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Delayed gastric emptying in classic pancreaticoduodenectomy vs pylorus-sparing pancreaticoduodenectomy, a retrospective and prospective comparative study

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Abstract

Background & objectives: The standard surgical method for treating pancreatic cancer and periampullary tumors is pancreaticoduodenectomy, Classic Whipple and Pylorus-preserving pancreaticoduodenectomy were the two surgical options, we intended to compare the incidence of delayed gastric emptying between Classic Whipple and Pylorus-preserving pancreaticoduodenectomy.

Methods: A retrospective and prospective comparative study included fifty patients who underwent elective surgical pancreaticoduodenectomy including both Classic Whipple or pancreaticoduodenectomy in Zheen and Par hospitals between 2019 and 2024, comparing the elements of delayed gastric emptying with the options of surgical techniques and pre-operative status of the patients.

Results: Most (37 patients) underwent the Classic Whipple, and the rest (13 patients) underwent the pancreaticoduodenectomy, significantly 100% of the Pylorus-preserving pancreaticoduodenectomy group had delayed gastric emptying, whether of grade A, or B (69.2%, and 30.8% respectively), while, 35.1% of patients in the Classic Whipple group didn't develop it ($p = 0.029$). Two patients in the Classic Whipple group developed pancreatic fistula, compared with 0% in the other group ($p = 1.000$). Three patients (8.1%) in the Classic Whipple group developed chyle leaks, compared with 0% in the other group ($p = 0.558$). Four patients (10.8%) in the Classic Whipple group developed wound infection, compared with 0% in the other group ($p = 0.561$).

Conclusion: delayed gastric emptying incidence significantly associated more with Pylorus-preserving pancreaticoduodenectomy, putting in consideration the postoperative morbidity which was increased in classic Whipple resection patients. Pylorus-preserving pancreaticoduodenectomy appears to be safe and just comparable with the Classic Whipple procedure.

Keywords: Classic Whipple, Delayed gastric emptying, Jejunojejunostomy, Pylorus-preserving pancreaticoduodenectomy

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Introduction

The gold standard surgical method for treating respectable pancreatic cancer and premalignant or malignant lesions in the periampullary region is pancreaticoduodenectomy (PD). This procedure was primarily described by Dr. Allen Oldfather Whipple, an American surgeon in 1935.[1] Later, with the development of innovative surgical techniques, the intraoperative steps were highly modified, and the surgeons had many technical and reconstructive alterations that must be investigated. The Classic Whipple (CW) included excising the distal stomach (antrectomy) with gastrojejunostomy reconstruction while Pylorus-preserving pancreaticoduodenectomy (PPPD) was another option described by Watson K. in 1944 as an alternative procedure performed for ampullary cancer, to decrease postgastrectomy syndrome of dumping, and diarrhea after PD, patients whose tumor does not comprise the proximal duodenum, pylorus, or distal stomach are candidates for a PPPD. [2,3] Saving the pylorus during PD has been reported in many studies to lead to a long-term progression in the function of the gastrointestinal tract, as marked by more postoperative weight gain, fewer peptic ulcers, and limited dumping. Moreover, the pylorus-preserving procedure decreases the complexity of the operation to some extent, thus shortening the operative time and decreasing intraoperative blood loss. Recorded disadvantages of PPPD include the rise in delayed gastric emptying (DGE) refers to the condition that the stomach cannot suitably take food due to the symptoms of early satiety, nausea, and vomiting following upper gastrointestinal surgery without the mechanical obstruction of anastomosis or distal intestine.[4] Furthermore difficult to attain negative tumor margins. The definition of DGE may differ according to the researchers, according to the International Study Group for Pancreatic Surgery (ISGPF), is defined by the number of days for which a nasogastric tube is used and, no solid food can be tolerated, according to this, DGE is divided into 3 grades (A, B and C) depending on nasogastric intubation, type of diet patient can tolerate, whether using a prokinetic drug, incidence of vomiting and using nutritional support like total parenteral nutrition (TPN). Grade A is when the nasogastric tube is removed within 7 days, dietary intake is tolerable, and self-limiting recovery is accomplished with no medications or surgical intervention. Conversely, Grade B or C is the condition that medication or dietary control is needed. [5] In this study, we intended to correlate the incidence of DGE between CW and PPPD and the provisional data on pre and postoperative measurements and morbidity after surgery.

Patients and methods

A retrospective and prospective comparative study will include adult patients of both sexes who had elective surgical PD including both procedures CW or PPPD at Zheen and Par private hospitals between 2019 and 2024, The study duration was from the surgery day 0 to 3 months after surgery. For the prospective cases, the patients were monitored daily from the surgery day till the day of hospital discharge, then followed using phone calls and outpatient visits. While the retrospective cases were collected using the hospital archives. The surgeries were performed by surgeons specialized in hepatobiliary surgery and liver transplantation. The primary outcome was the DGE rate after the surgery; while the secondary outcomes were the intra-operative required blood transfusions, operation time, rate of postoperative complications like wound infection, biliary leak, pancreatic leak, chylous leak, and duration of hospital stay. In the study, patients were divided into two groups, the first group underwent classical Whipple with distal gastrectomy,

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while the second group underwent PPPD where the duodenum was dissected and divided at least 2 cm distal to the pylorus. Reconstruction was performed either by loop or Reux en y, starting with pancreatic, biliary then gastric anastomoses in a retro-colic or ante-colic fashion, in all cases side to side jejunojejunostomy was done at last.[6] One drain was inserted below the pancreatic jejunal anastomosis and a nasogastric suction tube was placed, bypassing the anastomosis in all patients. The study protocol was approved by the Research Protocol Ethics Committee of the Kurdistan Higher Council of Medical Specialties (KHCMS). Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 26). The chi-square test of association was used to compare the proportions of two or more groups. Fisher's exact test was used when the expected frequency (value) was less than 5 of more than 20% of the table's cells. Student's t-test for two independent samples (unpaired t-test) was used to compare the means of the two study groups. A p-value of ≤ 0.05 was considered statistically significant.

Results

Fifty patients were included in the study. Their mean age (SD) was 60.12 (11.95) years. The median age was 60, and the age range was 28-83. The majority (37 patients) underwent the classic Whipple operation, and the rest (13 patients) underwent the (PPPD). No significant differences in age were detected between the two groups (p = 0.452). More than half (60%) of the patients were males, but there was no significant difference in sex between the groups (p = 0.430), as presented in Table (1). More than two-thirds (69.2%) of patients in the PPPD group had Ca head of the pancreas, compared with 48.6% of patients in the CW group, while, 37.8% of patients in the CW group had a periampullary tumor, compared with 23.1% of patients in the PPPD group (p = 0.777). The main chief complaints were abdominal pain (50%) and jaundice (36%), but the difference was not significant between the groups (p = 0.732). Other details are presented in Table (2). The mean operation time of CW's operation was 398.1 minutes, and that of the PPPD was 346.9 minutes (p = 0.073). Around one quarter (24.3%) of CW's operations took ≥ 480 minutes, compared with 0% of the PPPD operation (p = 0.120). More than half (54.1%) of the patients in the CW operation group stayed 3-5 days in the hospital, while all the patients in the PPPD operation stayed six or more days (p = 0.002). All the patients in the PPPD group had delayed gastric emptying (DGE), whether of grade A, or B (69.2%, and 30.8% respectively), while, 35.1% of patients in the CW group didn't develop DGE (p = 0.029). Regarding the complications, none of the patients developed bile leak, two patients (5.4%) in the Whipple's group developed pancreatic fistula, compared with 0% in the PPPD group (p = 1.000). Three patients (8.1%) in the CW group developed chyle leaks, compared with 0% in the PPPD group (p = 0.558). Four patients (10.8%) in the CW group developed wound infection, compared with 0% in the PPPD group (p = 0.561), as presented in Table (3).

Table (1): Age and sex distribution of patients by type of operation.

	Whipple	PPPD	Total	
	No. (%)	No. (%)	No. (%)	p-value
Age (years)				
< 50	4 (10.8)	3 (23.1)	7 (14.0)	
50-59	11 (29.7)	4 (30.8)	15 (30.0)	
60-69	12 (32.4)	5 (38.5)	17 (34.0)	
≥ 70	10 (27.0)	1 (7.7)	11 (22.0)	0.452**
Sex				
Male	21 (56.8)	9 (69.2)	30 (60.0)	
Female	16 (43.2)	4 (30.8)	20 (40.0)	0.430*
Total	37 (100.0)	13 (100.0)	50 (100.0)	

*Calculated by Chi-square test. **By Fisher's exact test.

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Table (2): Diagnosis and chief complaint.

	Whipple	PPPD	Total	
	No. (%)	No. (%)	No. (%)	p-value*
Diagnosis				
Ca head of the pancreas	18 (48.6)	9 (69.2)	27 (54.0)	
Periampullary tumor	14 (37.8)	3 (23.1)	17 (34.0)	
Cholangiocarcinoma	2 (5.4)	1 (7.7)	3 (6.0)	
CBD stricture	1 (2.7)	0 (0.0)	1 (2.0)	
Pancreatic NET	1 (2.7)	0 (0.0)	1 (2.0)	
Chronic pancreatitis	1 (2.7)	0 (0.0)	1 (2.0)	0.777
Chief complaint				
Abdominal pain	18 (48.6)	7 (53.8)	25 (50.0)	
Jaundice	14 (37.8)	4 (30.8)	18 (36.0)	
Fatigue	2 (5.4)	1 (7.7)	3 (6.0)	
Constipation	0 (0.0)	1 (7.7)	1 (2.0)	
Vomiting	1 (2.7)	0 (0.0)	1 (2.0)	
Loss of weight	1 (2.7)	0 (0.0)	1 (2.0)	
Hypoglycemia	1 (2.7)	0 (0.0)	1 (2.0)	0.732
Total	37 (100.0)	13 (100.0)	50 (100.0)	

Table (3): Operation details and outcome by type of operation.

	Whipple	PPPD	Total	
	No. (%)	No. (%)	No. (%)	p-value
Operation time (minutes)				
< 360	12 (32.4)	7 (53.8)	19 (38.0)	
360-479	16 (43.2)	6 (46.2)	22 (44.0)	
≥ 480	9 (24.3)	0 (0.0)	9 (18.0)	0.120**
Mean (SD)	398.1 (93.1)	346.9 (63.0)		0.073†
Hospital period of stay (days)				
3-5	20 (54.1)	0 (0.0)	20 (40.0)	
6-8	13 (35.1)	8 (61.5)	21 (42.0)	
≥ 9	4 (10.8)	5 (38.5)	9 (18.0)	0.002*
Delayed gastric emptying				
None	13 (35.1)	0 (0.0)	13 (26.0)	
Grade A	18 (48.6)	9 (69.2)	27 (54.0)	
Grade B	5 (13.5)	4 (30.8)	9 (18.0)	
Grade C	1 (2.7)	0 (0.0)	1 (2.0)	0.029**
Complications				
Bile leak	0 (0.0)	0 (0.0)	0 (0.0)	N/A
Pancreatic fistula	2 (5.4)	0 (0.0)	2 (4.0)	1.000**
Chyle leak	3 (8.1)	0 (0.0)	3 (6.0)	0.558**
Wound infection	4 (10.8)	0 (0.0)	4 (8.0)	0.561**
Total	37 (100.0)	13 (100.0)	50 (100.0)	

*Calculated by Chi-square test. **Calculated by Fisher's exact test. †Calculated by unpaired t-test. N/A: Not applicable.

In the CW group, no significant association was detected between delayed gastric emptying and the following variables: Diabetes (DM) ($p = 0.851$), hemoglobin (Hb) ($p = 0.802$), and total serum bilirubin (TSB) ($p = 0.357$). Also, in the PPPD group, no

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significant association was detected between DGE and the following: DM (p = 0.530), Hb (p = 0.217), and TSB (p = 1.000) Table (4). In CW's group, no significant association was detected between DGE and the following: type of gastrojejunostomy (p = 0.854), pre-operative biliary drainage (p = 0.208), and gastro-jejunal limb position (p = 1.000). The same can be applied to the PPPD group, as presented in Table (5).

Table (4): Delayed gastric emptying by DM, Hb, and TSB in each type of operation.

	Delayed gastric emptying					
	None	Grade A	Grade B	Grade C	Total	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	p-value*
Whipple						
Diabetes						
Yes	5 (45.0)	5 (45.0)	1 (9.1)	0 (0.0)	11 (100.0)	
No	8 (30.8)	13 (50.0)	4 (15.4)	1 (3.8)	26 (100.0)	0.851
Hemoglobin (g/dl)						
< 13	8 (32.0)	13 (52.0)	3 (12.0)	1 (4.0)	25 (100.0)	
≥ 13	5 (41.7)	5 (41.7)	2 (16.7)	0 (0.0)	12 (100.0)	0.802
TSB (mg/dl)						
< 1.2	4 (44.4)	3 (33.3)	1 (11.1)	1 (11.1)	9 (100.0)	
≥ 1.2	9 (32.1)	15 (53.6)	4 (14.3)	0 (0.0)	28 (100.0)	0.357
PPPD						
Diabetes						
Yes	0 (0.0)	2 (50.0)	2 (50.0)	0 (0.0)	4 (100.0)	
No	0 (0.0)	7 (77.8)	2 (22.2)	0 (0.0)	9 (100.0)	0.530
Hemoglobin (g/dl)						
< 13	0 (0.0)	7 (87.5)	1 (12.5)	0 (0.0)	8 (100.0)	
≥ 13	0 (0.0)	2 (40.0)	3 (60.0)	0 (0.0)	5 (100.0)	0.217
TSB (mg/dl)						
< 1.2	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	4 (100.0)	
≥ 1.2	0 (0.0)	5 (62.5)	3 (37.5)	0 (0.0)	8 (100.0)	1.000

*Calculated by Fisher's exact test.

Table (5): Delayed gastric emptying by multiple factors

	Delayed gastric emptying					
	None	Grade A	Grade B	Grade C	Total	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	p-value*
Whipple						
Gastrojejunostomy						
Roux-en-Y	11 (34.4)	16 (50.0)	4 (12.5)	1 (3.1)	32 (100.0)	
Loop	2 (40.0)	2 (40.0)	1 (20.0)	0 (0.0)	5 (100.0)	0.854
Pre-operative biliary drainage						
Yes	5 (38.5)	7 (53.8)	0 (0.0)	1 (7.7)	13 (100.0)	
No	8 (33.3)	11 (45.8)	5 (20.8)	0 (0.0)	24 (100.0)	0.208
Gastro-jejunal limb position						
Retro-colic	11 (35.5)	15 (48.4)	4 (12.9)	1 (3.2)	31 (100.0)	
Ante-colic	2 (33.3)	3 (50.0)	1 (16.7)	0 (0.0)	6 (100.0)	1.000
PPPD						
Gastrojejunostomy						
Roux-en-Y		9 (69.2)	4 (30.8)		13 (100.0)	N/A
Pre-operative biliary drainage						
Yes	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	
No	0 (0.0)	8 (66.7)	4 (33.3)	0 (0.0)	12 (100.0)	1.000
Gastro-jejunal limb position						
Retro-colic	0 (0.0)	8 (66.7)	4 (33.3)	0 (0.0)	12 (100.0)	
Ante-colic	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	1.000

*Calculated by Fisher's exact test.

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Discussion

The general idea was that PPPD was linked with an increased rate of DGE compared to CW as some argue that it increases postoperative morbidity. Warshaw and Torchiana was the first to associate DGE with PPPD, in our study The DGE was significantly more in PPPD group (100%). [7] Still, none of the patients in this group developed grade C in comparing to CW group (65%) with one patient (2.7%) having grade C, however, the PPPD operative time was less in about 50 min than the other group and postoperative hospital stay were significantly more in PPPD. The postoperative complication was reported also more in CW group that included (bile leak, pancreatic leak, chyle leak and wound infection), but it was obvious that after changing the protocol of using prophylactic antibiotics, the incidence of the wound infection decreased. Theoretically, many factors are believed to play a part in the pathophysiology of DGE. In our study, we tried to find a correlation between DGE and many other factors, unfortunately, we didn't find any relationship between the incidence of DGE and the preoperative Hb, TSB, and Albumin level, and pre-operative biliary drainage appeared that it has no role in DGE. Furthermore, there are increasing data that side-to-side gastrojejunostomy (STSGS) could be superior to end to side anastomosis (ETSGS) concerning the incidence of DGE. Nakamura et al. surveyed 160 patients, the rate of DGE was 21.3% in the ETSGS group compared with 2.5% in the STSGS group (P=0.0002). [8] In our study, there was no significant association concerning the technique of gastrojejunal anastomosis whether it is loop or reux en y anastomosis, also the position of the jejunal limb as being ante-colic or retro-colic didn't affect the extent of DGE which we believe settle the debate even if just a little of which method of anastomosis is superior or has fewer complications post-operatively, though C Varghese et al. reported a that Braun entero-enterostomy technique which consists of loop ante-colic gastrojejunostomy combining side to side jejunojejunostomy has the lowest DGE among the other types of anastomotic routes. [9] The published studies and RCTs till 2023 didn't guide us to decide the superiority of one technique to another which reduces the incidence of DGE. Paquet et al. and Wenger et al. In the late 1990s, reported that PPPD was better than CW in terms of postoperative quality of life.[10,11] Moreover, in 1999, Lin et al, showed more rate of DGE in patients who had PPPD. [12] Then, in the 2000s, Tran et al and Seiler et al, published similar results comparing the two techniques especially concerning postoperative morbidity and DGE. [13,14] But Srinarmwong et al. in 2008 showed that PPPD was related to a higher rate of DGE. [15] In 2015, Taher et al. showed comparable morbidity rates among both techniques, Hüttner FJ et al in 2016, and Ulla Klaiber in 2020,suggested no relevant and significant differences in mortality, morbidity, and survival between the two techniques.[16-19] Lastly, Symeonidis D et all in 2023 joined the team with comparable results but favored CW regarding DGE.Surprisingly, none of the current RCTs discussed the oncologic outcomes between PRPD and CW procedure though most of the pancreaticoduodenectomy cases were caused either by pancreatic head or periampullary cancer, which was the case in our study as 54 % of cases pancreatic head cancer and 34% were periampullary tumors.

Conclusion

Delayed gastric emptying incidence was significantly associated more with PPPD, putting into consideration the postoperative morbidity which was increased in CW patients. PPPD appears to be safe to perform and just comparable with the CW procedure, the choice of procedure can be left to the preference of the surgeon. However, a larger

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sample study with extended follow-up duration is required.

Conflict of interest:

The authors recorded no conflict of interest.

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