

EVALUATION OF RESULTS OF ERAS PROGRAM AFTER PANCREATODUODENECTOMY DEPENDING ON THE TYPE OF GASTROINTESTINAL RECONSTRUCTION

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ABSTRACT

The aim: To assess the effect of gastrojejunostomy with Braun anastomosis during PD for prevention of DGE in ERAS protocol patients.

Materials and methods: A total of 92 patients from 28 to 75 years were included in this study, who underwent PD with ERAS program. Patients were divided into 2 groups, depending on type of reconstruction - PD with Child reconstruction and PD with gastrojejunostomy with Braun anastomosis.

Results: In non-Braun group nasogastric tube was removed on POD 1 in 56 (93.3%) patients and was reinserted later in 4 (6.7%) patients. DGE was observed in 8 (13,3%) patients, which required enteral feeding via nasojejunal tube. In 51 (85.0%) patients feeding was started according to ERAS program without the need for other methods of nutritional support. In Braun group nasogastric tube was removed on POD 1 in all patients after the X-ray control and oral feeding was started. Due to the development of DGE, a nasojejunal tube for enteral nutrition was placed in two cases. In 30 (93,7%) patients peroral feeding was started in accordance to enhanced recovery program. Thus, the frequency of DGE in group II was lower (6.3%), but the difference did not reach statistical significance ($p = 0.299$).

Conclusions: The formation of a Braun anastomosis in PD with the use of ERAS program can reduce the frequency of DGE and eliminate the consequences of technical errors. More studies are needed for stronger evidence.

KEY WORDS: pancreatoduodenectomy, ERAS, Braun anastomosis

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INTRODUCTION

Pancreatoduodenectomy (PD) is the only radical treatment for benign and malignant diseases of pancreatic head and ampullary zone [1]. For the last decades the mortality rate after PD decreased for 20-30% to 1-5% in specialized surgical centers, however, the number of early postoperative complications, which are the main barrier to recovery, is still high (30-60%) [2,3].

One of the modern surgical trends is the concept of an enhanced recovery after surgery (ERAS) or fast-track surgery, proposed by H. Kehlet in 1997, on the basis of a systemic analysis of pathophysiological mechanisms of postoperative complications [4]. The use of ERAS program for pancreaticoduodenectomy allows to achieve equivalent or better results in terms of length of hospital stay, incidence of morbidity and mortality, readmission rates [5-8].

Delayed gastric emptying (DGE) is one of the most common complications after PD (19-61%) [1]. Pathophysiologic mechanisms of DGE remain unclear and are considered to be multifactorial [8]. This complication is not life threatening, but it significantly increases patient's discomfort, prolongs length of hospital stay and increases the cost of treatment, delays the start of adjuvant treatment [8,9]. It is considered, that the type of reconstruction after PD can affect the incidence of DGE. The results of ante- and retrocolic gastrojejunostomy [10,11], pylorus-resecting and pylorus-preserving PD [12,13], gastrojejunostomy by Bilioth II, Roux-en-Y and with Braun anasto-

mosis [14-16] were compared, but the results are contraversing.

THE AIM

The aim of this study was to assess the effect of gastrojejunostomy with Braun anastomosis during PD for prevention of DGE in ERAS protocol patients.

MATERIALS AND METHODS

A total of 92 patients from 28 to 75 years were included in this study, who underwent PD with ERAS program for benign and malignant diseases of pancreatic head and ampullary region for the period from January 2015 to February 2020. Into the first group 60 patients were retrospectively assigned, who underwent PD with Child reconstruction for the period from January 2015 to December 2017. Into the second group 32 patients were prospectively assigned, who underwent PD with gastrojejunostomy with Braun anastomosis for the period from January 2018 to February 2020. Exclusion criterias were PD with vascular resections and reconstructions, pylorus-preserving PD and PD with pancreatogastroanastomosis.

ERAS program after PD was based on recommendations of ERAS society [17], excluding two chapters – perioperative immunonutrition and wound catheter and transversus abdominis plane (TAP) block. Abdominal X-ray with peroral

contrast agent was used to evaluate gastric emptying on the first postoperative day.

All patients underwent pylorus-resecting PD. Standard lymphadenectomy included en bloc resection of the following groups: lymph nodes of the right side of the hepatoduodenal ligament (12b1, 12b2, 12c), posterior and anterior pancreaticoduodenal nodes (13a, 13b, 17a, 17b), nodes to the right side of the superior mesenteric artery from the origin of the superior mesenteric artery at the aorta to the inferior pancreaticoduodenal artery (14a, 14b).

In the first group of patients reconstruction was performed in the following manner: sequential formation of pancreatico-, hepatico- and antecolic gastroenteroanastomosis on the loop of small bowel as described by Child. Portal vein and hepatic artery branches were isolated by omental patch. Hepatico- and pancreaticojejunostomies were formed in end-to-side fashion "duct-to-mucosa". Gastroenteroanastomosis was formed by two layer continuous suture. Two drains were placed above and under pancreaticojejunostomy. In the second group of patients reconstruction was performed in the same manner, but additional Braun anastomosis was formed between afferent and efferent loops to gastroenteroanastomosis at a distance of 15 cm.

Patient characteristics included gender, age, body mass index (BMI), ASA risk assessment, duration of surgery, blood loss, pancreatic texture (soft or hard). The Clavien-Dindo classification was used to assess complications [18]. ISGPS definitions were used to characterize DGE and postoperative pancreatic fistula (POPF) [8, 19].

Statistical analysis was performed using statistical package for the social sciences (SPSS) software version 20 (SPSS Inc., Chicago, IL, USA). Continuous variables were compared using unpaired Student's t-tests. Descriptive data is reported as mean (standard deviation) and median (range), or number of patients and percentage. A p-value <0.05 was considered statistically significant.

RESULTS

There was no significant difference in age, sex, body mass index (BMI), ASA risk score, comorbidities, pathologic diagnosis and frequency of biliary decompression between groups (Table I).

Intraoperative parameters such as blood loss, pancreatic texture and diameter of the main pancreatic duct also did not differ significantly between groups (Table II). In group II there was a slightly longer operation time, but the difference was not statistically significant.

There were no postoperative mortality in both groups. The number of patients with complications (16 (26.7%) vs. 7 (21.9%) and the total number of complications (22 vs. 10) was lower in the group of patients with Braun anastomosis compared to the non-Braun group, but there was no significant difference ($p > 0,05$). In the analysis of complications according to the Clavien-Dindo classification, no significant differences were found between the groups, with POPF, DGE and infectious complications as most common complications (Table III). In non-Braun group one patient had an episode of mild bleeding from the pancreatojejunostomy, which manifested as extra- and intraluminal bleeding from the abdominal drains and into the jejunum on POD 20, which was treated conservatively.

In non-Braun group nasogastric tube was removed on POD 1 in 56 (93.3%) patients and was reinserted later in 4 (6.7%) patients. DGE was observed in 8 (13,3%) patients, which required enteral feeding via nasojejunal tube, inserted by endoscopy on postoperative day 3. In one case, there was an afferent loop syndrome, which manifested as DGE, possibly due to technical errors. Ultrasonography showed distended up to 5 cm afferent jejunal loop to gastroenteroanastomosis. Endoscopic decompression of this loop failed. This complication was treated conservatively with enteral feeding via nasojejunal tube. Thus, in 51 (85.0%) patients feeding was started according to ERAS program without the need for other methods of nutritional support.

In Braun group nasogastric tube was removed on POD 1 in all patients after the X-ray control and oral feeding was started. Due to the development of DGE, a nasojejunal tube for enteral nutrition was placed by means of endoscopy in two cases. In 30 (93,7%) patients peroral feeding was started in accordance to enhanced recovery program. Thus, the frequency of DGE in group II was lower (6.3%), but the difference did not reach statistical significance ($p = 0.299$).

The length of hospital stay did not differ statistically between the groups and was 13.1 vs 12.6 days in the Braun and non-Braun groups, respectively ($p = 0.655$).

DISCUSSION

DGE is the most common complication after PD. Akerberg D. et al. Report that among 1174 patients with overall number of complications 61,1%, the most frequent were DGE (24,4%), POPF (18%), intraperitoneal abscess (12,4%), bleeding (8,8%), wound infection (8,1%) and biliary fistula (4,7%) [20]. According to a number of publications, the use of ERAS in PD leads to equivalent or even better results in the length of hospital stay, number of complications, mortality and readmission rates without evidence of harm [5-7]. The program, proposed by the ERAS association, includes the removal of the nasogastric tube and the start of early oral nutrition on the first day after surgery. There is evidence that the use of the ERAS protocol leads to a decrease in the frequency of DGE [21-23]. The development of DGE and the delay in the implementation of one of the key components of the program may negatively affect its results.

Since the first description of DGE after PD by Warshaw in 1985 [1], many efforts have been made to further understand the mechanisms of DGE and to minimize the risk of its occurrence by various surgical techniques.

Kawai M. et al. in a prospective randomized controlled trial found that pylorus-resecting PD is accompanied by a significantly lower frequency of DGE than pylorus-preserving technique (4.5% vs. 17.2%, respectively) [24]. A meta-analysis of Li W. et al., which included eleven randomized controlled trials, also showed lower rates of DGE after pylorus resecting compared to pylorus-preserving PD [13]. Zhou Y. et al. based on the analysis of own experience and meta-analysis of eight non-randomized and two randomized clinical trials involving 804 patients, showed a significant difference ($P < 0.001$) in the frequency and

Table I. Preoperative characteristics

Preoperative factors	Non-Braun (n=60)	Braun (n=32)	p value
Age, years, mean (SD)	55,7 (±11,6)	60,4 (±10,9)	0,062
Gender, n (%)			
Male	35 (58,3%)	17 (53,1%)	0,631
Female	25 (41,7%)	15 (46,9%)	
IMT, (kg/m ²), mean (SD)	25,4 (±4,6)	24,5 (±3,8)	0,346
ASA score, n (%)			
I	10 (16,7%)	7 (21,9%)	0,829
II	48 (80%)	24 (75,0%)	
III	2 (3,3%)	1 (3,1%)	
Comorbidities, n (%)			
None	17 (28,3%)	9 (28,1%)	0,972
One	23 (38,4%)	13 (40,6%)	
Two or more	20 (33,3%)	10 (31,3%)	
Diagnosis, n (%)			
Pancreatic cancer	26 (43,3%)	16 (50,0%)	0,541
Ampulla of Vater Cancer	12 (20,0%)	5 (15,6%)	0,607
Bile duct cancer	7 (11,7%)	4 (12,5%)	0,907
pNET	5 (8,3%)	2 (6,3%)	0,720
Other malignancies	6 (10,0%)	4 (12,5%)	0,714
Benign disease	4 (6,7%)	1 (3,1%)	0,475
Biliary decompression, n (%)	22 (36,7%)	10 (31,3%)	0,603

Table II. Intraoperative characteristics

Intraoperative factors	Non-Braun (n=60)	Braun (n=32)	p value
Operative time, min, mean (range)	348,1 (240-540)	362 (275-540)	0,416
Blood loss, ml, mean (SD)	316 (± 161)	301 (± 83,1)	0,624
Pancreatic texture			
Soft	33 (55%)	19 (59,4%)	0,687
Hard	27 (45%)	13 (40,6%)	
Main pancreatic duct diameter			
< 3 mm	13 (21,7%)	8 (25%)	0,825
≥ 3 mm	47 (78,3%)	24 (75%)	

severity of DGE in pylorus-preserving PD and PD with pylorus resection in favor of the latter [25]. However, a recently published report showed that resection of the pylorus during PD does not reduce the frequency or severity of DGE compared to pylorus-preserving PD [12].

According to Tien Y.W. et al., although roux-en-Y gastrojejunostomy does not reduce the risk of DGE compared with the standard method, but has a positive effect on its severity [14]. Klaiber U. et al. didn't find any differences in the frequency and severity of DGE between using the standard Child reconstruction and Roux-en-Y gastrojejunostomy after PD [15]. There were also no differences found in the frequency of DGE after the formation of pancreatogastroanastomosis, gastroenteroanastomosis by Billroth II with Braun anastomosis and Roux-en-Y gastrojejunostomy [1].

To prevent DGE after PD, it was proposed to form a Braun enteroenterostomy between the afferent and efferent loops of the small intestine to gastroenteroanastomosis. The technique was first described by Braun more than 100

years ago in gastric surgery. It is suggested that the prevention of bile reflux into the stomach, which is achieved by Braun anastomosis, may be one of the mechanisms to prevent the development of DGE [26].

The results of studies aimed to evaluate the effectiveness of Braun anastomosis in prevention of DGE after PD are contradictory. In published meta-analysis, the authors concluded that Braun enteroenterostomy in PD helps to reduce the frequency of DGE and reduce the length of postoperative hospital stay [27]. But the studies included in these meta-analyses were retrospective and non-randomized.

According to a systematic review of the literature by Zhou Y. et al., which included eleven studies with a total of 1672 patients (1005 - with Braun anastomosis and 667 - without), Braun enteroenterostomy in reconstruction after PD statistically significantly reduces the frequency and severity of DGE [28]. In a randomized study, Dikmen K. et al. found that the period of gastric decompression with a nasogastric tube, length of hospital stay, the frequency of DGE, pancreatic fistula and overall

Table III. Postoperative characteristics

	Non-Braun	Braun	p value
Mortality, n (%)	0 (0%)	0 (0%)	
Patients with complications, n (%)	16 (26,7%)	7 (21,9%)	0,613
Patients with ≥ 2 complications, n (%)	5 (8,3%)	3 (9,4%)	0,866
Total number of complications, n	22	10	
Clavien-Dindo score, n (% from total number of complications)			
I	4 (18,2%)	2 (20%)	0,957
II	15 (68,2%)	7 (70%)	
III	3 (3,6%)	1 (10%)	
Delayed gastric emptying (DGE), n (%)	8 (13,3%)	2 (6,3%)	0,299
Grade A	4	1	
Grade B	3	1	
Grade C	1		
Pancreatic fistula, n (%)	7 (11,7%)	4 (12,5%)	0,907
Grade B	6	4	
Grade C	1	-	
Bleeding, n (%)	1 (1,7%)	1 (3,1%)	0,648
Afferent loop syndrome, n (%)	1 (1,7%)	-	-
Infectious complications, n (%)	5 (8,3%)	3 (9,4%)	0,86
Readmission	1 (1,7%)	-	
LOS, days, mean (SD)	13,1 ($\pm 4,1$)	12,6 ($\pm 6,6$)	0,655

incidence of complications after PD were significantly lower with Braun anastomosis than without it (14 (29.8%) vs. 6 (12,8%), $p < 0.05$) [29]. Results of a randomized controlled study by Hwang H.K. et al. of two groups of 30 patients each showed that overall incidence of DGE was lower in the group of patients with Braun anastomosis (26.7%), than in non-Braun group (46.7%), but the difference did not show statistical significance ($P = 0,108$). In multivariate analysis gastrojejunostomy without Braun anastomosis was identified as an independent factor in the development of a clinically significant DGE (coefficient of chance = 16.489; 95% confidence interval: 1.287–211.195; $P = 0,031$) [30]. Fujieda H. et al. in a randomized controlled study did not find significant difference between groups with and without Braun anastomosis, incidence of DGE was 20.6% and 29.4% respectively ($p = 0.401$). The results of multivariate analysis determined that the diameter of the main pancreatic duct < 5 mm was the only independent factor that was significantly associated with the development of DGE [16]. However, these data cannot be interpolated into ERAS-treated patients, because in this study patients received traditional enteral nutrition through a nasojejunal tube in the postoperative period.

There were no studies found of implication of ERAS program after PD with Braun enteroenterostomy. We found a decrease in the incidence of DGE after PD with the formation of gastroenteroanastomosis with Braun anastomosis (from 13.3% to 6.3%), but the difference was not significant ($p > 0.05$).

CONCLUSIONS

The formation of a Braun anastomosis in PD with the use of ERAS program can reduce the frequency of DGE, by reducing the bile and pancreatic juice reflux to the

stomach, and also, may reduce the incidence of gastroenteroanastomosis inflammation. Also, Braun anastomosis can eliminate the consequences of technical errors, such as angling or partial twisting of afferent or efferent loops, by creating an additional way to evacuate pancreatic juice and bile. More studies are needed for stronger evidence.

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The Authors declare no conflict of interest.

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