Impact of posterior wall gastrojejunostomy versus anterior wall gastrojejunostomy in pancreaticoduodenectomy on delayed gastric emptying and enhanced recovery: a prospective study

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Background
Pancreaticoduodenectomy (Whipple operation) is considered the main surgical management for duodenal, pancreatic head, and lower end common bile duct neoplasm. Gastrojejunostomy orientation has a direct impact on enteral feeding and delayed gastric emptying (DGE).
Aim
The primary outcomes were reviewing the effect of changing the orientation of gastrojejunostomy either anterior wall vertical gastrojejunostomy versus posterior wall vertical gastrojejunostomy on DGE, early enteral feeding, leakage, and overall enhanced recovery with early start of chemotherapy.
Patients and methods
A prospective randomized trial 55 patients total number of patients after substraction of lost follow up was 50 patients and were divided into two group; group A: 27 patients underwent posterior wall gastrojejunostomy and group B: 23 patients underwent anterior wall gastrojejunostomy both techniques done in antecolic vertical manner.
Results
Operative time, postoperative bleeding, and leakage was not significantly different between the two groups. The total incidence of DGE was significantly lower in group A (posterior wall vertical) than group B (anterior wall vertical), regarding grades of DGE grade a was significantly lower in group A while the incidence in grades B and C was not significantly different regarding the number of patients. Ryle removal and starting oral intake was earlier and statistically significant in posterior wall vertical gastrojejunostomy when compared to anterior wall vertical gastrojejunostomy. Readmission, the actual use of prokinetics and need for nutritional support was higher in group B (anterior wall vertical gastrojejunostomy) than group A (posterior wall vertical gastrojejunostomy) but was not statistically significant.
Conclusions
Posterior wall vertical gastrojejunostomy has a better overall significant better outcome regarding early enteral feeding and DGE over anterior wall vertical gastrojejunostomy group also has better enhanced recovery and earlier time of starting chemotherapy. This topic should be evaluated in depth in a large-volume studies.

Keywords:
gastrojejunostomy, orientation of gastrojejunostomy anterior wall anastomosis, posterior wall anastomosis, Whipple operation

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Introduction

Pancreaticoduodenectomy (PD) is the main stay management procedure for the treatment of pancreatic head, lower common bile duct, and periampullary tumors [1].

In the last few years centralization of pancreatic surgery in high-volume centers and even every surgical subspecialty showed consequent advancement in the perioperative management, major improvement of PD-related mortality improvement in surgical techniques and development of modifications in every step in this procedure assuming a better outcome and less morbidity [2].

However, the post-PD morbidity incidence still remains statistically significant, with an incidence swinging between 30 and 50% even in highly dependent hepatopancreaticobiliary centers [3].

Early returning to normal activities and resuming oral intake and nutrition is usually an important concern for every patient after any surgical procedure [4].

Delayed gastric emptying (DGE) represents one of the most frequent postoperative morbidity following PD, with steady incidence rate over the past 50 years, representing between 9 and 61% [5,6]. Despite it is not a lethal complication, DGE has a bad outcome related to postoperative recovery and early better life quality of PD operated cases, and it is moreover associated with a more prolonged ICU and ward stay, higher costs and high rate of hospital readmissions [7,8].

The triggering factor of DGE still not clear inspite of a multivariate origin has been supposed. A lot of literatures suggested the correlation between DGE symptoms and vagal and/or devascularization injury of the stomach during resection [9]. Another authors supposed that the duodenal resection would cause a decrease in secretion of motilin and pancreatic-related peptide affecting normal stomach emptying [10]. Moreover, previous studies documented a significant correlation between postoperative other PD-related complications and DGE, suggesting a stimulating effect of local inflammation in the occurrence of gastroparesis [11,12].

With development and modification of every technique in all PD anastomoses a lot of studies has been done to access the role of gastrojejunostomy in the early returning in normal solid intake and rapid nutritional improvement following PD which has a good impact on mean hospital stay which is directly affected by DGE incidence in those patients [12].

Two gastrojejunostomy routes are usually used: the antecolic route and the retrocolic route. Similarly, the antecolic (infracolic) gastrojejunostomy reconstruction was shown to be with better outcome superior to the retrocolic (supracolic) method in decreasing the incidence of DGE. Furthermore, the side-to-side gastrojejunostomy reconstruction showed a clear superiority when compared with the end-to-side reconstruction [9].

A meta-analysis published by Su *et al.* [3] compared five studies [4–8] and concluded that antecolic reconstruction route was associated with a statistically significant decrease in the incidence of DGE following PD [9]. More recently, four randomized controlled trials have reported that the way of gastrojejunostomy anastomosis does not affect the postoperative incidence of DGE or other morbidity after PD [10–12].

With advancement in research, the arrangement of the gastrojejunostomy reconstruction has widely gained interest. Specifically, the variability of the flow angle at the anastomosis site of the stomach to the jejunum which has been shown to be an effective factor in normal food emptying process. Indeed, some literatures showed a reduced flow angle, that derived from a vertical anastomosis of the jejunal limb to the stomach, would assist in an easier food flow by gravity, preventing the incidence of development of DGE [4].

Based on these studies and literatures, the antecolic horizontal side-to-side gastrojejunostomy reconstruction has been substituted with a vertical orientation and anastomosis of the efferent jejunal loop to the gastric remnants along the greater curvature, with the preservation of the antecolic orientation [5].

Hence our study aimed to determine the impact of posterior wall gastrojejunostomy versus anterior wall gastrojejunostomy in Whipple operation on DGE both techniques performed in vertical antecolic manner to improve outcome specially hospitalization and early enteral feeding and tolerance.

Data management and analysis

The collected data was revised, coded, tabulated, and introduced to a PC using Statistical package for Social Science (SPSS 25, Armonk, NY: IBM Corp). Data was presented and suitable analysis was done according to the type of data obtained for each parameter.

Descriptive statistics

(1) Mean, SD for numerical data, while median and interquartile range for nonparametric numerical data.
(2) Frequency and percentage of nonnumerical data.

Analytical statistics

(1) Student t test was used to assess the statistical significance of the difference between two study group means.
(2) χ^2 test was used to examine the relationship between two qualitative variables.
(3) Fisher's exact test: was used to examine the relationship between two qualitative variables when the expected count is less than 5 in more than 20% of cells.

Methods

Patient enrollment, demographic and clinical data after Institutional Review Board (IRB) approval.

Study design: prospective randomized study started with 55 patients divided into two groups: 29 patient

in group A (posterior wall vertical gastrojejunostomy) and 26 patient in group B (anterior wall vertical gastrojejunostomy) during PD performed in those patients, the choice of the type of the anastomosis either anterior or posterior wall gastrojejunostomy was randomly assigned as a closed envelope. Lost follow up in group A two patients and the lost follow up in group B was three patients. Both techniques done in antecolic vertical manner. All the procedures were done in Ain Shams University Hospitals.

Study period; January 2020 to April 2023.

Study endpoints: the primary outcomes were reviewing the effect of changing the orientation of gastrojejunostomy either anterior wall vertical gastrojejunostomy versus posterior wall vertical gastrojejunostomy on DGE, early enteral feeding, and overall enhanced recovery with early start of chemotherapy.

Inclusion criteria

All patients undergoing PD (Whipple's operation) either for benign or malignant condition.

In all cases of PD included in our study reconstruction done in a single loop manner.

Exclusion criteria

(1) Age below 16 years.
(2) American Society of Anesthesiologists score 4.
(3) Extended resection of other organs (colon or liver).
(4) Patients with pancreatic and bile leak during postoperative follow up course.
(5) Previous gastric surgery prior to PD.
(6) Patients with extended lymphadenectomy and vascular resection.
(7) Patient underwent reconstruction in an isolated biliary limb technique or isolated pancreatic limb.
(8) Pylori preserving PD.

Perioperative data were updated from prospectively maintained databases. Specifically, clinicodemographic characteristics included sex, age, BMI, American Society of Anesthesiologists score, tumor location (pancreatic head, distal biliary duct, ampulla, and duodenum) and type of lesion (benign/malignant).

Table 1 Details of patients under study: demographic data

	Group A	Group B	Test of significance		
	Mean±SD	Mean±SD	Value	*P* value	Significance
Age (years)	58.22±15.59	60.09±5.78	*t*=−0.58	0.568	NS
BMI	27.21±4.12	27.91±3.25	*t*=0.659	0.513	NS
	n (%)	*n* (%)	Test of significance		
Sex					
Male	9 (33.33)	13 (56.52)	χ^2=2.71	0.100	NS
Female	18 (66.67)	10 (43.48)			
ASA classification					
1	4 (14.81)	8 (34.78)			
2	12 (44.44)	6 (26.09)	χ^2=3.23	0.198	NS
3	11 (40.74)	9 (39.13)			

ASA, American Society of Anesthesiologists.

Table 2 Number and percentage of patients symptoms and patients comorbidities

			Test of significance		
	Group A [*n* (%)]	Group B [*n* (%)]	Value	*P* value	Significance
Smoking	9 (33.33)	7 (30.43)	χ^2=0.05	0.827	NS
Cardiac	3 (11.11)	2 (8.7)	Fisher exact test	1.000	NS
Diabetes	11 (40.74)	8 (34.78)	χ^2=0.19	0.665	NS
Hypertension	6 (22.22)	4 (17.39)	Fisher exact test	0.736	NS
Abdominal pain	5 (18.52)	3 (13.04)	Fisher exact test	0.711	NS
Anorexia	13 (48.15)	9 (39.13)	χ^2=0.41	0.522	NS
Itching	27 (100)	23 (100)			
Jaundice	27 (100)	23 (100)			
Vomiting	10 (37.04)	13 (56.52)	χ^2=1.9	0.168	NS
Weight loss	5 (18.52)	3 (13.04)	Fisher exact test	0.711	NS

Table 3 Pathology of each patient in both groups

Periampullary mass	7 (25.93)	6 (26.09)	χ^2 =0	0.990	NS
Distal CBD cholangiocarcinoma	5 (18.52)	5 (21.74)	Fisher exact test	1.000	NS
Duodenal mass	3 (11.11)	4 (17.39)	Fisher exact test	0.689	NS
Pancreatic head mass	12 (44.44)	8 (34.78)	χ^2 =0.48	0.487	NS

CBD, common bile duct.

Benign or malignant respectable pancreatic or duodenal neoplasm does not have any impact on orientation of gastrojejunostomy either antecolic or retrocolic (Tables 1–4).

Postoperative data analyzed were postoperative complications, mortality, and length of hospital stay.

Surgical procedure

Details of the surgical procedure and intraoperative data.

All PDs were performed by the same surgical team of hepatopancreaticobiliary unit Ain Shams University Hospitals all over the study period. In brief, all patients underwent a Whipple procedure. The stomach was always transected by stapler Ethicon 75 mm universal stapler 5–6 cm proximally to the pylorus and the reconstruction was performed side to side using Ethicon 75 mm universal stapler. Reconstruction in antecolic manner is done. In all cases of PD included in our study reconstruction done in a single loop manner. Ryle passed under vision through the stomach to the jejunum (efferent loop).

The enterotomy site closed with PDS 4/0, all suture line oversewed with running PDS 4/0 sutures.

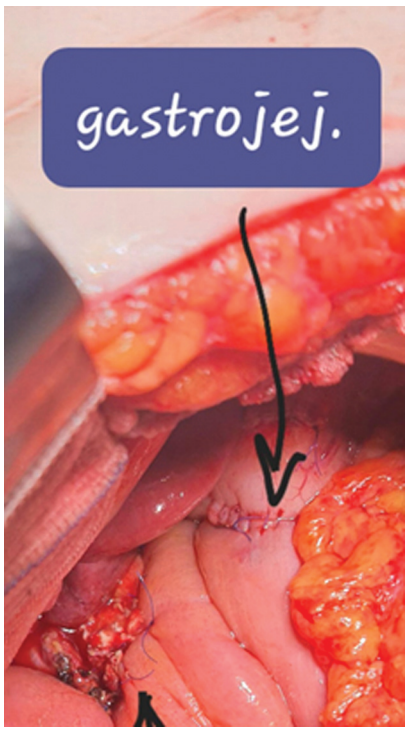
In group A, the anastomosis performed along the posterior wall 2 cm from gastric transection point. The anastomosis stapler length was 5.5 cm using Ethicon 75 mm universal stapler (Fig. 1).

In group B, the anastomosis performed along the anterior wall 2 cm away from the gastric transection point. The anastomosis stapler length was 5.5 cm using Ethicon 75 mm universal stapler (Fig. 2).

In both techniques the gastrotomy done at the greater curvature side of the stomach and the stapling done along line of the greater curvature. The gastrojejunostomy anastomosis was done at least 60 cm distally to the hepaticojejunostomy.

Close postoperative monitoring was performed including ICU stay, Ryle removal time, need of Ryle

Figure 1



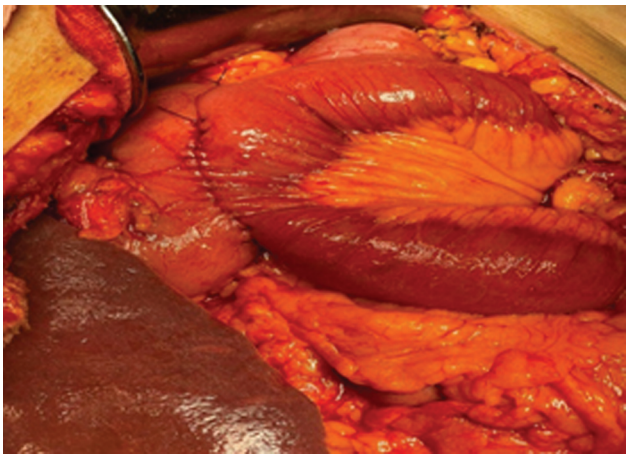
Posterior wall anastomosis with enterotomy closed by PDS 4/0.

Table 4 Preoperative laboratory tests

Total bilirubin	6.39±2.63	6.43±2.64	*t*=−0.06	0.956	NS
Alkaline phosphatase	474.15±80.81	461.35±90.06	*t*=0.53	0.599	NS
GGT	252.52±48.25	231.04±51.38	*t*=1.52	0.134	NS
TLC	8.92±2.62	8.46±2.16	*t*=0.68	0.501	NS
Hemoglobin	11.97±1.36	11.69±1.28	*t*=0.77	0.448	NS
Albumin	3.99±0.63	3.97±0.49	*t*=0.09	0.926	NS
ALT	86.04±34.25	68±19.3	*t*=2.34	0.024	S
AST	79.11±32.79	62.52±33.19	*t*=1.77	0.083	NS
CA 19-9	263.85±131.02	291.09±123.41	*t*=0.75	0.456	NS

ALT, alanine aminotransferase; AST, aspartate aminotransferase; GGT, gamma-glutamyltransferase; TLC, total leukocyte count.

Figure 2



Anterior wall vertical gastrojejunostomy anastomosis along the great curvature with enterotomy closed by PDS 4/0.

reinsertion, starting enteral intake, need for nutritional support and prokinetics, over all hospital stay, readmission, postoperative complications, and need for intervention putting in mind to analyze all data to access DGE in both techniques as the most important factor for early recovery for improvement of general condition and early start of chemotherapy.

In our study we classified DGE according to consensus definition proposed by the International Study Group of Pancreatic Surgery (ISGPS) in 2007. According to this, DGE is divided into three grades (A, B, and C) based on nasogastric intubation, type of diet patient is able to intake, and patient's general health condition, whether to use a prokinetic drug, and the need for further diagnostic tests. Grade A indicates the condition that the nasogastric intubation is removed within 7 days, dietary intake is possible, and self-limiting recovery is achieved without medications or surgical intervention. On the other hand, grade B or C is the condition that medication or dietary control is required (Table 5).

Ethical approval and consent statement

This research was performed at the Department of General Surgery, Ain Shams University. Ethical Committee approval and written, informed consent were obtained from all patients.

Results

Operative time, postoperative bleeding, and leakage was not significantly different between the two groups.

The total incidence of DGE was significantly lower in group A (posterior wall vertical gastrojejunostomy) than group B (anterior wall vertical gastrojejunostomy).

Regarding grades of DGE, grade A was significantly lower in group A, while the incidence in grades B and C was not significantly different regarding the number of patients.

Ryle removal and starting oral intake was earlier and statistically significant in posterior wall vertical gastrojejunostomy when compared with anterior wall vertical gastrojejunostomy.

Readmission, the actual use of prokinetics and need for nutritional support was higher in group B (anterior wall vertical gastrojejunostomy) than group A (posterior wall vertical gastrojejunostomy) but was not statistically significant.

Regarding surgical intervention only one case in group A needed due to leakage surgical repair done with omental patch with feeding jejunostomy and the patient died after 2 days in the ICU (Fig. 3).

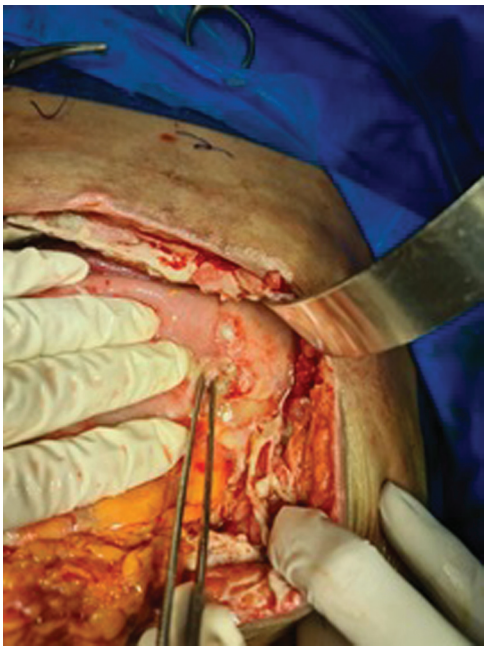
Upper gastrointestinal endoscopy performed in five patients: two in group A and three in group B. It was only diagnostic with no need for stenting or dilatation. Gastric stasis with dilatation and gastritis found in all cases with no stenosis or gastric outlet obstruction.

Table 5 Grades of delayed gastric emptying according to International Study Group of Pancreatic Surgery

DGE grade	No DGE	Grade A DGE	Grade B DGE	Grade C DGE
Gastric tube removal time by POD	≤3	4–7	8–14	>15
Gastric tube re insertion at any time at POD	None	>3	>7	>14
Unable to tolerate solid oral diet at POD	–	7–13	14–20	≥21
Vomiting/gastric distension	–	±	+	+
Use of prokinetics	–	±	+	+
Nutritional support enteral or parenteral	–	±	+	+
Association of postoperative complications	–	±	+	+
Diagnostic evaluation (UGI-CT)	–	–	±	+

DGE, delayed gastric emptying; UGI, upper gastrointestinal.

Figure 3



A leak in gastrojejunostomy in group B.

Discussion

PD (Whipple operation) is considered as the only curative modality in the management of pancreatic cancer and a valuable curative modality in duodenal and early periampullary cholangiocarcinoma.

Due to the stream of specialization in all surgical fields with directed flow to high volume centers modification of surgical techniques to obtain best results and improve outcome regarding early recovery, decreasing hospitalization with enhanced recovery, early discharge with good enteral feeding, and decreasing morbidity and mortality rates.

As gastrojejunostomy considered on of the three enteric anastomosis of Whipple operation and it is direct relation to feeding and enhanced recovery especially with pancreatic or bile leak. Multiple studies has been performed to assume the best orientation for such anastomosis.

Most literatures stated the superiority of antecolic vertical gastrojejunostomy over retrocolic and horizontal gastrojejunostomy with better overall outcome especially in enteral feeding and DGE.

Su and colleagues compared five studies [4–8] and concluded that antecolic reconstruction route was associated with a statistically significant decrease in the incidence of DGE following PD [3].

The variability of the flow angle at the anastomosis site of the stomach to the jejunum which has been shown to be an effective factor in normal food emptying process. Indeed, some literatures showed a reduced flow angle, that derived from a vertical anastomosis of the jejunal limb to the stomach, would assist in an easier food flow by gravity, preventing the incidence of development of DGE [4].

Based on these studies and literatures, the antecolic horizontal side-to-side gastrojejunostomy reconstruction has been substituted with a vertical orientation and anastomosis of the efferent jejunal loop to the gastric remnants along the greater curvature, with the preservation of the antecolic orientation [5].

Hence, our study investigated the role of change of anterior or posterior wall anastomosis and it has direct impact on enteral feeding and DGE.

Our study stated better overall outcome with better earlier enteral feeding with less incidence of DGE in posterior wall anastomosis. Operative time, postoperative bleeding, and leakage was not significantly different between the two groups (Table 6).

The mean time of Ryle removal was 3.33±0.62 per day in posterior wall vertical group while in anterior wall vertical group was 5.57±4.08. Also, the mean time of starting oral intake was 3.44±0.64 in posterior wall vertical group versus 3.87±0.76 in anterior wall vertical group, denoting significant outcome regarding enteral

Table 6 Operative details, blood transfusion, and hospital stay

	Group A	Group B	*t* test		
	Mean±SD	Mean±SD	*t*	*P* value	Significance
Operative time of anastomosis (min)	25.61±3.84	24.92±3.49	*t*=0.66	0.512	NS
Estimated blood loss (ml)	255.33±64.49	306.96±166.98	*t*=−1.48	0.144	NS
Tumor size (cm)	2.94±1	2.7±0.75	*t*=0.97	0.339	NS
Postoperative hospital stay (day)	10.48±2.26	10.96±4.23	*t*=−0.51	0.615	NS
Number of patients needed transfusion of PRBCs	5 (18.51)	4 (17.39)	χ^2=0.01	0.914	NS

Table 7 Postoperative course and mortality

			Test of significance		
	Group A [*n* (%)]	Group B [*n* (%)]	Value	*P* value	Significance
Postoperative ICU stay					
1	15 (55.56)	16 (69.57)			
2	10 (37.04)	6 (26.09)			
3	2 (7.41)	0	Fisher exact test	0.369	NS
10	0	1 (4.35)			
Leakage from gastrojejunostomy					
No	27 (100)	22 (95.65)	Fisher exact test	0.460	NS
Yes	0	1 (4.35)			
Mortality					
No	27 (100)	22 (95.65)	Fisher exact test	0.460	NS
Yes	0	1 (4.35)			
Bleeding in the Ryle					
No	26 (96.3)	22 (95.65)	Fisher exact test	1.000	NS
Yes	1 (3.7)	1 (4.35)			
Number of patients with DGE					
No	20 (74.07)	10 (43.47)	χ^2=4.84	0.043	S
Yes	7 (25.93)	13 (46.53)			
Grades of DGE					
No	20 (74.07)	10 (43.47)			
A	4 (14.81)	11 (47.83)	Fisher exact test	0.041	S
B	2 (7.41)	1 (4.35)			
C	1 (3.71)	1 (4.35)			

DGE, delayed gastric emptying.

Table 8 Postoperative oral intake and food tolerance

	Group A	Group B	*t* test		
	Mean±SD	Mean±SD	*t*	*P* value	Significance
Time of Ryle removal at postoperative day	3.33±0.62	5.57±4.08	*t*=–2.6	0.016	S
Time of starting oral intake	3.44±0.64	3.87±0.76	*t*=–2.15	0.036	S
Number of patients unable to tolerate solid food	7 (25.92)	6 (26.08)	*t*=0.1	0.952	NS
Unable to tolerate solid food by pod	12.71±3.5	12.58±3.81	*t*=0.05	0.962	NS
Reinsertion of Ryle by postoperative day	8±3.37	8.33±3.6	*t*=–0.2	0.845	NS

feeding and Ryle removal in posterior wall anastomosis over anterior wall anastomosis (Tables 7 and 8).

The total incidence of DGE was significantly lower in group A (posterior wall vertical gastrojejunostomy) than group B (anterior wall vertical gastrojejunostomy) (seven patients in group A vs. 13 patients in group B) (Table 7).

Regarding grades of DGE, grade A was significantly lower in group A (four patients in group A vs. 11 patients in group B). While the incidence in grades B and C was not significantly different regarding the number of patients (Table 7).

Readmission, the actual use of prokinetics and need for nutritional support was higher in group B (anterior wall vertical gastrojejunostomy) than group A (posterior wall vertical gastrojejunostomy) but was not statistically significant (Table 9).

The mean time of starting chemotherapy was better in posterior wall vertical group. Mean 41.22±5.52 day versus 47.09±6.08 day in anterior wall vertical group but was not statistically significant (Table 10).

Unfortunately studies in this topic comparing outcomes of anterior versus posterior wall anastomosis in PD is limited with no definite reference to compare our outcomes with other literatures either with or against our results aiming to evaluate this topic in larger volume of patients and different specialized centers in our country or outside our country.

Table 9 Actual management of delayed gastric emptying patients

	Group A	Group B	Test of significance		
	Mean±SD	Mean±SD	Value	*P* value	Significance
Use of prokinetics					
No	20 (74.07)	12 (52.17)	χ^2=2.59	0.108	NS
Yes	7 (25.93)	11 (47.83)			
Readmission by postoperative day					
No	25 (92.59)	19 (82.61)	Fisher exact test	0.395	NS
Yes	2 (7.41)	4 (17.39)			
Nutritional support					
No	24 (88.89)	17 (73.91)	Fisher exact test	0.270	NS
Yes	3 (11.11)	6 (26.09)			
Need for intervention					
No	24 (88.89)	20 (86.96)	Fisher exact test	1.000	NS
Yes	3 (11.11)	3 (13.04)			
Need for intervention					
UGI	2 (66.67)	3 (100)	Fisher exact test	1.000	NS
Operative	1 (33.33)	0			

UGI, Upper gastrointestinal.

Table 10 Details of chemotherapy in groups

	Group A	Group B	Test of signficance		
	Mean±SD	Mean±SD	Value	*P* value	Significance
Mean time of starting chemotherapy per day	41.22±5.52	47.09±6.08	*t*=3.58	0.001	NS
	n (%)	*n* (%)	Test of signfiiacnce		
Postoperative chemotherapy					
No	9 (33.33)	7 (30.43)	χ^2=0.05	0.827	NS
Yes	18 (66.67)	16 (69.57)			
Preoperative neoadjuvant chemotherapy					
Yes	5 (18.52)	6 (26.09)	χ^2=0.42	0.520	NS
No	22 (81.48)	17 (73.91)			

We tried to compare our results with anterior versus posterior wall gastrojejunostomy done in duodenal ulcers.

Umasankar and colleagues showed a different results regarding time of Ryle removal and overall postoperative outcome. There study compared perioperative and long-term parameters in the anterior and posterior gastrojejunostomy groups. Sixty-five (61.32%) patients were followed up; 31 in the anterior group and 34 in the posterior group. The median follow-up was 5 years (range, 2.5–7.5 years). Except for a significant difference in length of afferent loop ($P<0.0001$), there were no significant differences in the duration of hospital stay, nasogastric aspirates on postoperative days 1, 2, 3, and 4 and the day the nasogastric tube was removed. Early postoperative complications were uncommon and not different in the two groups and long-term outcomes were similar. The anterior gastrojejunostomy, being technically easier and needing less operative time, may be advocated in all cases of chronic duodenal ulcer, with gastric outlet obstruction requiring truncal vagotomy and drainage [13].

In our study there was no significance difference regarding the technical feasibility, operative time, blood loss, or early postoperative complications.

Conclusion

Posterior wall vertical gastrojejunostomy has a better overall significant better outcome regarding early enteral feeding and DGE over anterior wall vertical gastrojejunostomy group also has better enhanced recovery and earlier time of starting chemotherapy. This topic should be evaluated in depth in a large-volume studies.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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