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Original Research Article

Reduction of pancreatic leak rate after pancreaticoduodenectomy by changing anastomotic and drainage techniques: a long-term single center experience

Mohamed M. Elsheikh*, Amir F. Abdelhamid, Hossam R. Moussa

Department of General Surgery, Faculty of Medicine, Tanta University, Egypt

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***Correspondence:**
Dr. Mohamed M. Elsheikh,
E-mail: mohamed.elsheikh@med.tanta.edu.eg

ABSTRACT

Background: Pancreaticoduodenectomy is the best curative option for malignant pancreatic head neoplasms with a high perioperative morbidity rate. Pancreatic leak is the most feared complication. This study was done to describe our early and late experience outcomes of PD after implementing technical modifications to decrease the postoperative incidence of pancreatic leak.
Methods: The data of 53 patients were collected and divided into two groups: the early experience group (27 cases) and the late experience group (26 cases). The main two modifications performed in late group were Heidelberg technique for pancreatojejunostomy anastomosis (all cases) and irrigation of the pancreatic anastomosis (selected cases).
Results: All preoperative demographic, clinical, laboratory, and intraoperative findings showed insignificant differences between the two groups ($p \geq 0.05$). Nonetheless, cases in the late group had shorter operative time, less intraoperative blood loss, and less need for blood transfusion ($p<0.05$). Postoperatively, the incidence of pancreatic leak decreased with technical modifications (11.54% vs. 37.04% in the early group). The late group showed earlier time to oral intake and shorter hospitalization periods. In-hospital mortality occurred in 14.81% of early cases secondary to pancreatic leak and subsequent secondary haemorrhage and multiorgan failure. Obesity ($p<0.001$), soft pancreas ($p<0.001$), and small pancreatic duct diameter ($p=0.007$) were significant predictors of pancreatic leak.
Conclusions: Surgical expertise and technical modifications play a crucial role in improving PD outcomes with less incidence of complications, earlier oral intake, and shorter hospitalization period.

Keywords: Pancreaticoduodenectomy, Early experience, Late experience, Technical modifications

INTRODUCTION

Pancreaticoduodenectomy (PD), which has been called a 'formidable' operation is a complex and demanding surgical intervention for both patients and healthcare systems.[1] Pancreatic adenocarcinoma is the most common type of pancreatic neoplasms especially the periampullary type, with an incidence of 1-4.3 per 100000 individuals in North Africa and 3.78 per 100000 individuals in Egypt.[2,3] It is the mainstay management option for resectable pancreatic neoplasm, as it offers the only chance for cure.[4] However, it is a complex and challenging surgical procedure as it entails many extirpative and reconstructive steps including dissection near to important vascular structures like the main portal vein and superior mesenteric vessels.[4,5] Despite advances in surgical techniques and intraoperative ergonomics, PD is still associated with significant perioperative morbidity

and mortality. The former ranged between 40% and 60%, while the average value was 5% for the latter.[6,7] Pancreatic fistula, or leakage, is the most common and dreadful adverse event after PD, with an incidence ranging between 5% and 64.3%.[8,9] Various risk factors have been described for post-PD pancreatic fistula including preoperative and intraoperative ones. Examples of the former include old age, male gender, malnutrition, and preoperative jaundice, whereas the latter include soft pancreas, small pancreatic duct, intraoperative blood loss, and less surgical expertise.[10] Shrikhande et al published an interesting technique of pancreatic anastomosis after PD 10 years ago.[11] Multiple technical modifications (such as Heidelberg technique for anastomosis and perianastomotic irrigation) and pharmacological options (somatostatin administration) have been proposed to decrease the incidence and the impact of that dreadful complication.[7,12,13] Moreover, the learning curve also plays a crucial role, as surgeons need more experience to perform that complex procedure to improve perioperative outcomes.[14] The purpose of this study was to report our early and late experience outcomes of PD after we had implemented some technical modifications in pancreaticojeujonostomy anastomosis and drainage irrigation technique to decrease the postoperative incidence of pancreatic leak.

METHODS

This retrospective study was conducted at Tanta University, Gastro-intestinal and Surgical Oncology Department. It was designed for patients who underwent open PD during the period between 2016 and 2023 (an eight-year period). After obtaining informed written consent, the data of these cases were collected and analysed. Patients with operable and resectable pancreatic adenocarcinoma, ampullary carcinoma, distal cholangiocarcinoma, and duodenal carcinoma were included in this study. Patient who underwent palliative surgical bypass due to locally advanced or advanced neoplasms (detected intraoperatively) were excluded from the current study. Fifty-three patients were eligible for our research and were divided into two groups; the early experience group (27 cases performed over three years) and the late experience group (26 cases performed over five years). According to our center protocol, the standard preoperative assessment included detailed history taking (focusing on presentation, medical comorbidities, neoadjuvant therapy, and preoperative biliary drainage), clinical assessment (focusing on complexion, body mass index BMI, and abdominal examination), and laboratory investigations (including liver function tests and tumour markers). Radiological assessment was done initially by transabdominal ultrasonography and then confirmed by abdominal computed tomography (CT) with IV contrast with thin pancreatic cuts (3ml pancreatic protocol cuts). Additionally, CT portography and mesenteric angiography were done to delineate the relationship between the tumour and the surrounding vasculature and relation with the tumour. Before the operation, the procedure with its complexity, expected morbidity, and mortality was explained to all patients, and their approval was documented in a written consent.

Abdominal exploration was done through bilateral subcostal incision or midline in patients with BMI less than 35 kg/m^2 patients. After excluding hepatic and peritoneal metastasis, the mass was assessed for respectability. Firstly, the duodenum was kocherized and that helped to identify if there was any vascular invasion by the primary neoplasm. The usual steps of resection were used in all cases. The pancreatic parenchyma was divided by a scalpel left to the mass and the pancreatic duct diameter was measured. The reconstructive phase started with the creation of pancreatico-jejunostomy (PJ). It was done in an end-to-side fashion. However, the reconstruction method differed between early and late cases. In our early experience, the anastomosis was created using the invagination technique using vicryl 3/0 in four layers anastomosis without pancreatic duct suturing with inner pancreatic edge to full thickness of jejunal layer, then, outer invagination anterior and posterior layers. In our late experience, we used the Heidelberg technique that was performed in four layers anastomosis using PDS 4/0 sutures; the outer layer between the pancreatic capsule layer and the seromuscular jejunal layer in inverted fashion and then, the inner layer between the pancreatic duct with 3 sutures applied posteriorly with full thickness of edge of pancreas with completion of whole layer with full jejunal wall thickness.[11] These steps were repeated anteriorly (Figure 1 and 2).

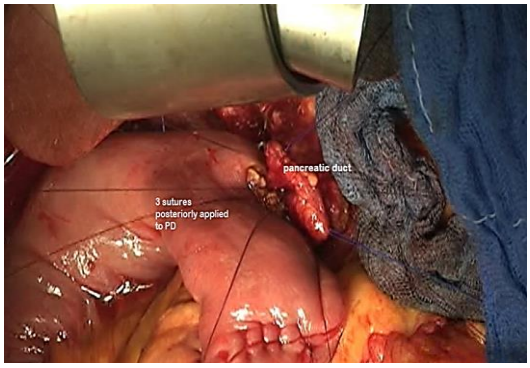

Figure 1: The applied 3 sutures posteriorly and anteriorly before finishing the inner layers anastomosis.

All sutures of a layer always kept as stay on a mosquito tip forceps and tied at the end of each layer. Moreover, in patients with risky anastomosis based on subjective assessment (older age, high serum bilirubin, neoadjuvant therapy, narrow pancreatic duct or soft pancreas), we performed PJ irrigation. A triple-way Foley catheter was inserted anterior to the PJ, and during the postoperative period, ringer or saline 0.9% solution was used to irrigate the anastomosis at a rate of 200 ml/hour for the first 48

hours. Drainage of collected fluid accrued by passive gravity.

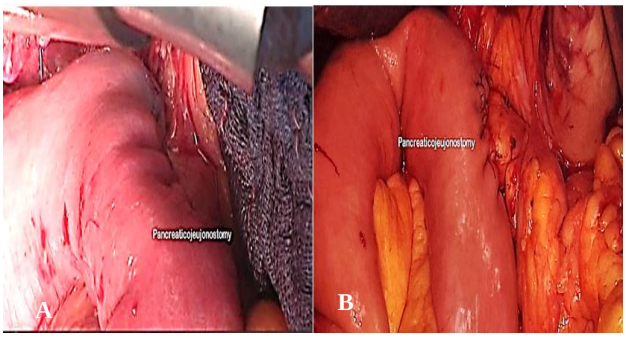

Figure 2 (A and B): Finished pancreaticojeujonostomy anastomosis.

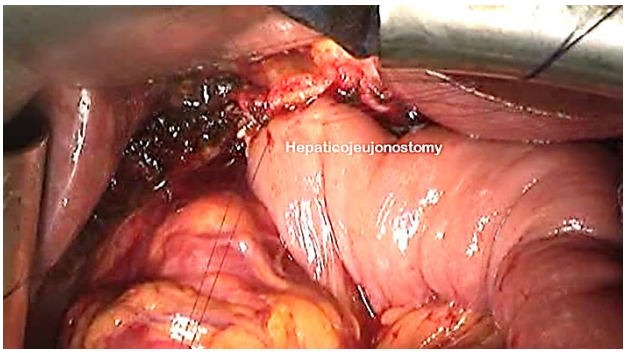

Figure 3: The hepaticojeujonostomy, single layer, interrupted anterior layer sutures.

The volume and quality of drained fluid inspected everyday by the senior surgeon, also, biochemical test measuring the pancreatic enzymes and bilirubin levels in drained fluid after interruption of irrigation for 2 hours every day recorded. Irrigation stopped on the 3rd day if level of biochemical tests below the 3 times of serum level and if it was more irrigation continued until reaching these levels.

Distal to the PJ, an end-to-side hepaticojejunostomy was created with the same loop using posterior and anterior interrupted PDS 4/0 sutures. The (Figure 3). Then, the pylorojejunostomy was created in an end-to-side manner. Operative time, blood loss, and the need for blood transfusion were recorded. The incidence of postoperative complications, including pancreatic fistula, bile leak, delayed gastric emptying, and wound infection was recorded. The incidence and aetiology of mortality were also recorded.

Study outcomes

The main outcome of our research was the incidence of postoperative pancreatic fistula, whereas other outcomes included operative time, blood loss, hospitalization period, the incidence of other complications, and mortality rate.

Definition of outcomes

Pancreatic leak (fistula) was diagnosed when the amylase level in the drain output was ≥ three times than serum amylase on the third postoperative day or later. It was graded into A (biochemical leak with no significant clinical sequelae), B (change in postoperative management like percutaneous drain insertion for drainage), or C (multiorgan failure or need for reoperation).[15] Bile leak was diagnosed when drain bilirubin met the same criteria previously mentioned in the pancreatic leak, compared to serum bilirubin.[16,17] Delayed gastric emptying was defined based on the criteria published by "International study group of pancreatic surgery", while wound infection was established by the presence of purulent discharge, not only peri-incisional hyperaemia.[18]

Statistical analysis

The SPSS software (version 26 for MacOS) was used for the analysis of the collected data. Means (with standard deviations) were compared using the student-t test, whereas medians (and ranges) were compared using the Mann-Whitney test. Additionally, the Chi-square test was applied to compare frequencies. Regression analysis was done to reveal significant predictors for pancreatic fistula, $p<0.05$ was considered statistically significant.

RESULTS

The distribution of age, BMI, and gender, in addition to the prevalence of medical comorbidities and smoking revealed no notable statistical difference between the study groups ($p\geq0.05$).

Jaundice was present in the majority of cases, while other symptoms included abdominal pain and weight loss. Preoperative endoscopic biliary drainage was done in 44.44% of early cases and 50% of late cases, while history of neoadjuvant chemotherapy was positive in 29.62% and 23.08% of early and late cases, respectively. The previous parameters along with preoperative laboratory work-up, including carcinoembryonic antigen (CEA) and carbohydrate antigen 19-9 (CA 19-9), are presented in (Table 1).

Pancreatic adenocarcinoma was the most common pathology in both groups. Other types in order of prevalence were ampullary carcinoma, distal cholangiocarcinoma, and duodenal carcinoma. The median size of the detected masses was 2.8 and 2.9 cm, whereas common bile duct diameter was 11.78 and 11.04 mm in the early and late groups, respectively. The texture of pancreatic parenchyma did not differ between the two groups, with most cases having a soft pancreas (51.85% and 65.38% in the two groups, respectively). The mean diameter of the pancreatic duct was 2.26 in early cases and 2.6 in the late cases ($p=0.058$).

Table 1: Preoperative demographic, clinical, and laboratory parameters of the study groups.

Parameters	Early experience (n=27)	Late experience (n=26)	P value
Age (years) (mean±SD)	54.56±8.86	52.46±8.91	0.395
Gender, N (%)			
Male	18 (66.67)	20 (76.92)	0.407
Female	9 (33.33)	6 (23.08)	
BMI (kg/m2)	29.77±4.74	29.67±4.89	0.939
Medical comorbidities, N (%)			
Diabetes mellitus	6 (22.22)	7 (26.92)	0.691
Hypertension	11 (40.74)	9 (34.62)	0.646
Stable coronary artery disease	1 (3.7)	0 (0)	0.322
Smoking	8 (29.63)	6 (23.08)	0.589
Presentation, N (%)			
Abdominal pain	22 (81.48)	21 (80.77)	0.947
Jaundice	26 (96.3)	26 (100)	0.322
Weight loss	10 (37.04)	12 (46.15)	0.501
Preoperative biliary drainage	12 (44.44)	13 (50)	0.685
Neoadjuvant chemotherapy	8 (29.62)	6 (23.08)	0.589
Preoperative laboratory parameters (mean±SD)/mean (range)			
Hemoglobin (gm/dl)	12.66±1.04	12.63±1.03	0.921
Albumin (gm/dl)	3.96±0.28	3.94±0.29	0.795
Bilirubin (mg/dl)	4.5 (2.5-14.7)	5.2 (2.5-13.4)	0.471
CEA (ng/ml)	5.1 (1.9-115)	6.4 (1.6-112.6)	0.606
CA 19-9 (ng/ml)	20.2 (3-208.10)	19.75 (3.5-210)	0.434

Table 2: Intraoperative and pathological parameters of the study groups.

Parameters	Early experience (n=27)	Late experience (n=26)	P value
Pathology, N (%)			
Pancreatic adenocarcinoma	18 (66.67)	20 (76.92)	0.478
Ampullary tumour	6 (22.22)	4 (15.38)	
Distal cholangiocarcinoma	3 (11.11)	1 (3.84)	
Duodenal carcinoma	0 (0)	1 (3.84)	
Mass size (cm), mean (range)	2.8 (1.1-4.5)	2.9 (1.3-4.5)	0.499
Bile duct diameter (mm) (mean±SD)	11.78±3.38	11.04±2.63	0.379
Pancreatic texture, N (%)			
Soft	14 (51.85)	17 (65.38)	0.606
Firm	10 (37.04)	7 (26.92)	
Hard	3 (11.11)	2 (7.69)	
Pancreatic duct diameter (mm)	2.26±0.43	2.60±0.69	0.058
PJ reconstruction, N (%)			
Invagination	27 (100)	0 (0)	<0.001
Modified Heidelberg	0 (0)	26 (100)	
PJ irrigation	0 (0)	18 (69.2)	< 0.001*
Operative time (hours) mean (range)	5 (4-6)	4 (4-5.5)	<0.001
Blood loss (ml) mean (range)	500 (300-1000)	400 (300-700)	0.002
Blood transfusion, N (%)	10 (37.04)	3 (11.54)	0.031
Harvested lymph nodes mean (range)	14 (10-22)	16 (12-25)	0.200
Infiltrated lymph nodes mean (range)	0 (0-5)	0 (0-4)	0.455

All PJ anastomoses were performed via the invagination technique in early cases while it was performed via the Heidelberg technique in late ones. Additionally, PJ irrigation was done in 69.2% of late cases while omitted in early ones. The late group had shorter operative time; 4 (4-5.5) vs. 5 (4-6) hours in early cases, less intraoperative blood loss; 400 (300-700) vs. 500 (300-1000) ml in early cases, and less need for blood transfusion (11.54% vs. 37.04% in early cases).

Table 3: Postoperative data, including morbidity and mortality, in the study groups.

Parameters	Early experience (n=27)	Late experience (n=26)	P value
Oral intake, mean (range)	7 (5-22)	5 (5-15)	0.019
Hospital stays (day), mean (range)	8 (6-30)	6 (6-20)	0.027
Pancreatic leak, N (%)	10 (37.04)	3 (11.54)	0.031
Bile leakage, N (%)	3 (11.11)	4 (15.38)	0.646
Delayed gastric emptying, N (%)	4 (14.81)	6 (23.08)	0.442
Wound infection, N (%)	4 (14.81)	4 (15.38)	0.954
In-hospital mortality, N (%)	4 (14.81)	0 (0)	0.041
Secondary hemorrhage, N (%)	4 (14.81)	0 (0)	0.041

Table 4: Predictors of post-PD pancreatic leak.

Predictors	Univariate regression				Multivariate regression			
	P value	Odds ratio	95% CI for odds ratio		P value	Odds ratio	95% CI for odds ratio	
			Lower	Upper			Lower	Upper
Age (in years)	0.184	1.051	0.977	1.131	-	-	-	-
Gender	0.820	0.853	0.218	3.349	-	-	-	-
BMI	<0.001	2.692	1.584	3.172	0.001	2.002	1.604	2.964
Diabetes	0.549	0.653	0.162	2.628	-	-	-	-
Hypertension	0.174	0.413	0.115	1.478	-	-	-	-
Coronary artery disease	0.996	1.048	0.982	1.103	-	-	-	-
Smoking	0.263	0.465	0.121	1.776	-	-	-	-
Abdominal pain	0.260	0.287	0.033	2.516	-	-	-	-
Jaundice	0.990	1.002	0.916	1.056	-	-	-	-
Weight loss	0.131	1.016	0.721	2.624	-	-	-	-
Preoperative biliary drainage	0.471	1.600	0.446	2.742	-	-	-	-
Neoadjuvant chemotherapy	0.682	0.750	0.189	2.976	-	-	-	-
Haemoglobin	0.709	0.889	0.479	1.649	-	-	-	-
Albumin	0.562	1.932	0.208	2.641	-	-	-	-
Bilirubin	0.918	0.991	0.831	1.182	-	-	-	-
CEA	0.300	0.986	0.961	1.012	-	-	-	-
CA 19-9	0.128	1.008	0.998	1.018	-	-	-	-
Pancreatic adenocarcinoma	-	-	-	-	-	-	-	-
Ampullary tumour	0.225	0.609	0.274	1.357	-	-	-	-
Distal cholangiocarcinoma	0.888	1.200	0.094	5.260	-	-	-	-
Duodenal carcinoma	0.078	0.329	0.095	1.135	-	-	-	-
Mass size	0.289	0.712	0.380	1.334	-	-	-	-
Hard texture	-	-	-	-	-	-	-	-
Soft texture	<0.001	2.147	1.479	2.436	0.006*	1.030	1.087	1.257
Firm texture	0.153	1.240	0.823	1.636	-	-	-	-
Bile duct diameter	0.949	1.007	0.818	1.240	-	-	-	-
Pancreatic duct diameter	0.007	0.035	0.003	0.392	0.015*	0.546	0.238	0.762
Invagination technique	0.040	4.510	1.074	8.929	0.532	1.254	0.630	1.245
PJ irrigation	0.346	0.200	0.474	8.444	-	-	-	-
Operative time	0.002	1.472	1.355	1.755	0.214	1.23	0.71	1.46
Blood loss	0.327	1.002	0.998	1.005	-	-	-	-
Blood transfusion	0.749	1.333	0.230	7.743	-	-	-	-
Infiltrated lymph nodes	0.407	0.807	0.485	1.341	-	-	-	-

However, the number of excised and infiltrated lymph nodes did not differ between the study groups (p=0.200 and 0.455), (Table 2). All surgical cut margins were free from neoplasm after the histopathological examination (not shown in tables). Patients in the late experience group showed significantly earlier time to oral intake as well as shorter hospitalization periods, compared to early cases (p=0.019 and 0.027, respectively). In addition, the incidence of postoperative pancreatic leak was lower in the late group (11.54% vs. 37.04% in early cases p=0.031). All patients in the late group had a grade-A fistula, while patients in the early group were distributed as follows; grade A (four cases), grade B (two cases), and grade C (four cases).

Nonetheless, the incidence of other complications, including bile leak, delayed gastric emptying, and wound infection did not differ between the study groups ($p \geq 0.05$). In-hospital mortality was not encountered in late cases. However, four patients in the early group died during the first hospital admission, (Table 3). These cases developed pancreatic fistula that was complicated by secondary haemorrhage and infection. These four cases needed reoperation and died of multiorgan failure.

Univariate regression analysis revealed that higher BMI ($p<0.001$, OR=2.002), soft pancreatic texture ($p<0.001$; OR<0.006), smaller pancreatic duct diameter (p=0.007, OR=0.015), PJ via the invagination method (p=0.040, OR=0.532), and longer operative time (p=0.002, OR=0.214) were significant risk factors for post-PD pancreatic leak. Nevertheless, only the first three parameters preserved their statistical significance in the multivariate analysis, (Table 4).

DISCUSSION

Our current study was conducted to compare our early versus late experience regarding perioperative outcomes in patients undergoing open PD for malignant pancreatic head neoplasms. Despite the non-randomized nature of our study, the reader could notice no statistically significant differences between baseline demographic and clinical criteria. That should reduce the risk of any bias deviating our findings in favor of one group over the other. Numerous technical methods, such as the duct-to-mucosa, Peng, Blumgart, and invagination techniques and its modifications, have been described as ways to prevent pancreatic fistula. Regardless of the duct diameter and pancreatic texture, the ideal one should be linked to a low incidence of pancreatic fistula and simplicity of anastomosis.[12] Our findings revealed a significant beneficial impact of surgical expertise on multiple perioperative outcomes, as late cases showed shorter operative times, less intraoperative blood loss, less incidence of postoperative complications like pancreatic leak, and shorter hospitalization period ($p<0.05$).

Likewise, El Nakeeb et al reported their surgical experience in 1000 PD cases who were divided into three groups based on the year of performance; the first group included patients performed between 1993 and 2002, the second group included patients performed between 2003 and 2012, and the third group included patients performed between 2013 and 2017. Operative time had median values of six hours in the first group compared to five hours in the other two groups (p=0.001). In addition, blood loss had median values of 500, 400, and 300 ml in the same three groups, respectively (p=0.001). The incidence of pancreatic leak was higher in the first group (15%) compared to the other two groups (12.7% and 14.7%, respectively p=0.01). Furthermore, the hospitalization period had a median value of nine days in the first group compared to eight days in the other two groups ($p<0.001$).[6]Tsamalaidze and Stauffer reported that the operative time significantly improved with time as it had median values of 402, 320, 293, and 271 minutes after one, two, three, and four years, respectively ($p<0.001$).

However, the incidence of pancreatic leaks and hospitalization periods did not show significant improvement with time ($p>0.05$).[19] Differences in sample size, patient criteria, tumour characteristics, and intraoperative complications could explain the previous heterogenicity. In our study, we noted a significant decline in the incidence of pancreatic leaks when we applied the Heidelberg technique for pancreatic anastomosis instead of the invagination method only. Tension free anastomosis by using very fine interrupted sutures with less traumatizing effects on pancreatic duct and parenchyma with less chance for obstruction of duct (preplaced ductal sutures) and free passage of pancreatic juice with the no need for pancreatic stenting.[11]

Moreover, the invagination technique was a significant risk factor for pancreatic leak in the univariate analysis. This is in accordance with Torres et al who reported that the former technique is beneficial in reducing the incidence of post-PD pancreatic leak as the incidence of that complication was 23.5% and all patients had grade-A fistula. The same authors reported that in the invagination method, the sutures are only taken in the pancreatic parenchyma without proper involvement of the pancreatic duct. That could induce duct obstruction or laceration which may increase the incidence of leak. Additionally, the exposure of the pancreatic stump to the intestinal lumen carries a high risk of haemorrhage from the pancreatic stump.[12] Other authors confirmed the safety and reliability of the Heidelberg technique and its modification in such cases.[20] In cases of complicated acute pancreatitis, the concept of continued irrigation and passive drainage following surgical debridement decreased mortality and necrosectomies.

Our findings revealed that the incidence of pancreatic leaks significantly declined when PJ irrigation was done. Multiple mechanisms could explain the beneficial impact

of perianastomotic irrigation including the removal of blood clots and debris in the surgical bed, reduction of bacterial load, and dilution of inflammatory mediators and pancreatic enzymes. All of the previous factors could impair the healing process of the anastomosis. Adamenko et al confirmed the previous findings, as the application of pancreatic anastomosis irrigation in high-risk patients led to a significant decline in the incidence of pancreatic leaks (12.7% vs. 69.2% in the non-drainage group $p<0.001$).[7]

A more recent systematic review also confirmed the benefit of perianastomotic irrigation to decrease the incidence of such a complication.[21] Our findings revealed that higher BMI was a significant predictor for post-PD pancreatic leak. Multiple mechanisms could explain the previous association including intraoperative technical challenges that increase the difficulty of anastomotic creation, increased intraabdominal pressure that could lead to impaired blood supply and tissue healing, and obesity-associated comorbidities like insulin resistance and diabetes mellitus that impairs healing and increase the susceptibility for infection.[22-25] Multiple previous studies reported similar outcomes regarding the significant association between high BMI and post-PD pancreatic fistula ($p<0.05$).[8,26]

Main pancreatic duct diameter was set at 3 mm; pancreatic parenchyma graded as "soft" or "hard." Patients named as "low-," "intermediate-," and "high-risk" according to the presence of none, one or two risk factors, respectively.[7] In the current study, the soft pancreas was a significant risk factor for post-PD pancreatic leak. The presence of a soft pancreas could propose handling difficulties during the operation and the taken sutures are more prone to tearing. As a result, the anastomotic integrity is jeopardized leading to pancreatic leak.[28,29] Other studies reported similar findings.[8,30,31] Our findings revealed that small pancreatic duct diameter was a significant predictor for post-PD pancreatic leak that could be secondary to reduced tissue support in patients with smaller pancreatic ducts as well as impaired pancreatic drainage capacity. That agrees with numerous previous studies that confirmed the relationship between small pancreatic duct diameter and post-PD pancreatic fistula.[8,31-33] Prolonged operative time was a significant risk factor for post-PF pancreatic leak, and that agrees with Purkayastha et al who confirmed the previous association.[34,35] Prolonged surgery time could reflect intraoperative difficulties and more tissue manipulation which pose a risk for fistula formation. Our findings revealed a marked decline in perioperative mortality in late cases compared to the early ones. That could be explained by the decreased incidence of post-PD pancreatic leak which led to morbid consequences like secondary infection and haemorrhage. That was the main aetiology of mortality in the four early patients in this study. Our study has some limitations. Its retrospective nature, small patient sample, single center study, and lack of oncological and long-term follow-up are the main drawbacks. Future studies should address the previous limitations.

CONCLUSION

Surgical expertise and technical modification in anastomosis with pancreatic anastomosis irrigation play a crucial role in improving PD outcomes. That was evident in the late experience group which showed less incidence of pancreatic leak, earlier oral intake, and shorter hospitalization period. Obesity, soft pancreatic texture, and small pancreatic duct diameter were significant predictors of pancreatic leaks after PD. Patients with such criteria should be operated on by highly experienced surgeons and undergo technical surgical modifications to enhance perioperative outcomes.

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