatic Duct Drainage After Whipple Procedure

Magdy Salah El-Din Hussain, Mahmoud Abd-El-Hady Abd-El-Aziz, Ahmed Alsayed Mohamed Abd Elrahman, Al Sayed FottohAbd El Wanis El Garhy*

Department of General Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: **Surgery is the primary mode for treatment of pancreatic cancer. Surgical options include Whipple surgery (pancreaticoduodenectomy) with or without pylorus preservation. The Whipple surgery, also known as a pancreaticoduodenectomy, is a significant operation used to remove malignancies from the periampullary region and the pancreatic head.**

Aim: **To assess two techniques of pancreatic duct anastomosis after Whipple pancreaticoduodenectomy and compare these techniques as regard operative procedure and postoperative complications.**

Subject and methods: **Thirty patients at Al-Azhar University Hospitals with pancreatic or periampullary lesions requiring Whipple pancreaticoduodenectomy were analyzed in this research.**

Results: **There was no statistically significant difference among our study population regarding demographic, Operative and postoperative data in addition there was no statistically significant difference among our study population regarding Postoperative complications.**

Conclusion: **In conclusion, both the Duct-to-mucosa and Invagination PJ methods of pancreatic duct anastomosis following Whipple pancreaticoduodenectomy were shown to be safe and successful. Duct-to-mucosa Associating PJ with slightly longer Anastomosis time in comparison to Invagination PJ. roux-en-y hepaticojejunostomy has less postoperative pancreatic and biliary leakage as compared to conventional whipple single-loop anastomosis.**

Keywords: Cancer of the pancreas, Pancreatic duct, Whipple procedure

1. Introduction

Pancreatic cancer accounts for seven percent of all cancer-related fatalities in males, while being the 10th most prevalent disease in men and the 9th most common cancer in women. Seventy-five percent of pancreatic carcinomas develop in the organ's neck or head, compared to 15−20 persent in the body and 5-10persent in the tail.[1]

Surgery is the primary mode for treatment of pancreatic cancer. Surgical options include Whipple surgery (pancreaticoduodenectomy) with or without pylorus preservation. Pancreaticoduodenectomy has come a long way since Kausch conducted the first successful two-stage treatment in 1912. Yet, in the 1890s, Codivilla in Italy conducted the first pancreaticoduodenectomy, the patient of which tragically passed very shortly after surgery. Whipple procedure is the renowned given to this operation in honor of Allen Oldfather Whipple, the surgeon who first documented a series of pancreaticoduodenectomies in 1935. Initially a two-stage operation, includinthe the closure of the pancreatic duct, he had successfully conducted the technique on three patients before refining his approach to a single-stage operation.[2]

In 1937, Brunschwig included pancreatic head lesion removal to the list of reasons for pancreaticoduodenectomy. In 1946, Waugh and Clagett described the traditional pancreaticoduodenectomy, which included removing the gallbladder, common bile duct, gastric antrum, duodenum, and pancreatic

Accepted 14 June 2023.
Available online 12 January 2024

* Corresponding author at: Department of General surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: drelsayedelgarhey1984@gmail.com (A.S.F. El Wanis El Garhy).

https://doi.org/10.58675/2682-339X.1976

head all at once. With the goal of reducing postoperative postgastrectomy symptoms, Traverso and Longmire presented a pylorus-preserving modification in 1978. Laparoscopic and robotic methods were significant advances in the treatment of pancreaticoduodenectomy in the years that followed.[3]

Immediately after gaining access to the abdominal cavity, the surgeons examine the peritoneal and liver surfaces for signs of metastatic illness. While active metastatic illness is an absolute surgical contraindication, this is a crucial initial step.[4]

The pancreas receives blood flow from two different arteries: the celiac artery (through the superior pancreaticoduodenal artery) and the superior mesenteric artery (via the inferior pancreaticoduodenal artery). The right gastric artery, which itself originates from the celiac artery, divides into several smaller branches. As they share the same arterial blood supply, the duodenum and the pancreatic head must be removed during surgery. These arteries pass through the pancreatic head, making removal of the entire organ necessary. Tissue necrosis in the duodenum might happen from severing blood supply from the pancreas if only its head were removed.[5]

Even if the liver's blood supply is unharmed, the common bile duct is cut. Because of this, even though the liver will continue to get adequate blood flow, the surgeon will need to create a new link to remove bile from the liver. This is done when the operation is wrapping up. If the pancreatic duct is disconnected from the jejunum or stomach, the surgeon can create a new connection. Surgery is required to remove the gallbladder. The gallbladder is taken out at a separate time, so this is not a complete procedure.[6]

As a technical difficulty, dealing with the remnants of the pancreas after a pancreaticoduodenectomy has been tackled in a number of different methods. Removing the complete pancreas, as opposed to only the pancreatic head, is one option. Total pancreatectomy results in diabetes for all patients. This condition might be difficult to control.[7] At the time of Whipple's first report of pancreaticoduodenectomy, the pancreatic duct was suture ligated rather than reanastomosed to the gastrointestinal system. The possibility of leaking at a pancreaticoenteric anastomosis has led some surgeons to advocate for this method. High rates of pancreatic leaking at the suture site after duct ligation, leading to the development of a pancreaticocutaneous fistula along surgical drain routes, have been linked to duct ligation. Patients who undergo duct ligation inevitably have pancreatic exocrine insufficiency in addition to the creation of pancreatic fistulae.[8] In many cases, the pancreatic duct measures barely one or two mm in diameter and is located eccentrically on the pancreas's snipped edge. Many methods, depending on whether the pancreatic duct is externally or internally drained, are used by surgeons to stent the anastomosis between the pancreatic duct and the jejunal mucosa and keep it open.[9] When the pancreatic duct's internal diameter is three mm or more, a duct-to-mucosa anastomosis can be done without a stent.[10]

Delayed gastric emptying, bile leak and pancreatic leak are three of the most common postoperative complications. Delayed gastric emptying, medically speaking, is when a patient needs a nasogastric tube since they cannot eat properly after surgery and it's been a week. It happens in approximately seventeen percent of surgical procedures. During surgery, a new biliary connection (usually a choledocho-jejunal) is established. In 1–2% of cases, this additional connection may cause a leak. It is standard practice for the surgeon to keep a drain in place after this treatment due to the frequency with which this issue arises. By measuring the concentration of bilirubin in the drained fluid, a bile leak can be identified. Fluid drained after postoperative day 3 with an amylase content greater than or equal to 3 times the upper limit of normal indicates a pancreatic leak or pancreatic fistula, which occurs in 5–10% of operations but may now include a much larger proportion of patients (upwards of forty percent).[11]

2. Patients and methods

This study was a prospective study was conducted in general surgery department, faculty of medicine, al-Azhar University. The duration of the study was 2 years with follow up 6 months.

Thirty patients participated in this study suffering from pancreatic or periampullary lesions necessitating Whipple pancreaticoduodenectomy in Al-Azhar university hospitals.

Thirty patients participated in this study suffering from pancreatic or periampullary lesions necessitating Whipple pancreaticoduodenectomy in Al-Azhar university hospitals.

The **Inclusion criteria** were: Any patient has pancreatic and periampullary lesions submitted for pancraticoduodenectomy fit for surgery with no known metastasis. The following procedures will be performed on every patient.

2.1. Preoperative diagnosis

Patient history: for painless jaundice, obstructive pattern with progressive course in old age patient plus weight loss is suggestive of cancer head of

pancreas. General examination: including vital signs, head and neck, eye, chest and heart, upper and lower limbs. Abdominal examination: may be normal, distended palpable but not tender gall-bladder in a jaundiced patient (Courvoisiers sign) is sensitive for malignant obstruction of bile duct.

Preoperative investigation: CBC, serum urea and creatinine, liver enzyme, Coagulation profile, blood sugar, Alkaline phosphatase, bilirubin, and Tumor indicators CA19-9.**Surgery**.

All patients will be submitted to open pancreaticoduodenectomy.

Pancreaticoduodenectomy will be carried out by different methods of pancreatic duct anastomosis.

Both groups will be compared as regard operative procedure, time consuming, blood loss, and post-operative complications like leakage, and stricture formation.

2.2. Techniques

As the classc steps of whipple with focusing on some steps as follow: a) pancreaticoduodenectomy with stent fixed by 6% PDS that detach spontaneously in the lumen of jujenum. b) loop arrangement gastrojejunstomy and pan-creaticoduodenectomy in the same loop and hep-aticojejonostomy on isolated loop. c) Feeding jujenostomy with benefit of early feeding postoperatively.

2.3. Statistical analysis

Collecting, tabulating, and statistically analyzing all data was done in SPSS 22.0 for Windows (SPSS Inc., Chicago, IL, USA). The Shapiro–Wilk test was used to determine if the data followed a normal distribution. Quantitative data was shown as per-centages and frequencies, whereas qualitative data was shown in frequency charts. Distinction between qualitative variables was determined using the Chi-square ($\chi 2$) test and the Fisher exact test, as shown. In the case of parametric data, the results were presented as a mean ± SD, whereas nonparametric data were given as a median and range.

Parametric quantitative variables were compared using the Independent T test, while nonparametric variables were compared using the Mann Whitney

Table 1. Demographic characteristics among the studied groups.

	Duct-to-mucosa PJ ($n = 15$)	Invagination PJ ($n = 15$)	t	*P*
Age (years) Mean ± SD	54.15 ± 6.99	56.28 ± 8.61	0.744	0.463
Gender				
Female	3 (20%)	4 (26.7%)	χ^2 0.186	0.666
Male	12 (80%)	11 (73.3%)		
BMI (kg/m^2) Mean ± SD	27.48 ± 2.67	28.13 ± 3.14	0.611	0.546
Symptoms				
Jaundice	14 (93.3%)	13 (86.7%)	0.371	0.543
Abdominal pain	8 (53.3%)	10 (66.7%)	0.556	0.456
Loss of weight	12 (80%)	11 (73.3%)	0.186	0.666
Preoperative steatorrhea	4 (26.7%)	5 (33.3%)	0.159	0.691
Preoperative DM	5 (33.3%)	6 (40%)	0.144	0.705
Preoperative biliary drainage	4 (26.7%)	5 (33.3%)	0.159	0.691
Preoperative albumin	3.91 ± 0.531	4.04 ± 0.522	0.676	0.505
Preoperative bilirubin	9.14 ± 5.62	10.97 ± 6.29	0.840	0.408

This table shows that the two studied groups were comparable regarding age, sex, BMI, symptoms, and preoperative albumin and bilirubin without significant difference between the groups.

Table 2. Operative data distribution among the studied groups.

	Duct-to-mucosa PJ ($n = 15$)	Invagination PJ ($n = 15$)	t	*P*
Mean mass (cm) Mean ± SD	3.54 ± 1.27	3.65 ± 1.36	0.229	0.821
Pancreatic duct D. (mm) Mean ± SD	6.47 ± 2.76	5.14 ± 2.35	1.42	0.166
Cirrhotic liver	1 (6.7%)	2 (13.3%)	0.371	0.543
Pancreatic consistency				
Firm	6 (40%)	7 (46.7%)	0.136	0.713
Soft	9 (60%)	8 (53.3%)		
Operative time (hrs) Mean ± SD	5.35 ± 1.14	4.76 ± 0.951	1.54	0.135
Anastomosis time (min) Mean ± SD	38.75 ± 10.54	25.18 ± 8.65	**3.85**	**0.001**
Blood loss Mean ± SD	878.49 ± 851.62	613.57 ± 756.28	0.901	0.375

This table shows that there was a significant difference between the groups regarding anastomosis time.

Table 3. Postoperative data among the studied groups.

	Duct-to-mucosa PJ ($n = 15$)	Invagination PJ ($n = 15$)	$\chi 2$	P
Hospital stay (days) Mean ± SD	15.84 ± 7.31	14.39 ± 6.45	0.576	0.569
Drain removal (days) Mean ± SD	11.7 ± 4.65	8.52 ± 3.88	2.03	0.052
Amount of draining (ml) Mean ± SD	11,269 ± 6854	17,864 ± 10,635	2.02	0.053
Drain amylase (U/L) Mean ± SD	315.13 ± 459.62	247.83 ± 392.66	0.431	0.686
POPF classification	*N* (%)	*N* (%)		
Grade A	0 (–)	2 (13.3%)	6.23	0.101
Grade B	1 (6.7%)	4 (26.7%		
Grade C	2 (13.3%)	0 (–)		
Complication	*N* (%)	*N* (%)		
Pancreatitis	5 (33.3%)	2 (13.3%)	1.68	0.196
Biliary leakage	5 (33.3%)	2 (13.3%)	1.68	1.96
Delayed gastric empty	4 (26.7%)	3 (20%)	0.186	0.666
Internal hemorrhage	0 (000%)	1 (6.7%)	1.15	0.284
Wound infection	4 (26.7%)	2 (13.3%)	0.833	0.361
Pulmonary complications	3 (20%)	1 (6.7%)	1.15	0.284
SIRS	1 (6.7%)	0 (–)	1.03	0.311
Mortality	0 (0000)	1 (6.7%)	1.15	0.284

Table 4. Basic characteristics among the studied groups.

	End to side PJ ($n = 15$)	End to end PJ ($n = 15$)	t	P
Age (years) Mean ± SD	56.62 ± 7.51	55.42 ± 7.12	0.449	0.657
Gender				
Female	5 (33.3%)	7 (46.7%)	χ^2 0.556	0.456
Male	10 (66.7%)	8 (53.3%)		
BMI (kg/m^2) Mean ± SD	27.63 ± 2.41	27.51 ± 2.82	0.125	0.901
Operative time (min) Mean ± SD	472.63 ± 91.56	485.71 ± 96.87	0.381	0.708
Blood loss Mean ± SD	841.3 ± 926.5	875.26 ± 1056.7	0.094	0.926
Hospital stay (days) Mean ± SD	16.84 ± 6.31	16.39 ± 6.25	0.196	0.846
Drain removal (days) Mean ± SD	12.13 ± 5.22	11.72 ± 4.89	0.222	0.826
Drain amylase (U/L) Mean ± SD	368.26 ± 255.38	351.25 ± 267.54	0.367	0.717

This table shows that there is no significant difference between the groups.

test. In all cases, we used two tailedo testing to determine statistical significance. If the P value is less than and equal 0.05, the difference is statistically significant; if it's greater than 0.05, it's not.

3. Results

Tables 1–3.

In terms of postoperative data and complications, there was no statistically significant difference

Table 5. Postoperative complications among the studied groups.

	End to side PJ ($n = 15$)	End to end PJ ($n = 15$)	$\chi 2$	P
POPF classification	*N* (%)	*N* (%)		
Grade A	1 (6.7%)	1 (6.7%)	0.373	0.830
Grade B	1 (6.7%)	2 (13.3%)		
Complication	*N* (%)	*N* (%)		
Pancreatitis	1 (6.7%)	2 (13.3%)	0.371	0.543
Biliary fistula	1 (6.7%)	0 (–)	1.03	0.311
Enteric fistula	0 (–)	2 (13.3%)	2.14	0.143
Delayed gastric empty	0 (–)	1 (6.7%)	1.03	0.311
Internal hemorrhage	1 (6.7%)	1 (6.7%)	–	1
Wound infection	3 (20%)	2 (13.3%)	0.24	0.624
Intraabdominal fluid collection	3 (20%)	4 (26.7%)	0.186	0.666
Mortality	0 (–)	1 (6.7%)	1.03	0.311

This table shows that there was no significant difference between the groups regarding postoperative complications.

between the groups, as shown in the table Tables 4 and 5.

4. Discussion

Pancratectomy Indicated mostly for periampullary disorders, pancreaticoduodenectomy (PD) is a difficult, high-risk conventional كلمه حذفتها surgery. Postoperative mortality and morbidity are at the heart of the discipline of PD. While operational mortality has gone down for PD patients, post-operative morbidity rates still stay high around (45–50 persent)[12,13]

The main results of this study were as follows:

POPF classification	*N* (%)	*N* (%)		
Grade B	2 (13.3%)	1 (13.3%)	2.17	0.339
Grade C	2 (13.3	0 (13.3%)		
Complication	*N* (%)	*N* (%)		
Pancreatitis	4 (26.7%)	3 (20%)	0.186	0.666
Biliary fistula	2 (6.7%)	1 (6.7%)	–	1
Delayed gastric empty	5 (33.3%)	3 (20%)	2.14	0.143
Internal hemorrhage	3 (20	2 (13.3%)	0.240	0.624
Wound infection	4 (26.7%)	5 (33.3%)	0.159	0.690
Pulmonary complications	2 (13.3%)	4 (26.7%)	0.833	0.361
Cardiac complications	2 (13.3%)	3 (20%)	0.240	0.624
Mortality	1 (6.7%)	1 (6.7%)	–	1

In the current study, no significant differences were found between the two groups with respect to age, sex, BMI, symptoms, or albumin and bilirubin levels before surgery, whether the PJ was performed by duct-to-mucosa or invagination.

Anastomosis time was found to be significantly different across the groups tested, whereas there were no statistically significant differences between the groups in terms of operative mean mass, pancreatic duct width, cirrhotic liver, pancreatic consistency, operating duration, or blood loss.

No significant differences were seen in the post-operative data or complications of the study groups. In line with the current study, **Singh** et al.[14] conducted a randomized trial comparing the two most popular PJ procedures (duct-to-mucosa and dunking) and included 193 patients (97 in the duct-to-mucosa group and 96 in the dunking group). The demographic and clinical characteristics of the two groups were similar from the outset. Among all participants, the research found a 23.8 percentage prevalence of POPF. A comparison of the 2 groups reveals no statistically significant distinction (24.7 percent vs. 22.9 persent, $P = 0.71$). As expected, there was no statistically significant difference in the rates of POPF of grades B and C (clinically relevant) POPF was comparable (16.5% vs 13.5%, $P = 0.57$). The secondary results were similar across the two groups. The current study also compared the outcome of End-to-side PJ and End-to-end PJ, each technique included 15 patients each, there were no significant differences between the studied groups as regard age, sex, BMI, symptoms, and preoperative albumin and bilirubin.

No statistically significant difference in post-operative complications was seen between the groups. Our results were supported by **Xiang** et al.[15] enrolled 263 patients who underwent pancreaticoduodenectomy divided into two groups: Group A, who underwent end-to-end invagination pancreaticojejunostomy with discontinuous U suture ($n = 176$); and Group B, who underwent end-to-side duct-to-mucosa pancreaticojejunostomy ($n = 87$). The study revealed that the median surgical time in the U-suture group was 5.50 (1.00) hours, shorter than 7.00 (2.75) hours in the duct-to-mucosa group ($P = 0.000$). The median intraoperative blood loss volumes significantly differed between the two procedures (U-suture group: 300.00 (400.00) ml, duct-to mucosa group: 400.00 (500.00) ml; $P = 0.037$). The rates of clinically relevant pancreatic fistula were as follows: cohort as a whole, 5.32%; U-suture group, 2.84%; and duct-to–mucosa group, 10.34%. The rates of clinically relevant and grade B pancreatic fistulas were significantly lower in the U-suture group ($P = 0.017$ and $P = 0.017$, respectively). The 2 groups did not significantly differ in other factors ($P > 0.05$). The study concluded that End-to-end invagination pancreaticojejunostomy with discontinuous U suture can evidently decrease the rates of clinically relevant and Grade B pancreatic fistulas, with no increase in other complications, and with a shorter surgical time and less intraoperative blood loss. The U-suture technique is a safe, relatively easy anastomotic method with great clinical value.

The current study also compared the outcome of Triple anastomosis and PG techniques, each technique included 15 patients each, there were no significant differences between the studied groups as regard age, sex, BMI, symptoms, and preoperative albumin and bilirubin.

The study revealed that there was no significant difference between the groups regarding post-operative complications.

Our research is the first to directly compare the success rates of PG and Triple anastomosis following PD.

Hayama et al.,[16] who set out to compare DGE rates after pancreaticojejunostomy (PJ) and pancreaticogastrostomy (PGG), corroborated our findings (PG). Overall, 83 participants were included in the study, split evenly between the PJ ($n = 46$) and PG ($n = 37$) groups. Preoperative cholangitis/biliary drainage was not associated

with any demographic variables (mean age, gender ratio, or body mass index). Pancreatic cancer was the most common underlying illness in the PG group. When comparing the PJ group to the PG group, the surgical duration was substantially longer for the PJ group and the intraoperative blood loss was significantly lower (p less than 0.001 and 0.99, respectively). The incidence of surgical complaints was similar across the two kinds of reconstruction, with the exception of DGE, which occurred more frequently in the PG group than in the PJ group (40.5 percent vs. 17.4 persent, respectively, $P = 0.019$). Notably, pancreaticogastrostomy patients tended to experience delayed gastric emptying with intraabdominal problems more frequently than patients without the procedure (36.8 percent vs. 66.7 persent, respectively, $P = 0.07$). PG had a higher prevalence of DGE with PF in particular (37.5 percent vs. 100 persent, respectively, $P = 0.013$).

However, **Pandey** et al.[17] contrasted PJ and PG as reconstructive techniques for PD. With a p value of 0.027, the study found that pancreatic fistula was considerably lower in the PG group than in the PJ group (24% vs. 47%). Just three percent of PG participants had a clinically relevant (grade B) fistula, compared to 32percent of PJ participants. Post-pancreatectomy hemorrhage (PPH) and delayed stomach emptying were more common in the PG group (DGE). There was no statistically significant difference between the two groups in terms of 1 month and three months mortality, ICU stays, re-exploration, readmissions, or length of hospital stays.

4.1. Conclusion

In conclusion; After a Whipple pancreaticoduodenectomy, duct-to-mucosa and Invagination PJ were both secure and reliable methods of pancreatic duct anastomosis. Comparing Ductto-Mucosa PJ to Invagination PJ, shorter Anastomosis time was found to be linked. Regarding surgical outcome, duct-to-mucosa and invagination PJ were comparable.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

Conflicts of interest

The authors declared that there were NO conflicts of Interest.

References

1. Fingerhut A, Vassiliu P, Dervenis C, Alexakis N, Leandros E. What is in a word: pancreatoduodenectomy or pancreaticoduodenectomy? *Surgery*. 2007 Sep 1;142(3):428–429.
2. Sun J, Yang Y, Wang X, et al. Meta-analysis of the efficacies of extended and standard pancreatoduodenectomy for ductal adenocarcinoma of the head of the pancreas. *World J Surg*. 2014;38:2708–2715.
3. Cameron JL, Riall TS, Coleman J. 1000 consecutive pancreaticoduodenectomies. *Ann Surg*. 2006;244:10–15.
4. Clancy TE. Surgery for pancreatic cancer. *Hematol/Oncol Clin*. 2015;29:701–716.
5. Korc M, Jeon CY, Edderkaoui M, Pandol SJ, Petrov MS. Tobacco and alcohol as risk factors for pancreatic cancer. *Best Pract Res Clin Gastroenterol*. 2017;31:529–536.
6. Wolff RA. Adjuvant or neoadjuvant therapy in the treatment in pancreatic malignancies: where are we? *Surg Clin*. 2018;98: 95–111.
7. Passeri MJ, Baker EH, Siddiqui IA, et al. Total compared with partial pancreatectomy for pancreatic adenocarcinoma: assessment of resection margin, readmission rate, and survival from the US National Cancer Database. *Curr Oncol*. 2019; 26:346–356.
8. Rankin MM, Wilbur CJ, Rak K, Shields EJ, Granger A, Kushner JA. β-Cells are not generated in pancreatic duct ligation-induced injury in adult mice. *Diabetes*. 2013;62: 1634–1645.
9. Wolfgang CL, Herman JM, Laheru DA, et al. Recent progress in pancreatic cancer. *CA A Cancer J Clin*. 2013;63: 318–348.
10. van der Wilden GM, Yeh DD, et al. Trauma Whipple: do or don't after severe pancreaticoduodenal injuries? An analysis of the National Trauma Data Bank (NTDB). *World J Surg*. 2014; 38:335–340.
11. Zhao X, Cui N, Wang X, Cui Y. Surgical strategies in the treatment of chronic pancreatitis: an updated systematic review and meta-analysis of randomized controlled trials. *Medicine*. 2017;96:9.
12. Andrianello S, Marchegiani G, Malleo G, et al. Pancreaticojejunostomy with externalized stent vs pancreaticogastrostomy with externalized stent for patients with high-risk pancreatic anastomosis: a single-center, phase 3, randomized clinical trial. *JAMA Surg*. 2020;155:313–321.
13. Cheng Y, Briarava M, Lai M, et al. Pancreaticojejunostomy versus pancreaticogastrostomy reconstruction for the prevention of postoperative pancreatic fistula following pancreaticoduodenectomy. *Cochrane Database Syst Rev*. 2017;(9): 1–57.
14. Singh AN, Pal S, Mangla V, et al. Pancreaticojejunostomy: does the technique matter? A randomized trial. *J Surg Oncol*. 2018;117:389–396.
15. Xiang Y, Sheng J, Yang Y, et al. End-to-End invagination pancreaticojejunostomy with discontinuous U suture in pancreaticoduodenectomy. Available at SSRN 4248629.
16. Hayama S, Senmaru N, Hirano S. Delayed gastric emptying after pancreatoduodenectomy: comparison between invaginated pancreatogastrostomy and pancreatojejunostomy. *BMC Surg*. 2020;20:1–7.
17. Pandey AK, Sharma AK, Singh KJ, et al. To compare the outcomes of pancreaticojejunostomy and pancreaticogastrostomy reconstruction after pancreaticoduodenectomy: a prospective observational study. *Med J Armed Forces India*. 2023;79:64–71.