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## EXPERIENCE OF PANCREATODIGESTIVE ANASTOMOSIS PERFORMING IN PANCREATODUODENECTOMY

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**Abstract.** Experience of pancreaticodigestive anastomosis performing in pancreaticoduodenectomy. Kutovyi O.B., Denysova K.O. The aim of the study was to analyze the short-term and long-term results of pancreaticoduodenectomy (PD) on condition of performing different types of pancreaticodigestive anastomoses. The results of 108 PD of the period from 2008 to 2021 performed in the Department of Surgery N 2 on the basis of the Dnipro Regional Hospital named after I. Mechnikov were analyzed. Pancreatojejunostomy (PJ) was formed in 88 (81.5%) cases, pancreaticogastrostomy (PG) – in 20 (18.5%). Depending on the transverse size of pancreatic isthmus and body, diameter of the pancreatic duct the method of PJ was chosen: telescope-type PJ «end-to-end» (n=26), Wirsung-jejunostomy (n=28), original method (n=34). In the PJ group the dense parenchyma of the pancreas was in 51 (58.0%) cases, soft parenchyma – in 37 (42.0%), and in the PG group the dense gland was observed in 12 (60%) cases, soft – in 8 (40%) patients ( $p>0,05$ ). The number of the early postoperative complications was 43 (39,8±4,7%), among them there were (15,7±3,5%) patients with severe complications who required additional interventions. Mortality was 6.5±2.4%. The best results for the early postoperative complications were obtained in the groups of PG and original PJ. There were statistically significant differences in the total number of cases of the early postoperative complications between the groups of PG (20.0±8.9%) and telescope-type PJ (50.0±9.8%,  $p=0.037$ ) and Wirsung-jejunostomy (50.0±9.4%,  $p=0.034$ ), as well as while comparing the total number of patients with complications in the groups of PG and PJ (44.3±5.3%,  $p=0.045$ ). There were not any statistically significant differences among the late postoperative complications ( $p>0.05$ ).

**Реферат.** Досвід виконання панкреатодигестивних анастомозів при панкреатодуоденальних резекціях.

**Кутовий О.Б., Денисова К.О.** Метою роботи був аналіз найближчих та віддалених результатів панкреатодуоденальної резекції (ПДР) за умови використання різних методів формування панкреатодигестивних анастомозів. Проаналізовані результати 108 ПДР, що були виконані за період з 2008 до 2021 року в клініці хірургії № 2 на базі Дніпровської обласної лікарні ім. І.І. Мечникова. Панкреатоеюноанастомоз (ПЄА) був сформований у 88 (81,5%), панкреатогастроанастомоз (ПГА) – у 20 (18,5%) випадках. Залежно від поперечного розміру перешийка та тіла підшлункової залози, діаметра Вірсунгової протоки обирали методику ПЄА: телескопічний «кінєць-у-кінєць» (n=26); вірсунгоєюноностомію (n=28), оригінальний анастомоз (n=34). У групі ПЄА щільна паренхіма підшлункової залози була в 51 (58,0%) випадку, м'яка – у 37 (42,0%), а в групі ПГА щільна залоза спостерігалась у 12 (60%), м'яка – у 8 (40%) пацієнтів ( $p>0,05$ ). Кількість пацієнтів з ранніми післяопераційними ускладненнями становила 43 (39,8±4,7%), серед них у 17 (15,7±3,5%) хворих були тяжкі ускладнення та ускладнення, що потребували додаткових втручань. Летальність становила 6,5±2,4%. Найкращі результати щодо ранніх післяопераційних ускладнень були отримані в групах ПГА та оригінального ПЄА. При цьому були виявлені статистично значущі відмінності в загальній кількості випадків ранніх післяопераційних ускладнень між групами ПГА (20,0±8,9%) та телескопічним ПЄА (50,0±9,8%,  $p=0,037$ ) і вірсунгоєюноанастомозом (50,0±9,4%,  $p=0,034$ ), а також при порівнянні загальної кількості хворих з ускладненнями в групах ПГА та ПЄА (44,3±5,3%,  $p=0,045$ ). Серед пізніх післяопераційних ускладнень статистично значущих відмінностей між групами виявлено не було ( $p>0,05$ ).

The problem of oncological diseases of the pancreatoduodenal zone does not lose its actuality. According to statistics in the EU, the incidence of pancreatic cancer

(PC) varies from 4 to 9 per 100 thousand population [10]. The incidence of PC in Ukraine is 9.5 among men and 4.8 per 100 thousand among women [7].

The most radical operation for this pathology is pancreaticoduodenectomy (PD) – one of the most difficult surgical interventions [16]. For a long time in the history of pancreatic surgery PD was accompanied by a high level of postoperative complications and mortality, reaching sometimes up to 50-60% [12, 15, 16]. Postoperative mortality has been reduced to 0-4.1% in high-volume centers, but the level of complications still remains quite high – 31.3-43.5% [3, 12, 15, 16].

One of the main causes of postoperative mortality is the failure of pancreaticodigestive anastomoses (PDA). Many variants of PDA have been developed, but implementation of any of them does not guarantee the complete absence of complications. Recently information about benefits of pancreaticogastrostomy (PG) over pancreatojejunostomy (PJ) [11, 13] has started to appear in scientific literature. Comparative analysis of these anastomoses results may be interesting in terms of choosing the best option for surgery in each case.

The aim of the study was to analyze short-term and long-term results of PD on the condition of performing different methods of pancreaticodigestive anastomoses.

#### MATERIALS AND METHODS OF RESEARCH

The results of 108 PD of the period from 2008 to 2021 performed in the Department of Surgery No. 2 on the basis of the Dnipro Regional Hospital named after I. Mechnikov were analyzed. Among them there were 57 (52.8%) men and 51 (47.2%) women aged from 24 to 74 years. The mean age of patients ( $M \pm SD$ ) was  $56.2 \pm 9.7$  years. The study inclusion criteria were patients with PD performed by same surgeon, PD with the standard volume of lymphadenectomy. The study exclusion criteria were the PD with vascular reconstructions, PD with gastrectomy and total pancreatectomy. The majority of cases were represented by adenocarcinomas of the head of pancreas 80 (74.1%). Other patients were operated on due to chronic pseudotumoral pancreatitis – 18 (16.7%);

tumor of choledochus – 4 (3.7%); neuroendocrine tumors – 2 (1.9%); tumors of major duodenal papilla – 2 (1.9%); gastrointestinal stromal tumor – 1 (0.9%); undifferentiated cancer – 1 (0.9%).

The research was conducted in accordance with the principles of bioethics set out in the WMA Declaration of Helsinki – “Ethical principles for medical research involving human subjects” and “Universal Declaration on Bioethics and Human Rights” (UNESCO).

In 82 (75.9%) cases of severe mechanical jaundice the two-steps tactics has been applied. As the first stage percutaneous transhepatic drainage (PTD) of the biliary tract was used. PD was performed as the second step after reducing the bilirubin blood level down to  $\leq 50 \mu\text{mol/l}$ . Isolation and removal of organocomplex in 34 (31.5%) cases were performed by standard methods, in 74 (68.5%) cases – by “no-touch” technology [14]. Child and Whipple reconstructive procedures were used in the reparative phase [16]. The retrocolic gastroenterostomy has been performed in 18 (16.7%) patients, pylorus-preserving PD was performed in 38 (35.2%) cases, PJ was formed in 88 (81.5%) cases, PG – in 20 (18.5%). The choice of PJ method depended on the transverse size of the pancreatic isthmus and body, diameter of the pancreatic duct. When the diameter of the pancreatic duct was more than 3 mm the Wirsung-jejunostomy was formed using the “duct-to-mucosa” technique ( $n=28$ ), when the lateral dimensions of the pancreas body and the small intestine diameter coincided ( $n=26$ ) the “end-to-end” telescope-type PJ was formed [15]. In 34 cases the invaginating PJ was performed using the original method (Fig. 1). It was carried out in forming a “coupling” from the loop of the small intestine, which fits the pancreatic stump, the anastomosis was strengthened by the marginal nodal sutures providing invagination of the pancreatic stump into the small intestine lumen and reducing the pancreas trauma [4].

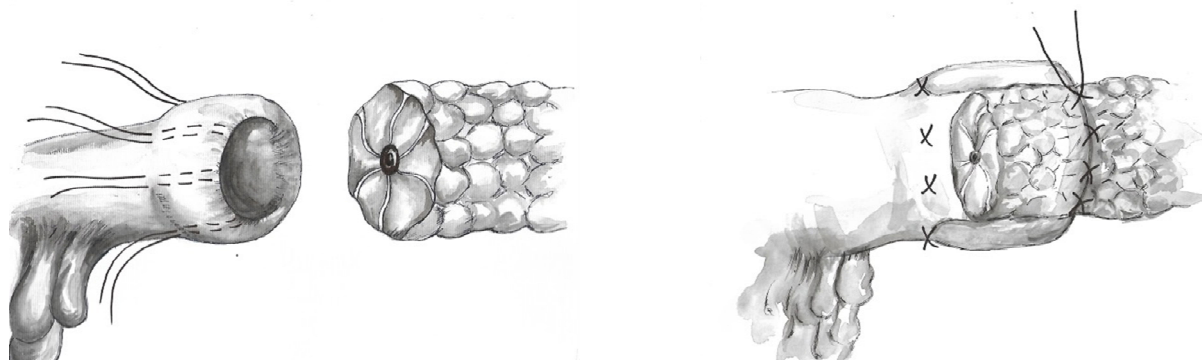


Fig. 1. Scheme of original pancreatojejunostomy

In 8 cases, when diameters of pancreatic stump and small intestine did not match, PJ was formed according to the original method in modification (Fig. 2). After formation of the “coupling” from the small intestine, dissections of the serous-muscular

layer of the edge of the “coupling” were performed in the transverse direction, followed by suturing in the longitudinal direction. From 2 to 4 notches were made to achieve the desired diameter of the “coupling” [5].

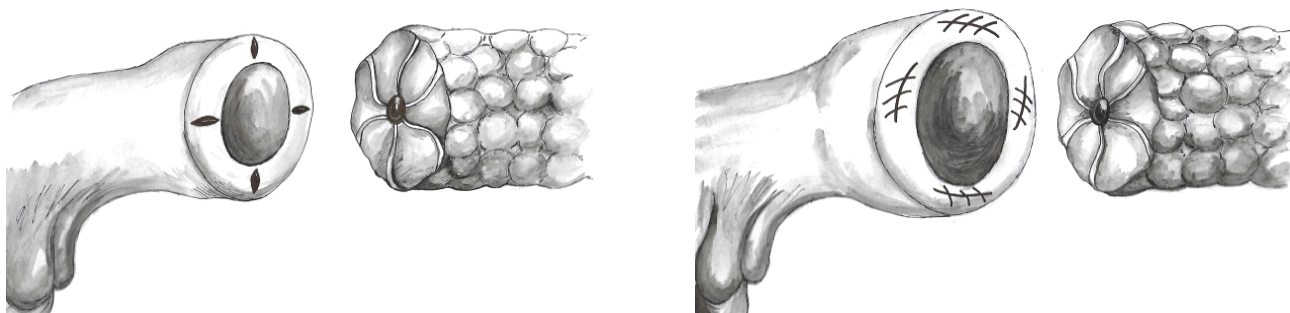


Fig. 2. Original pancreatojejunostomy in modification

The distribution of patients into groups depending on the type of the formed anastomosis, as well as their age and gender composition is shown in the Table 1.

The pancreas parenchyma density was assessed according the Halperin classification [2]. It was noted

that in the PJ group pancreatic parenchyma was dense in 51 (58.0%) cases, soft – in 37 (42.0%), and in the PG group the dense gland was observed in 12 (60%) cases, soft – in 8 (40%) patients ( $\chi^2=0,03$ ;  $p>0.05$ ).

Table 1

Distribution of patients depending on age and gender

Index	Total (n=108)	Pancreaticojejunostomy (n=88)			Pancreaticogastrostomy (n=20)
		telescope-type anastomosis (n=26)	wirsung-jejunostomy (n=28)	original anastomosis (n=34)	
Mean age, years, (M±SD)	56.2±9.7	53.7±10.7	58.0±7.2	55.1±11.1	58.7±8.5
Gender, abs. (%)					
male	57 (52.8%)	12 (46.2%)	17 (60.7%)	20 (58.8%)	8 (40.0%)
female	51 (47.2%)	14 (53.8%)	11 (39.3%)	14 (41.2%)	12 (60.0%)

Note. Differences between the groups are not significant ( $p<0.05$  according to Tukey's test and Pearson's chi-squared test).

Number and specificities of postoperative complications were studied. Thus, complications arising within 30 days from the date of operation were defined as early, and in terms of more than 30 days – as late [8]. In the postoperative period the degree of PDA insufficiency was assessed using the postoperative pancreatic fistulas classification developed by ISGPS (International Study Group of Pancreatic Surgery), according to it:

1. The A-type fistulas do not require specific treatment and are defined as an increase the of alpha-

amylase level in the fluid from the abdominal cavity, obtained from drains, above the level of alpha-amylase in the patient's blood.

2. The B-type fistulas manifest by increased volume of fluid from the abdominal drains or by accumulating of fluid in the abdominal cavity, deterioration of the patient's condition. Treatment usually requires the drug therapy appointment, as well as invasive procedures (puncture drainage of accumulated fluid).

3. The C-type fistulas are severe, treatment of patients requires relaparotomies, may be accompanied by necrosis of the pancreas with peritonitis [8].

If alpha-amylase level did not increase in the fluid from the drains above the level of alpha-amylase in the patient's blood and presence of serous fluid discharge was more than 50 ml and more than 7 days, the last was assessed as lymphorrhea.

Statistical analysis was performed using the software product STATISTICA 6.1 (StatSoftInc., Serial No. AGAR909E415822FA). Data are presented as arithmetic mean with standard deviation ( $M \pm SD$ ) or frequency with standard error ( $P \pm m\%$ ). To compare the mean values between the study groups Student's t-test (for pair-comparison), Tukey's test (Tukey HSD) for multiple comparison, Pearson's chi-squared test ( $\chi^2$ ) without Yates' continuity correction for relative values were used [1]. The differences were considered statistically significant at  $p \leq 0.05$ .

#### RESULTS AND DISCUSSION

In the most patients the PTD of the biliary tract as the first step of treatment was not associated with technical difficulties. In 2 cases cholecystostomy did not provide adequate external bile secretion due to the functional insufficiency of the cyst duct requiring additional puncturing and drainage of the common bile duct. Among 72 patients who underwent PDT two patients ( $2,8 \pm 1,9\%$ ) had drainage dislocation.

Analysis of the early postoperative complications was performed according to the type of pancreatodigestive anastomosis (Table 2). The calculations were made with adjustment for the presence of several complications in the same patient. Both surgical and general complications were taken into account.

The study revealed statistically significant differences in the total number of cases of the early postoperative complications between the PG ( $20,0 \pm 8,9\%$ ), telescope-type PJ ( $50,0 \pm 9,8\%$ ,  $p=0,037$ ) and Wirsung-jejunosomy ( $50,0 \pm 9,4\%$ ,  $p=0,034$ ) groups, as well as in the total number of patients with complications in the PG and PJ groups ( $44,3 \pm 5,3\%$ ,  $p=0,045$ ).

Pancreatic fistulas were found in 19 of 108 patients ( $17,6 \pm 3,7\%$ ), among them: A type – in 7 ( $6,5 \pm 2,4\%$ ) cases, type B/C – in 12 ( $11,1 \pm 3,0\%$ ) cases. The B type fistulas manifested by increased amount of serous fluid through abdominal drains, as well as accumulated fluid in the sub phrenic spaces. It was accompanied by deterioration in the general condition of patients, increasing of the body temperature up to  $39^\circ\text{C}$  and more, abdominal pain, stool and gas retention. In 5 ( $4,6 \pm 2,0\%$ ) cases the fluid drainage procedures were performed by puncture method under ultrasound control. In 3 ( $2,8 \pm 1,6\%$ ) patients the condition improved after conservative drug therapy. The C type fistulas

developed in 3 ( $2,8 \pm 1,6\%$ ) cases were severe, treatment required relaparotomy with additional drainage of the abdominal cavity. In 2 ( $1,9 \pm 1,3\%$ ) patients they were accompanied by necrosis of the pancreatic stump with symptoms of peritonitis, increasing multiorgan failure and, ultimately, caused the death of patients. All cases were observed in telescope-type and Wirsung-jejunosomy groups. There were not any C type fistulas in the PG group. Among 12 patients with B/C-types pancreatic fistulas there were 8 ( $66,7 \pm 13,6\%$ ) patients with soft pancreatic parenchyma.

Gastric stasis was observed in 4 cases of 108 patients ( $3,7 \pm 1,8\%$ ), in 3 ( $2,8 \pm 1,6\%$ ) of them after PJ with placing gastroenteroanastomosis in the retrocolic position. Conservative therapy, gastric decompression and prolonged tube enteral feeding led to improvement in all patients. The maximum duration of clinical manifestations of gastric stasis was 4 weeks. In 1 ( $0,9 \pm 0,9\%$ ) patient gastric stasis developed after application of PG with pyloric preserving resection of the stomach on the 20<sup>th</sup> postoperative day. It was accompanied by stenosis of the gastroenteroanastomosis. This required relaparotomy and additional gastroenterostomy.

In general, bleeding of various severity in the early postoperative period occurred in 10 ( $9,3 \pm 2,8\%$ ) patients. In most cases, they accompanied or were the result of other complications, such as C-type pancreatic fistulas, necrosis of the pancreatic stump. Internal bleeding from PJ in the early postoperative period occurred in 2 of 88 patients ( $2,3 \pm 1,6\%$ ). It required relaparotomy to stop bleeding. During intraluminal bleeding after PJ blood clots of a characteristic elongated shape were detected in the lumen of the stomach. It has been described in the patent of Ukraine for a utility model No. 133883 "Method for bleeding diagnosing from PJ" [6].

The total number of patients with various early postoperative complications was 43 ( $39,8 \pm 4,7\%$ ), among them 17 ( $15,7 \pm 3,5\%$ ) patients had severe complications and complications that required additional interventions and/or reoperations. In particular, in 12 of 17 cases ( $70,6 \pm 11,1\%$ ) they were associated with pancreatic fistulas. In the early postoperative period 7 of 108 patients died, mortality was  $6,5 \pm 2,4\%$ . Moreover, all mortalities occurred after PD with the formation of PJ ( $\chi^2=1,70$ ;  $p=0,192$  compared with PGA). In the structure of the early postoperative complications the total number of complications associated with surgery was 65 ( $60,2 \pm 4,7\%$ ), wherein pancreatic fistulas, bleeding of various localizations and gastric stasis prevailed among them – 33 ( $50,8 \pm 6,2\%$ ).

Table 2

Early complications after PD

Complications	Pancreaticojejunostomy (n=88)				Pancreaticogastrostomy (n=20), abs. (P±m %)
	telescope-type anastomosis (n=26)	wirsung-jejunostomy (n=28)	original anastomosis (n=34)	PJ total (n=88), abs. (P±m %)	
Pancreatic fistulas, total:	4	7	5	16 (18.2±4.1)	3 (15.0±8)
- type A	1	2	3	6 (6.8±2.7)	1 (5.0±4.9)
- type B	1	4	2	7 (8.0±2.9)	2 (10.0±6.7)
- type C	2	1	-	3 (3.4±1.9)	-
Bleeding from PDA:					
- extraluminal	1/1*	-	-	1/1* (1.1±1.1)	-
- intraluminal	-	-	1/1*	1/1* (1.1±1.1)	-
Necrosis of pancreatic stump	2/1*	1	-	3/1* (3.4±1.9)	-
Abscess in the abdominal cavity	1/1*	-	-	1/1* (1.1±1.1)	-
Bleeding into abdominal cavity	1/1*	2/2*	1/1*	5/5* (5.7±2.5)	1/1* (5.0±4.9)
Gastric stasis	1	1	1	3 (3.4±1.9)	1 (5.0±4.9)
Wound abscess	1	-	2	3 (3.4±1.9)	-
Failure of the hepaticojejunostomy	-	-	2/1*	2/1* (2.3±1.6)	2/2* (10.0±6.7)
Lymphorrhoea	1	1	4/2*	6/2* (6.8±2.7)	-
Hepatic failure	1	1/1*	-	2/1* (2.3±1.6)	-
Gastrointestinal bleeding	-	2/2*	-	2/2* (2.3±1.6)	-
Gastroenterostomy ulcer	-	2/1*	-	2/1* (2.3±1.6)	-
Acute early intestinal obstruction	1	1	-	2 (2.3±1.6)	-
Hepatitis, hepatic jaundice	-	1	-	1 (1.1±1.1)	-
Acute cardio-vascular insufficiency	-	1/1*	-	1/1* (1.1±1.1)	-
Pneumonia	1	1/1*	-	2/1* (2.3±1.6)	-
Pleural effusion	2	2/1*	1	5/1* (5.7±2.5)	-
Total number of patients with complications: abs. (P±m%)	13 ^ (50.0±9.8%)	14 ^ (50.0±9.4%)	12 (35.3±8.2%)	39 ^ (44.3±5.3)	4 (20.0±8.9)

Notes: \* – number of several complications cases in one patient; probable differences as compared with the PG group: ^ – p<0.05 (Pearson's test).

The late postoperative complications after PD were also analyzed depending on the type of anastomosis (Table 3).

Peptic ulcer of gastroenterostomy as a late postoperative complication was diagnosed in 2 of 108 patients (1.9±1.3%). In one of them it developed in 5 years after PD for neuroendocrine tumor of

pancreas head. The ulcer led to subcompensated pyloric stenosis. The patient underwent reconstructive resection of the stomach stump and part of the afferent loop with good results. The same complication developed in 12 years after PD, there was recurrent bleeding from the ulcer, which together with other comorbidities led to the death of the patient.





Table 3

## Late complications after PD

Complications	Pancreaticojejunostomy (n=88)				Pancreaticogastrostomy (n=20), abs. (P±m %)
	telescope-type anastomosis (n=26)	wirsung-jejunostomy (n=28)	original anastomosis (n=34)	PJ total (n=88), abs. (P±m %)	
Internal bleeding from the PDA	-	1	1	2 (2.3±1.6%)	-
Internal bleeding from the hepaticojejunostomy	-	-	-	-	1 (5.0±4.9%)
Gastric stasis	1	-	-	1 (1.1±1.1%)	1 (5.0±4.9%)
Peptic ulcer of gastroenterostomy	1	1	-	2 (2.3±1.6%)	-
Postoperative ventral hernias	4	3	5	12 (13.6±3.7%)	-
PDA stenosis	-	-	-	-	1 (5.0±4.9%)
<b>Total number of patients with complications: abs. (P±m %)</b>	<b>6 (23.1±8.3%)</b>	<b>5 (17.9±7.2%)</b>	<b>6 (17.6±6.5%)</b>	<b>17 (19.3±4.2%)</b>	<b>3 (15.0±8.0%)</b>

Note. Differences between the groups are not significant ( $p>0.05$  according to Pearson's test).

2 of 88 (2.3±1.6%) patients had erosive bleeding from the PJ area in the late postoperative period in three and six months after surgery. They caused multiple organ failure and death of patients.

Postoperative ventral hernias were detected in 12 of 88 (13.6±3.7%) patients after PJ at different times of the postoperative period (from 0.5 years to 3 years). These patients underwent open mesh repair. It should be noted that in the PG group such complications were not observed ( $\chi^2=3.07$ ;  $p=0.08$  compared with PJ).

Regarding the late complications after PG, 1 of 20 patients (5.0±4.9%) was diagnosed with gastric stasis 35 days after the operation. It developed after the pyloric-preserving PD, required re-hospitalization, but was cured conservatively. Another 1 (5.0±4.9%) patient developed complete obliteration of PG with Wirsung dilatation 6 months after surgery, not associated with prolongation of the disease. Neopancreaticogastrostomy was performed.

The available results in reducing the number of postoperative complications after PG generally correspond to the results of studies presented in meta-analyses [11, 13]. However, it should be noted that according to the obtained data there are no statistically significant differences between the results of PG and PJ in our own modification.

Thus, the total number of patients with the early postoperative complications after the PJ formation was 44.3±5.3%, after PG – 20.0±8.9% ( $p<0.05$ ). Moreover, the pancreatic fistulas predominated among the severe surgical complications (70.6±11.1%). The

percentage of patients with the late postoperative complications in the groups of PJ and PG was 19.3±4.2% and 15.0±8.0% respectively ( $p>0.05$ ). Ventral hernias – 12 cases from 20 (60.0±11.0%) dominated in the structure of the late complications. The total number of patients with various types of the early and late complications after PD was 63 (58.3±4.7%).

## CONCLUSIONS

1. Among all anastomoses analyzed during the study, the best results in the early postoperative period were obtained for pancreaticogastro- and pancreatojejunostomy in the original modification.

2. In the structure of the early postoperative complications after pancreaticoduodenectomy 33 (50.8±6.2 %) were formed by pancreatic fistulas, gastric stasis and bleeding of different localizations, and among the late postoperative complications the ventral hernias predominated – 12 (60.0±11.0 %).

3. The reduction in the total number of complications after PD is associated with the choice of variant of pancreaticodigestive anastomosis and improvement of surgical technique.

## Contributors:

Kutovyi O.B. – conceptualization, validation, writing – review & editing;

Denysova K.O. – formal analysis, investigation, writing – original draft

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