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Surgical management of pancreatoduodenal tumors: the experience of using the developed operation technique

Relevance: The results of surgery in patients with pancreaticoduodenal cancer remain unsatisfactory. This complicates the choice of an optimal surgical technique in modern oncology.

Surgery in the pancreaticoduodenal zone is associated with complications due to anatomical and physiological features of the pancreas and technical challenges of this surgical intervention. Despite preventive actions and innovative technologies, such a traumatic operation as pancreatoduodenal resection often produces complications, though recently fewer.

This article describes a pancreaticoduodenal resection technique that reduces postoperative complication frequency and lethality in operable pancreaticoduodenal cancer.

The purpose of the study was to assess the efficiency of an authorial pancreaticoduodenal resection technique (pancreaticojejunal invagination anastomosis) in pancreaticoduodenal cancer.

The proposed pancreaticojejunal anastomosis-forming technique allowed reducing the postoperative complication frequency from 54.2% to 38,0% and postoperative lethality from 22.8% to 9,5%.

Conclusion: This highly traumatic surgery is associated with postoperative complications (up to 50-70% of cases), which are quite severe and difficult to resolve and result in high fatality. The proposed pancreaticojejunal anastomosis forming technique has efficiently reduced postoperative complications and fatality to a significant extent.

Keywords: pancreatoduodenal cancer, pancreatoduodenal resection, malignant neoplasm of pancreas (ICD C25).

Introduction: Pancreatoduodenal cancer is the 9th most common cancer nosology and the 4th most lethal. Despite the development of new ways of pancreatic surgery, the introduction of laparoscopic and robotic technologies, this type of surgery remains the most difficult in abdominal surgery.

These high traumatic operations are associated with postoperative complications (up to 50-70% of cases), which are rather severe and hard to resolve. The absence of these specialized centers is one of the reasons for unsatisfactory results and high mortality, reaching 10%. With a rational approach to solving such a complex problem, the authors consider it reasonable to create specialized centers for surgical care with the routing of patients with pancreatoduodenal diseases. The results of such a center (e.g., National Medical Research Center of Surgery named after A.Vishnev, Federal State Budgetary Institution. A.V. Vishnevsky National Medical Research Center) are characterized by relatively low postoperative complications (38.6%) and mortality (2.4%). In addition, a system of accreditation of specialized centers and clinics under international requirements for high-volume centers is needed [1].

Multidisciplinary and multicenter studies have demonstrated the effectiveness of new approaches and technologies. However, there are sporadic clinical observations in the literature, which are unlikely to draw definite conclusions about the efficacy of various tech-

niques of pancreaticoduodenal resection. However, their results should be taken into account. There is no doubt that at correctly performed pancreatoduodenal resection high survival rate can be achieved in patients with non-spread pancreatic cancer. However, if complications develop, only proper management tactics allow improving the results. Thus, pancreatectomy in case of total pancreatic necrosis development allowed to achieve good results in the form of patient survival despite a long (several months) in-patient treatment [2-4].

The desire of surgeons to perform radical interventions forces them to perform radical operations, but their traumatic nature and duration cause the development of postoperative complications. Sometimes, in unusual situations, it is necessary to change the surgical tactics. Several clinical observations demonstrate prolonged survival or recovery of patients with malignant pancreatic tumors after radical surgery [5].

The surgical interventions on the pancreas (especially on the Virgin's duct) are characterized by a high traumatic effect that results in pancreatitis and pancreatic necrosis development. In its turn, pancreatic necrosis leads to purulent-inflammatory phenomena in the abdominal cavity with the development of anastomosis failure and, subsequently, abdominal sepsis and even lethal outcome [6, 7].

Preoperative antitumor treatment has a positive effect on the long-term outcome. However, it may cause

immunosuppression and thus adversely affect the immediate results of surgical treatment, exacerbating the severity of postoperative complications. A comprehensive therapeutic approach, including timely surgical treatment of complications of disseminated postoperative pancreatic necrosis in the conditions of a specialized hospital, can significantly reduce mortality. Currently, there is no convincing evidence showing a positive or negative effect of postoperative pancreatic necrosis on long-term survival after radical interventions in pancreatic cancer patients [8].

Laparoscopic pancreatoduodenal resection **is an innovative technology**. Despite the complexity and traumatism of this operation, it is possible to obtain good results with the accumulation of experience. At the same time, the general incidence of complications was 35.5% of the patients, and mortality was 6%. The most frequent complication was pancreatic fistula formation; at the same time, we noted a considerable decrease of pancreatic fistula formation rate from 21% to 9.6% compared to open-access pancreatoduodenal resection [9].

Laparoscopic surgery outcomes could be compared to traditional open surgery based on literature data and the statistics of large centers which use high-tech minimally invasive interventions to operate on the pancreatoduodenal area. Khatkov et al. identified the advantages of laparoscopic and robotic interventions and obtained reasonably good results for minimally invasive surgical interventions. There was significantly less intraoperative blood loss and, importantly, a faster recovery period. It is advisable to perform laparoscopic and robotic interventions in specialized centers with surgeons with sufficient experience [10].

The most high-tech method of intervention on the pancreas is robot-assisted surgery. This technology is gradually being introduced in the CIS countries, and experience is being gained in it. It should be noted that during the period of mastering robot-assisted surgery, no significant decrease of postoperative complications rate was observed; however, with the accumulation of experience, there was a tendency to improve the results in malignant T1-T2 pancreatic tumors. It is reasonable to perform robotic technologies only in specialized centers managing patients with pancreatic neoplasms [11].

Veligotsky et al. recorded complications in 56 (27.2%) of operated patients during their observations. Formation of anastomosis on an isolated loop of jejunum allowed to decrease the incidence of postoperative pancreatitis in pancreatic stump from 31.6% to 14.1%. Another severe complication – the failure of the pancreatico-jejunal anastomosis with the formation of pancreatic fistula – was observed in 8.7% of patients. During the reconstructive stage, pancreatico-jejunal anastomosis was formed on the isolated loop of the jejunum to obtain better results. Differentiated approach to the choice of pancreatico-jejunal anastomosis formation method at pancreatoduodenal resection taking into account the diameter and state of pancre-

atic parenchyma contributes to reducing postoperative complications [12].

In pancreatoduodenal resection, intraluminal hypertension, the impact of pancreatic enzymes on the suture line, and the formation of pancreatico-enteric anastomosis rather than pancreatico-jejunal anastomosis can cause anastomosis failure. The effectiveness of pancreatico-enteric anastomosis has been convincingly proved in the literature, even when performed by surgeons with little experience. External drainage was effectively applied to achieve decompression. However, it necessarily required extra intervention for drainage elimination, which is a negative characteristic of the method suggested by O.I. Kit et al. There were complications in 3.4% of patients, but without lethal outcome, unlike the patients who used pancreatojejunal anastomosis. The most frequent complications included: postoperative pancreatitis – 24.5%, pancreatodigestive anastomosis failure – 7.7%, gastrostasis – 9.0%, external pancreatic fistulas – 5.2%, peritonitis – 5.8%, and hepatic-renal insufficiency – 11.6%. Such a severe complication as postoperative pancreatic necrosis was relatively less frequent – 1.9%, indicating the effectiveness of pancreatico-enteric anastomosis used by Hal-le-Smith et al. [13, 14].

The results of surgical interventions for pancreatic tumors depend on the method of pancreatico-jejunal anastomosis formation. The authors propose to use termino-terminal pancreatico-jejunal anastomosis. This method consists of the formation of the single-row termino-terminal pancreatico-jejunal anastomosis. The main positive results of this method in comparison with other ways of pancreatico-jejunal anastomosis formation are: the reduction of the operative intervention duration down to 170 minutes, a decrease of complications rate - repeated operations were needed in 12% of cases, general decrease of the stable disability loss - in 50% of patients and the most important one is the absence of lethality. The authors used biliary tract decompression in more than 60% of patients. In the distant period, the rate of permanent disability turned out to be 15% lower and quality of life according to MOS SF-36 and EORTC QLQ-C30 was better. Thus, the proposed method of single-row termino-terminal pancreatico-jejunal anastomosis significantly reduced the incidence of early and late complications [15, 16].

The purpose of the study was to assess the efficiency of an authorial pancreaticoduodenal resection technique (pancreaticojejunal invagination anastomosis) in pancreaticoduodenal cancer.

Material and Methods:

In 2011-2021, 56 surgical interventions for pancreatoduodenal tumors were performed at Karaganda Multiprofile Hospital №3 (Regional Oncology Center). The majority of them were the tumors of pancreas head – 41 (73.2%), carcinoma of large duodenal papilla – 5 (8.9%), tumor of extrahepatic bile duct as cholangiocarcinoma – 4 (7.1%), less often: duodenum masses – 2 (3.5%) and other tumor localizations – 4 (7.1%) (Table 1).

Таблица 1 – Частота опухолей панкреатодуоденальной зоны в группах сравнения

Nosologies	Control group (n=35)		Experimental group (n=21)	
	Abs.	%	Abs.	%
Pancreatic head cancer	24	68.57	17	80.95
Cancer of the greater duodenal papilla	3	8.57	2	9.52
Cholangiocarcinoma	3	8.57	1	4.76
Formation of the duodenum	2	5.71	–	–
Other localizations*	3	8.57	1	4.76
Total	35	99.99	21	99.99

*Other localizations were colorectal tumor with pancreatic duct infiltration - 1, cancer in the distal part of the stomach with infiltration of the gland head - 1, pancreatic tail tumor - 2. Despite the primary localization of the tumor outside the pancreas itself, these patients underwent radical surgery for the underlying disease and pancreatoduodenal resection.

The tumors were detected against the background of the main manifestation of the pathology, such as mechanical jaundice in the majority of patients, 52 (92.8%). And the level of jaundice varied from mild - in 24 (46.2%) patients to moderate - in 19 (35.5%) and severe - in 9 (17.3%) patients. Biliary hypertension was not detected in 4 patients (76.9%), in which a tumor was revealed as a diagnostic finding. After the liquidation of biliary hypertension in various technical variants, the patients underwent radical surgeries.

Considering the applied method of pancreatoduodenal resection, we singled out two groups of patients: the first group of patients in whom traditional conventional technique of pancreatoduodenal resection was carried out - 35 (62.5%), and the experimental group - 21 patients (37.5%). We used the suggested method of forming the invaginated pancreatojejunal anastomosis (copyright certificate of the Republic of Kazakhstan No. 51820) with the decompression of this zone with the help of the "lost" probe, which was set in the lumen of the Virsungal duct stump (copyright certificate of the Republic of Kazakhstan No. 21411) in the experimental group

Two patients with localization of the process in the body and tail of the pancreas underwent corpuscular resection; the postoperative period was relatively smooth, no complications were registered.

In the control group, 35 patients underwent pancreatoduodenal resections with the end-to-end pancreatojejunal anastomosis formation in a usual way.

In both groups, technical difficulties were noted intraoperatively due to the spread of the tumor process, which hampered lymph node dissection. During the operation, bleeding from the mesenteric vessels and portal vein were observed; these complications were resolved intraoperatively. We had to involve an angiosurgeon in 2 cases to perform plastic repair due to tumor invasion of large vessels.

One of the causes of pancreatojejunal anastomosis failure is intraluminal hypertension. In order to exclude the factor of hypertension in the intestinal lumen, the method of internal drainage of the pancreatic duct was developed in the oncology clinic of KSMU. At the formation of the anastomosis, a "lost" polyvinylchloride catheter, an average length of 25 cm, through

which pancreatic juice enters the small intestine distal to the anastomosis, preventing exposure of the remaining part of the pancreas to the area of the sutures is established in the lumen at a depth of 2-3 cm. After complete healing of the anastomosis, the catheter fixed to the wall falls out of the lumen of the Virsungian duct stump and migrates further distally along the intestinal tract. As a result of intestinal decompression, a significant decrease of anastomosis incidence from 11.4% to 4.7% was registered in our observations; it testifies to the efficiency of the proposed method of the pancreatojejunal anastomosis formation.

The method of anastomosis formation is of great importance in anastomosis healing. The proposed invagination method of pancreatojejunal anastomosis "end-to-end" consists of the articulation between the pancreatic stump and the jejunum. The posterior row of external sutures is formed, capturing the peripancreatic and gastropancreatic ligaments, retreating 3 cm from the pancreatic stump. The posterior lip of the anastomosis is formed using a Pirogov-Mateshuk suture without capturing the mucous membrane of the small intestine and pancreatic tissue. Then sutures are applied to the anterior lip of the anastomosis. Subsequently, the intestine is wrapped over the pancreatic stump, and a series of separate anterior sutures are placed, creating an invagination. Then intestinal, gastrojejunal, and biliary-digestive sutures are formed by the traditional method.

Results:

The effectiveness criterion of the suggested method of pancreatojejunal anastomosis was the incidence of postoperative complications and the lethality rate decrease.

In order to assess more objectively, complications in three periods, intraoperative, early postoperative, and in the remote period, were taken into account (Table 2).

Table 2 shows that the most frequent and severe postoperative complications are pancreatojejunal anastomosis failure and bleeding, and in the long-term period - postoperative hernias.

Thus, in the control group, complications were observed in 19 (54.2%) patients, and the fatality rate was 22.8% (n=8). Intraoperative complications in the form

of bleeding from the mesenteric and splenic veins occurred in 3 patients (8.5%). Early complications were registered in 7 cases, pancreatojejunal anastomosis failure - in 4 patients (11.4%), other complications - in 3 patients (8.5%). Other complications were hepato-renal syndrome - in 2 patients (5.7%) and acute cerebral circulation disorder - in 1 (2.8%). Pancreatojejunal anastomosis failure was dangerous and always resulted in the development of peritonitis and severe wound complications. Late complications were registered in 9 observations, among them: anastomosis stenosis in 2 (5.7%),

disease relapse in 3, postoperative hernias in 4. Two patients were operated on repeatedly because of the decompensated stenosis; at the relapse of the disease, symptomatic therapy was prescribed to the patients; 2 patients died because of the disease progression. Four patients with postoperative hernias underwent herniotomy with non-tension hernioplasty. Fatal cases in the control group occurred due to peritonitis resulting from anastomosis failure (n=3), hepatic and renal failure (n=2), cerebral circulation disorders (n=1), disease progression and cancer intoxication (n=2).

Table 2 - Frequency of postoperative complications in comparison groups after pancreatoduodenal resection

Complications	Control group (n=35)		Experimental group (n=21)	
	A6c.	%	A6c.	%
Intraoperative bleeding (vessel damage)	3	8.5	–	–
Failure of pancreatojejunal anastomosis	4	11.4	1	4.7
Mechanical jaundice	–	–	1	4.7
Anastomosis stenosis	2	5.7	–	–
Disease relapse	3	8.5	1	4.7
Postoperative intra-abdominal bleeding	–	–	2	9.5
Postoperative hernias	4	11.4	1	4.7
Abdominal abscess	–	–	1	4.7
Small bowel perforation	–	–	1	4.7
Fatalities	8	22.8	2	9.5
Others*	3	8.5	–	–
Total complications	19	54.2	8	38.0

In the experimental group, complications were noted in 8 (38.0%) patients, and the mortality rate was 9.5%.

Intraoperative complications such as damage of the vena mesenterica superior wall when performing lymph node dissection were noted in 1 patient (4.7%). The vascular suture was performed, the vein patency was not impaired. The clinical picture of jaundice, bilirubin level was 313 $\mu\text{mol/l}$ in the postoperative period in 1 patient. This patient was operated on on Day 8, dilated tense choledochal infiltrate was revealed. When the stumps of the choledochal stump were removed, a large amount of dense dark bile was excreted, biliary tract patency was restored. Subsequently, the patient was discharged in satisfactory condition.

One of the most severe complications was anastomosis failure, which was observed in 1 patient and indicated relaparotomy. Bleeding on Day 3 after surgery was observed in 2 patients. The source of bleeding was the hepatic artery; final hemostasis and elimination of the defect by suturing the vessel wound were performed. The defect in the arterial vessel wall appeared rather due to the burn of the wall during mobilization and lymph node dissection. Subsequently, this patient died of wound purulent-infectious complications.

There were early complications such as small intestinal fistula - in 1 patient, subdiaphragmatic abscess - in 1, postoperative intraabdominal bleeding - in 2, perforation

of the small intestine wall with the non-silicone tube complicated by peritonitis - in 1 patient. On the 8th day, the patient underwent relaparotomy, suturing of the defect, and abdominal cavity lavage, but the patient died of decompensated heart failure despite the carried therapy.

Complications developed in the long-term period in 3 patients, including a postoperative ventral hernia in 1 patient and a relapse of the disease in 1 patient, who died one year after the operation.

Complications in the form of pancreatojejunal anastomosis failure were significantly more frequent in patients with non-invasive anastomosis formation and without the use of temporary decompression drainage. Such complications occurred in 4 patients (11.4%).

Conclusions:

1. Treatment of pancreatoduodenal tumors is one of the complex problems of modern oncology because of the frequent complications and relatively high lethality.

2. As the result of the new method of operative intervention and innovative technologies introduction, the tendency to decrease complications and lethality rate at the treatment of the pancreatoduodenal zone tumors is registered.

3. One of the severe complications of pancreatoduodenal tumor treatment is pancreatojejunal anastomosis failure. This complication leads to peritonitis and more severe outcomes and mortality.

4. The use of invagination pancreatojejunal anastomosis, particularly the method of decompressive drainage of the Virsungal duct using a "lost" probe, excludes the aggressive pancreatic juice ingress into the area of the newly formed anastomosis.

5. When performing the reconstructive stage of the operation, it is advisable to use the proposed method of pancreatojejunal anastomosis, taking into account its high reliability.

6. The described method of pancreatojejunal anastomosis allows to decrease the complication rate to 38,0% and to decrease the lethality to 9,5%.

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Панкреатодуоденальды аймақ ісіктерінің хирургиясы: операцияның әзірленген тәсілін қолдану тәжірибесі

Өзектілігі: панкреатодуоденальды аймақтың қатерлі ісігі бар науқастарды емдеуде хирургиялық тактиканы оңтайлы таңдау қазіргі онкологияның толық шешілмеген мәселесі болып қала бермейді, бұл хирургиялық араласудың қанағаттанарлықсыз нәтижелеріне байланысты.

Панкреатодуоденальды аймақ ісіктерінің хирургиясы асқынулармен бірге жүреді, бұл ұйқы безінің анатомиялық және физиологиялық ерекшеліктерімен және араласудың техникалық қиындықтарымен түсіндіріледі. Панкреатодуоденальды резекция сияқты травматикалық операциядан кейін және инновациялық технологиялардың алдын-алуға және енгізуге қарамастан, асқынулар жиі пайда болады, дегенмен жақында олардың төмендеу тенденциясы байқалады.

Бұл мақалада операциядан кейінгі асқынулардың жиілігін және панкреатодуоденальды аймақтың жедел қатерлі ісігіндегі өлімді азайтуға мүмкіндік беретін панкреатодуоденальды резекция әдісі сипатталған.

Мақсаты: панкреатодуоденальды аймақтың қатерлі ісігі кезінде панкреатодуоденальды резекцияның (панкреатоюнальды инвагинациялық анастомоздың) авторлық әдісінің тиімділігін бағалау.

Нәтижелер: панкреатиялық анастомозды қалыптастырудың ұсынылған әдісі операциядан кейінгі асқынулардың жиілігін 54,2%-дан 38,0%-ға дейін төмендетуге және ерте кезеңдегі өлімді 22,8%-дан 9,5%-ға дейін азайтуға мүмкіндік берді.

Қорытынды: операцияның жоғары жарақаттануы нәтижесінде операциядан кейінгі асқынулар (жағдайлардың 50-70% дейін) және, тиісінше, жоғары өлім-жітім байқалады. Панкреатоюнальды анастомозды қалыптастырудың ұсынылған әдісі операциядан кейінгі асқынулар мен өлімнің айтарлықтай төмендеуіне байланысты жоғары тиімділікті көрсетті.

Түйінді сөздер: панкреатодуоденальды аймақтың қатерлі ісігі, панкреатодуоденальды резекция, ұйқы безінің қатерлі ісігі (ICD C25).

АННОТАЦИЯ

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Хирургия опухолей панкреатодуоденальной зоны: опыт применения разработанного способа операции

Актуальность: В лечении пациентов с раком панкреатодуоденальной зоны оптимальный выбор хирургической тактики остается не до конца решенным вопросом современной онкологии, что обусловлено неудовлетворительными результатами оперативных вмешательств.

Хирургия опухолей панкреатодуоденальной зоны сопровождается осложнениями, что объясняется анатомо-физиологическими особенностями поджелудочной железы и техническими сложностями вмешательства. После столь травматичной операции, как панкреатодуоденальная резекция, и несмотря на профилактику и внедрение инновационных технологий, часто возникают осложнения, хотя в последнее время имеется некоторая тенденция к их уменьшению.

В данной статье описан способ панкреатодуоденальной резекции, который позволяет снизить частоту послеоперационных осложнений и летальность при операбельном раке панкреатодуоденальной зоны.

Цель: оценка эффективности авторского способа панкреатодуоденальной резекции (панкреатоеюнального инвагинационного анастомоза) при раке панкреатодуоденальной зоны.

Результаты: Предложенный способ формирования панкреатоеюнального анастомоза позволил снизить частоту послеоперационных осложнений с 54,2% до 38,0% и уменьшить летальность в раннем периоде с 22,8% до 19,5%.

Заключение: В результате высокой травматичности операции отмечаются достаточно грозные и трудно разрешаемые послеоперационные осложнения (до 50-70% случаев) и, соответственно, высокая летальность. Предложенный способ формирования панкреатоеюнального анастомоза показал высокую эффективность за счет значительного снижения послеоперационных осложнений и летальности.

Ключевые слова: рак панкреатодуоденальной зоны, панкреатодуоденальная резекция, злокачественное новообразование поджелудочной железы (МКБ C25).