

Initial Experience of Pancreaticoduodenectomy in a Newly Developed Hepato-Pancreato-Biliary Unit Serving in a Lower-Middle-Income Country

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Abstract

Introduction: Pancreaticoduodenectomy (PD) is the only potentially curative treatment for pancreatic head adenocarcinoma. This study aimed to determine the short-term outcomes of PD performed over 1 year at a newly established hepato-pancreato-biliary unit in Khyber Pakhtunkhwa province of Pakistan. **Material and Methods:** A retrospective analysis of a prospectively maintained hospital information system (HIS) was undertaken of all patients referred to the unit between May 2021 and August 2022. Data were collected from the medical records of patients in the HIS. Data were analyzed for primary location, age, complications, and operative parameters. **Results:** The primary sites of disease were ampulla ($n = 18$, 52.9%), pancreas ($n = 11$, 32.4%), and duodenum ($n = 5$, 14.7%). The median duration of surgery was 7 h. 16 (47.1%) patients required blood transfusion either intraoperatively or in the perioperative period. Patients with pre-operative biliary drainage (PBD) were more likely to have multidrug-resistant positive bile cultures with a P -value of 0.2 ($n = 12$ [35.3%] vs. $n = 5$ [14.7%]). Overall morbidity was 38.2%. The most common complications were wound infection ($n = 12$, 35.3%), delayed gastric emptying ($n = 6$, 17.6%), and type B pancreatic fistula ($n = 3$, 8.8%). The complication rate was higher in patients with biliary stenting ($n = 11$ [32.4%] vs. $n = 2$ [5.9%]; $P = 0.06$). The median length of hospital stay for patients without complications was less (6 vs. 12 days; $P < 0.001$). The complication rate was lower in total laparoscopic PD (TLPD) with $P = 0.4$ (TLPD: 2.9%, open: 23.5%, laparoscopic assisted: 11.8%). 90-day mortality was zero. **Conclusion:** Short-term outcomes for PD in our facility are comparable to high-volume centers. PBD can significantly increase operative time, hospital stay, and morbidity.

Keywords: Pancreaticoduodenectomy, post-operative pancreatic fistula, pre-operative biliary drainage, total laparoscopic pancreaticoduodenectomy, Whipple's procedure

Introduction

Pancreaticoduodenectomy (PD), also called the Whipple surgery, is a complex procedure involving meticulous dissection and extensive reconstruction introduced by Allen Whipple in 1935.^[1] The only treatment with a chance of curing pancreatic head adenocarcinoma is PD. Other pancreatic head tumors, tumors of the ampulla of Vater, common bile duct (CBD), and, infrequently, chronic pancreatitis may also be managed with it.^[2] PD mortality is 5% and has decreased to <1–2% in high-volume centers, but post-operative morbidity is still significantly high and affects about 52% of patients. The most common complications included delayed gastric emptying (DGE) (16%), post-operative pancreatic fistula (POPF) (9%), and surgical site complications (12%).^[3,4] The dramatic decline in PD mortality is attributable to advancements in anesthesia, intensive care units, and other aspects of critical care surgery. However, surgical specialization has played a more significant role.^[5]

Total laparoscopic PD (TLPD) has become one of the most complex and challenging laparoscopic procedures.^[6] The learning curve for TLPD is steep. The advantages of TLPD over open PD (OPD) are debatable. The objective of using a TLPD is to reduce post-operative complications and recovery time while preserving quality oncologic outcomes.^[7]

In May of 2021, we initiated hepato-pancreatico-biliary (HPB) services at our non-profit cancer hospital, Shaukat Khanum Memorial Cancer Hospital and Research Centre (SKMCH&RC) in Peshawar city of Khyber Pakhtunkhwa (KPK) province in Pakistan. The unit was led by a surgeon who had completed his higher surgical training with a Certificate of Completion of Training from Oxford Deanery in the United Kingdom (UK) with a sub-specialist interest in HPB surgery. In addition, the surgeon completed a fellowship at Queen Elizabeth Hospital, Birmingham, UK, in HPB and liver transplantation. The KPK province is considered resource limited, with scattered health-care facilities and multiple barriers limiting access

to health care. Since there is not an established oncological HPB unit in KPK, multiple challenges had to be overcome including establishing a reliable supply chain, procurement of specialized equipment, and training of the workforce in complex HPB surgery. The initial period of the unit was dedicated to setting up patient pathways, including post-operative protocols, creating a fellowship program, and integrating allied health-care professionals. This study was undertaken to analyze the outcomes of the unit in its first year and compare the results to those benchmarked by well-established units.

Material and Methods

This retrospective study was conducted between May 2021 and August 2022 on all patients who were referred to the unit at SKMCH&RC, Peshawar, with an indication for PD. The study was approved by the Institutional Review Board of the hospital.

Data collection

Data were collected from a prospectively maintained hospital information system. All patients referred to our hospital are initially discussed in a multidisciplinary team (MDT) meeting on a weekly basis. Resectability is based on NCCN guidelines.^[8] Data recorded included demographics and pre-operative and perioperative parameters. The pre-operative parameters studied included biochemical profile, hematologic studies, tumor markers, endoscopic retrograde cholangiopancreatography (ERCP), endoscopic ultrasound (EUS), and the need for biliary stenting. Perioperative parameters included operative time, dissection difficulty, stent-related complications, portal vein resection, pancreatic texture, pancreatic duct size, and blood transfusion. Post-operative parameters included surgical site infection (SSI), POPF, DGE, bile leak, re-operation, thromboembolic complications, readmission within 30 days, length of hospital stay, and 90-day mortality.

From the final post-operative histopathology report, pathological factors including tumor

location, margin involvement, histological differentiation (good, moderate, and poor), and tumor-node-metastasis stage were extracted. The pathologist routinely comments on the pancreatic neck, bile duct, and uncinate margins for tumor involvement. Gross involvement is classed as R2, < 1 mm is classed as R1, and more than 1 mm is classed as R0. The maximal tumor size was defined as the maximum diameter at histopathological examination. The presence of microscopic tumor in the lymphovascular and perineural tissues of contiguous normal tissue surrounding the tumor was defined as lymphovascular and perineural invasion.

The existence of glucose intolerance requiring diet modification and oral antidiabetics or insulin use within 2 years of the diagnosis of a pancreatic tumor was defined as new-onset diabetes mellitus. Patients gave a rough estimation of their weight loss at the pre-operative consultation and subsequently monitored on subsequent visits with input from a trained nutritionist where needed. POPF was defined and graded according to the International Study Group of Pancreatic Fistula. Postoperatively patients were started on a normal diet as per tolerance, and drain amylase was tested on the 3rd post-operative day. Type A POPF (biochemical leak) was diagnosed when drain amylase levels were 3 times the upper limit of normal serum at any volume. Grade B POPF was defined as drains that were left *in situ* for >3 weeks or required endoscopic or percutaneous interventions. Grade C POPF was defined as necessitating reoperation, leading to organ failure and/or death attributed to the pancreatic fistula.^[9] DGE was defined as the inability to return to a normal diet by the end of the 1st post-operative week after PD or the reinsertion of a nasogastric tube before this period.^[10]

Pre-operative workup

All patients underwent a pre-operative workup for anesthetic fitness. This included a complete blood count, liver profile, renal profile, serum electrolytes, coagulation studies, electrocardiography, and

a chest X-ray for all patients who were planned to undergo PD. All patients underwent a pre-rehabilitation program that included optimization of diet and regular exercises. Pre-operative triphasic computed tomographic (CT) scan, EUS, and in one case, magnetic resonance imaging liver were done to rule out liver metastasis. Positron emission tomogram scans are not routinely undertaken at our institution unless there is a specific indication. All patients who were jaundiced and required neoadjuvant therapy or had evidence of cholangitis underwent a pre-operative ERCP with biliary stent insertion.

Operative techniques

The World Health Organization perioperative checklist was undertaken for all patients before starting surgery. All patients receive piperacillin and tazobactam 30–60 min before the skin incision. Laparoscopy is routinely used to determine tumor resectability and to look for liver and peritoneal metastases. For OPD, a rooftop incision is made, and the lesser sac is opened followed by Kocher maneuver. The duodenum (pylorus-preserving PD) and stomach (classic PD) are then transected. The common hepatic artery lymph node is dissected, the gastroduodenal artery is ligated, and CBD is divided above the insertion of the cystic duct. The jejunum is then mobilized and transected distal to the ligament of Treitz and delivered to the right hypochondrium. The pancreatic neck is transected with a surgical scalpel and monopolar cautery in open surgery, whereas harmonic or ligasure is used in laparoscopic PD. The specimen is then dissected off the portal vein and retrieved. The degree of dissection difficulty, post-ERCP pancreatitis, texture of the pancreatic parenchyma, and pancreatic duct size are various factors the surgeon considers when doing the resection. We perform a modified Blumgart pancreaticojejunostomy over a pancreatic stent (feeding tube) for both laparoscopic and open Whipple operations. Three interrupted transpancreatic sutures are taken using Prolene 3/0, and Prolene 4/0 is used for the duct-to-mucosa anastomosis. The hepaticojejunostomy is done in an end-to-side anastomosis fashion

using polydioxanone (PDS) 3/0, followed by a duodeno- or gastrojejunostomy in a single continuous layer using PDS 3/0. Two Jackson-Pratt drains are placed anterior and posterior to the pancreatojejunostomy in all patients.

Post-operative management

All patients are shifted to a monitored bed postoperatively once cleared by an anesthesia team. Antibiotics and octreotide are given to all patients. Oral feeding is initiated usually by the 1st post-operative day and progresses as tolerated. Serum amylase is checked on post-operative day 1 for post-pancreatectomy remnant pancreatitis. Drain amylase is checked on days 3 and 5. To detect any intra-abdominal collections, imaging studies such as ultrasonography and CT scanning were performed as indicated. Patients are discharged once discharge criteria are met. Follow-up clinic visits were scheduled for 1 week, 1 month, 3 months, 6 months, and at 1 year postoperatively. Specific questions and investigations tailored for the assessment of exocrine/endocrine dysfunction were undertaken at each appointment. Patients were also scheduled into clinics if they experienced symptoms in between follow-up appointments. All patients were referred for assessment of adjuvant chemotherapy to the Medical Oncology Department.

Statistical analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences for Windows, version 26. For continuous variables, descriptive statistics were calculated and expressed as the medians and ranges. Categorical variables

were expressed by numbers and percentages and compared using a Chi-squared test (or Fisher's exact test). Continuous variables were compared using analysis of variance. $P < 0.05$ was considered to be statistically significant.

Results

A total of 40 patients were scheduled to undergo Whipple's procedure with an intention of curative resection after being discussed in the MDT at SKMCH&RC, Peshawar. The age of the patients at the time of presentation ranged from 18 to 74 years (mean: 46.68 years). Periampullary adenocarcinoma was the most common indication for PD, as shown in Table 1. Abdominal pain, jaundice, and weight loss were the most common presenting symptoms. Hypertension and diabetes mellitus were the most common comorbidities [Table 2].

About 73.5% of the patients had some stigmata of malnutrition, and 58.8% of the cohort had hemoglobin levels below the reference range indicating anemia. CA19-9 levels were found to be elevated in 64.7% of patients. Obstructive jaundice was found in 52.9% of the cohort represented by elevated serum bilirubin. The majority of the patients (61.8%) underwent ERCP and stenting before surgery, though the majority of the stenting was carried out before their presentation at our institution [Table 3].

Out of the 40 patients who were scheduled for curative intent PD, laparoscopy identified five patients (14.7%) with liver metastasis and one patient (2.94%) with omento-peritoneal spread.

Table 1: Summary of the tumor location and type of the study participants (n=34)

Variables	Ampulla 18 (52.9%)	Pancreatic 11 (32.4%)	Duodenal 5 (14.7%)	Total
Adenocarcinoma	17 (50%)	8 (23.5%)	5 (14.7%)	30 (88.2%)
Solid pseudopapillary	0	2 (5.9%)	0	2 (5.9%)
Neuroendocrine tumor	1 (2.9%)	0	0	1 (2.9%)
IPMN	0	1 (2.9%)	0	1 (2.9%)

IPMN: Intraductal papillary mucinous neoplasm

Table 2: Summary of the demographics, clinical symptoms, and medical history of the study participants (n=34)

Variable	Value, n (%)
Age	46.68 (18-74)
Mean (Range)	
Gender	
Male	18 (52.9)
Female	16 (47.1)
Symptoms	
Pain	30 (88.2)
Jaundice	22 (64.7)
Anorexia and weight loss	19 (55.9)
Vomiting	14 (41.2)
Fever	7 (20.6)
Diabetes	3 (8.8)
Steatorrhea	1 (2.9)
Comorbidity	
Hypertension	6 (17.6)
Diabetes mellitus	4 (11.8)
Asthma	1 (2.9)
Chronic kidney disease	1 (2.9)

In 30 patients (88.2%), pylorus-preserving PD was performed, whereas classic PD was performed in four patients (11.7%). The median duration of surgery was 7 h and 17 min (mean, 7 h and 18 min). Four patients had sealed off duodenal perforation on intraoperative findings (post-ERCP), and 16 (47.1%) had difficult dissection due to presumed stent-related pancreatitis. There was a statistically significant difference between the average blood loss in patients with and without biliary stent-related complications (700 mL vs. 330 mL; $P = 0.004$). A mean transfusion of 0.8 U of packed red blood cells was needed for surgery (median: 0; range: 0-8). The mean blood loss was 370 mL (median: 300 mL). Two of the 34 patients with pancreatic adenocarcinoma underwent portal vein resection after having completed neoadjuvant chemotherapy for borderline resectable pancreatic cancer.

We conducted a subset analysis of the pathologic characteristics of periampullary adenocarcinomas, including tumor diameter, differentiation, lymphovascular invasion, perineural invasion,

Table 3: Pre-operative and intraoperative parameters of the study participants (n=34)

Variable	n (%)
Total bilirubin, mg/dL, Median (IQR)	1.2 (0.6–7.2)
Albumin, U/L, Median (IQR)	4.18 (3.7–4.5)
Hemoglobin, g/dL, Median (IQR)	12.6 (10.4–13.8)
WBC, cells/mL, Median (IQR)	7.8 (6.3–9.08)
CA 19-9, serum U/mL, Median (IQR)	38.2 (16–272)
Pre-operative ERCP	21 (61.8)
Pancreatic duct, median (IQR)	3 mm (2.38–3)
Pancreatic texture	
Soft	10 (29.4)
Medium	15 (44.1)
Hard	9 (26.5)
Difficult dissection	16 (47.1)
Duodenal perforation	4 (11.8)
Portal vein resection	2 (5.9)
Blood transfusion	16 (47.1)
Operative time (hh: mm), Mean (Range)	7:17 (4:46–11:00)
HDU days, median (IQR)	2 (1–2)
Length of hospital stay, Median (IQR)	6 (6–10.5)

WBC: White cell count, HDU: High dependency unit, ERCP: Endoscopic retrograde cholangiopancreatography, IQR: Interquartile range

margin status, lymph node involvement, and recurrence. Statistically, the mean tumor diameter varied by the periampullary adenocarcinoma subtype ($P < 0.001$). The average diameter of all tumors was 2.8 cm (range: 0.55-9.5). The overall yield of lymph nodes was 16. Twenty (50.8%) out of 30 cases of periampullary adenocarcinoma had positive lymph nodes on final histology. Periampullary adenocarcinoma subset was characterized by lymphovascular invasion (26.4%), perineural invasion (14.7%), and recurrence (23.5%). There was a statistically significant difference in perineural invasion according to periampullary adenocarcinoma diagnosis ($P = 0.02$) [Table 4]. More than 94% of patients had a negative margin status.

Overall morbidity was 38.2% ($n = 13$). The most common complication was superficial SSI, followed by DGE and type B POPF. In one case, relook operation was carried out for

Table 4: Tumor characteristics of periampullary adenocarcinoma of the study participants

Variables	Ampulla (n=17)	Pancreatic (n=8)	Duodenal (n=5)	Total (30)	P-value
Diameter, Mean±SD, cm	1.70±0.9	3.59±1.5	4.66±1.02		<0.001
Differentiation					
Well	3	2	1	6	
Moderate	12	5	3	20	
Poor	2	1	1	4	
Margin status					
R0	17	6	5	28	0.3
R1	0	1	0	1	
R2	0	1	0	1	
Positive node status	12	5	3	20	0.3
Perineural invasion	0	4	1	5	0.02
Lymphovascular invasion	5	3	1	9	1.0
Recurrence	3	5	0	8	0.3

SD: standard deviation

periportal hematoma. In one case, there was a gastrojejunostomy site ulcer bleed requiring upper gastrointestinal (GI) endoscopy for clip ligation of a small ulcerated vessel. Type C POPF rate was zero in our study. Three patients were readmitted; two of them experienced fever related to collection, which was managed conservatively, and one of them developed gastroparesis, for which a nasojejunal tube was inserted [Table 5].

The complication rate was high in patients with pre-operative biliary drainage (PBD) as compared to patients who had no PBD (32.4% vs. 5.9%; $P = 0.06$). 50% of the patients had positive bile cultures for multidrug resistance (MDR) bacteria. Patients with biliary stenting were more likely to have MDR bile cultures than those without stenting (35.3% vs. 14.7%; $P = 0.29$). The median length of stay in the hospital for patients without post-operative complications was 6 days, compared to 12 days for those with post-operative complications ($P < 0.001$). One case of a conservatively managed bile leak (type B) following a hematoma evacuation with a hospital stay of 34 days and one case of systemic fungal infection (patient was intraoperatively found to have a sealed perforation related to ERCP stent

Table 5: Details of the post-operative complications

Variable	Total number	Percentage
SSI	12	35.3
Delayed gastric emptying	6	17.6
Type B POPF	3	8.8
Acute kidney injury	2	5.9
Fungal infection	2	5.9
Organ SSI	2	5.9
Bile leak requiring Relook operation	1	2.9
DVT	1	2.9
Pulmonary embolism	1	2.9

SSI: Surgical site infection, POPF: Post-operative pancreatic fistula, DVT: Deep vein thrombosis

insertion) with a hospital stay of 36 days merit special mention. Both patients received Total Parenteral Nutrition (TPN) till they tolerated oral diet and were discharged home with no further complications.

In our cohort, the complication rate was less in TLPD (2.9%) as compared to open (23.5%) and laparoscopic assisted (11.8%), but this difference was not statistically significant ($P = 0.4$) [Table 6].

Table 6: Breakdown of the comparison between laparoscopic (n = 7), laparoscopic-assisted (n = 8), and open Whipple's procedure (n = 19)

Variables	Laparoscopic	Laparoscopic assisted	Open Whipple's	P-value
PS				
0	2	2	7	0.8
1	5	6	12	
Biliary stent	5	7	9	0.1
Operative time hh: mm (mean)	7: 31	7:47	7:03	0.53
Overall morbidity	2.9%	11.8%	23.5%	0.4
SSI	2	3	7	0.9
Type B POPF	1	0	2	0.4
Hospital stay, median (IQR)	6 (6–8)	6 (6–9)	7 (6–12)	0.7
Tumor location				
Ampulla	5	6	7	0.2
Pancreatic	0	0	5	
Duodenal	2	2	11	

PS: Performance status, SSI: Surgical site infection, POPF: Post-operative pancreatic fistula, IQR: Interquartile range

The median operative duration for TLPD was 7 h 30 min, compared to 7 h 15 min for OPD.

Three of the 34 patients who underwent PD had completed neoadjuvant chemotherapy for borderline resectable pancreatic cancer. CAPOX, gemcitabine plus capecitabine, and cisplatin plus gemcitabine regimens were used for these three patients. Of the remaining 31 patients, there was no indication for adjuvant chemotherapy in four patients, as per the oncologist. Four patients declined chemotherapy despite recovering uneventfully from surgery and being appropriately counseled. Out of the remaining 23 patients, 19 (82%) successfully completed adjuvant treatment. Six of the 19 patients in the adjuvant setup received CAPOX, and the remaining 13 received gemcitabine plus capecitabine. Four patients (17%) missed the chemotherapy window due to prolonged recovery from surgery. Overall, 90-day mortality in our sample was zero. Eight patients had recurrent disease within the 1st year of surgery.

Two patients passed away from recurrent disease-related issues at 120 days. All these patients had stigmata of poor biology on final histology [Table 7].

Discussion

PD is a difficult and complex procedure. Hospital mortality has decreased significantly as a result of improved anatomical knowledge, shorter operating times, less blood loss, better anticipation, and management of post-operative complications.^[3-5]

The selection of patients remains a crucial factor in reducing post-operative morbidity and mortality. Age, obesity, poor functional status, chronic obstructive pulmonary disease, leukocytosis, raised serum creatinine, prothrombin time/international normalized ratio, and hypoalbuminemia are significant predictors of morbidity.^[11] In our sample, the median age was 46 years, and 17.6% of patients were older than 60. The older age group tolerated the procedure and with virtually the same post-operative length of stay and incidence of complications as the younger age group. Therefore, age alone should not be a barrier to this surgery.

The impact of PBD on post-operative outcomes is still debatable. PBD before PD is associated with major post-operative morbidities, including infection, pancreatitis, and adhesions.^[12,13] About

Table 7: Summary of the characteristics of participants with recurrence

Site of recurrence	Margin status	Tumor size (cm)	Lymph nodes involved	CA19-9 levels	Time to recurrence from surgery (months)	Time death from surgery (months)
Local	R1	3	1	49	8	Alive
Local	R0	2.5	1	<1.2	9	13
Liver	R0	4	2	16	11	Alive
Local	R0	2.5	0	<1.2	6	Alive
Peritoneal	R2	4.6	11	5219	4	Alive
Peritoneal	R0	3.2	10	3459	2	3
Liver	R0	1.4	3	20	6	Alive
Brain	R0	4.5	10	267	3	4

61.8% of patients in our study underwent PBD. Our experience in patients undergoing PD surgery has shown that pre-operative ERCP makes dissection and separation of the pancreas from the portal vein more challenging, resulting in a longer operative time. We noticed a rising trend in the presence of MDR bacteria in intraoperative bile cultures from patients who had undergone ERCP and stenting, although these findings lacked statistical significance. Four out of 21 patients who underwent biliary stenting had sealed off duodenal perforation at the time of surgery. There was a statistically significant difference between the average blood loss in patients with and without duodenal perforation ($P = 0.004$). The mean blood loss was 370 mL (median: 300 mL) which is comparable to data published by other countries.^[5,14]

At our institution, TLPD has been proposed as a feasible alternative for OPD. In all cases, the pancreatic anastomosis was a modified Blumgart pancreaticojejunostomy. The median operative duration was 7 h 30 min which is lower than the data published in literature.^[6,7] The rate of complications was lower for TLPD (2.9%) than for open (23.50%) and laparoscopic-assisted (11.8%) procedures. The median hospitalization stay was 6 days. The most important aspect of performing a TLPD safely is to perform the procedure on carefully selected patients.^[15] In our experience, smaller tumors with fewer adhesions were amenable to laparoscopic removal. In our study, TLPD had a mean tumor

size of 1.6 cm compared to 3.3 cm for OPD. The frequency of PBD was lower in TLPD (23.8%) compared to open (42.9%) and laparoscopic-assisted PD (33.3%). According to our observations, adhesions from PBD cause difficult surgical planes, making TLPD more challenging.

The overall complication rate in our sample was 38.2% with a mortality rate of zero at 90 days. The complication rate was higher in patients with PBD as compared to patients who had no PBD (32.4% vs. 5.9%; $P = 0.06$). The majority of complications were minor and not life-threatening. In comparison to other studies published in Pakistan and other countries, the rate of post-operative complications and mortality is notably low.^[4,5,11,14,16-20] The difference can be attributed to the high volume of oncologic major resections at our center, better anesthesia, and an improved intensive care unit care. Nevertheless, surgical specialization may have played a larger role. At present, PD is frequently performed in centers by surgeons who specialize in hepatobiliary and pancreatic surgery. At our setup, familiarity with anatomy, decreased blood loss, improved anticipation, identification, and management of post-operative complications have all influenced the decline in hospital morbidity.

In our study, SSI (35.3%) was the most prevalent complication. However, this is attributed to PBD (29.4% vs. 5.9%; $P = 0.05$) and positive MDR bile cultures (23.5% vs. 11.8%; $P = 0.15$) in our sample

compared to patients who did not have PBD and MDR positive cultures. The SSI rate in our cohort is comparable to regional and international published data which ranged from 6% to 37.8%.^[3-5,7,16,17,20,21]

The second most common complication was DGE (17.6%) which was comparable to published studies, ranging from 14% to 36%.^[3-5,7,15] In five out of six cases, DGE was caused by other complications, such as systemic fungal infection, type B POPF, pancreatitis, and one instance of anastomotic site ulcer bleeding requiring an upper GI endoscopy.

In our study, 8.8% of our patients experienced pancreatic leakage when non-absorbable monofilament (Prolene 4/0) was used for duct-to-mucosa pancreaticojejunostomy and PDS 3/0 was used for transpancreatic sutures. Although the incidence of pancreatic leakage varies considerably between centers, ranging from 9% to 23%, our results are acceptable.^[3-5,7,11,14,16-19] Thromboembolism was seen in two patients with a hospital stay of more than 30 days. One patient with a bile leak had a segmental pulmonary embolism and a second patient with systemic fungal infection developed deep vein thrombosis despite being on venous thromboembolism prophylaxis and being mobilized. In both cases, the hospital stay was 34 and 36, respectively. The median in-hospital stay for patients without complications was 6 days, compared to 12 days for those with post-operative complications ($P < 0.001$).

PBD can significantly increase operative time, hospital stay, and morbidity. This necessitates further evaluation utilizing multivariate analysis. Modified Blumgart pancreaticojejunostomy technique has good short-term outcomes with low rates of POPF, but the long-term outcomes require further study. Long-term outcomes, recurrence, and survival in our system require additional analysis.

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Author Contributions

Conceived and designed the analysis: N, SIK; Collected the data: MHUR, MW; Contributed data or analysis tools: SIK; Performed the analysis: N, MHUR; Wrote the paper: N, AR, MW, AUK, SIK.