

## **Method of reconstructive surgery for damaged extrahepatic bile ducts: immediate and long-term results**

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### **Abstract**

**Background.** *Reconstructive surgery for iatrogenic injuries of the bile ducts involves the formation of a biliodigestive anastomosis. The development of anastomotic stricture is the most severe complication of this operation.*

**Aim of the study.** *To evaluate the immediate and long-term results of treatment and follow-up of patients with iatrogenic injuries of the bile ducts who underwent reconstructive surgery on the bile ducts with additional creation of gastroenteroanastomosis.*

**Material and methods.** *The study included 26 patients operated on according to the original method in the period 2010-2018.*

**Results.** *In the study group, complications in the early postoperative period developed in 3 (11.5%) patients. Endoscopic interventions using the formed gastroenteroanastomosis in the long-term period were performed in 7 patients. The results of treatment were followed in 25 (96%) patients. The median follow-up period was 90 months [81.5;110] (42-129).*

**Conclusion.** *The use of the proposed original technique of reconstructive surgery has demonstrated its effectiveness and safety, with the possibility of dynamic endoscopic control and, if necessary, the treatment of postoperative complications such as cholelithiasis and biliodigestive anastomosis strictures.*

**Keywords:** reconstructive operations on the bile ducts, hepaticojejunostomy, stricture of biliodigestive anastomosis

**Conflict of interests** Authors declare no conflict of interest

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## **Introduction**

Treatment of patients with iatrogenic injuries and postoperative cicatricial strictures of the extrahepatic bile ducts (EBDs) is both an urgent medical, and also a serious social-and-economic problem.

For a patient undergoing elective laparoscopic or open cholecystectomy, an intraoperative bile duct injury is an unexpected and severe complication. This affects changes in the patient's quality of life, and is also associated with increased requirements and costs for subsequent treatment due to the need for repeated hospitalizations, reconstructive surgical interventions, and long-term rehabilitation. The severity of injury to the bile ducts varies from marginal damage to the bile duct to complete dissection or even excision of one or more bile ducts, sometimes accompanied by vascular damage, most often of the right hepatic artery and the right portal vein.

The most common cause of injury to the main bile ducts, in addition to technical errors, is the presence of pronounced morphological

abnormalities in the hepatopancreatoduodenal zone caused by acute or chronic inflammation in the bile ducts and surrounding tissues [1]. There are several classifications of bile duct injuries, but the generally accepted classification is that developed by S.M. Strasberg, which is an extension of H. Bismuth classification. (Table 1) [2, 3].

The choice of treatment tactics for each bile duct injury is individual, since not only the type of injury, but also the time of its detection, concomitant pathology, the patient's clinical condition, and the time of diagnosis and re-hospitalization affect the treatment. Achieving optimal results requires a multidisciplinary approach involving hepatopancreatobiliary surgeons, gastroenterologists, endoscopists, and interventional radiologists. Preferably, the patient should be referred to a center specializing in the treatment of post-traumatic injuries of the bile ducts [4-6].

**Table 1. S.M. Strasberg classification of the bile duct injuries**

Type	Criteria
A	Bile leak from cystic duct stump or minor biliary radical in gallbladder fossa
B	Occluded right posterior sectoral duct
C	Bile leak from divided right posterior sectoral duct
D	Bile leak from main bile duct without major tissue loss
E1	Transected main bile duct with a stricture more than 2 cm from the hilus
E2	Transected main bile duct with a stricture less than 2 cm from the hilus
E3	Stricture of the hilus with right and left ducts in communication
E4	Stricture of the hilus with separation of right and left ducts
E5	Stricture of the main bile duct and the right posterior sectoral duct

To restore the outflow of bile, reconstructive operations are performed, among which the formation of hepatico-enteroanastomosis on the excluded loop of the small bowel by the Roux technique is considered the optimal by many authors [7, 8].

After surgical treatment, the incidence of biliodigestive anastomosis (BDA) strictures ranges from 5% to 69%, with most studies reporting the incidence in the range of 10-20%. The average time till stricture formation ranges from 11 to 30 months. This is a severe complication that leads to remitting cholangitis, and in 9.2% of cases, to secondary biliary cirrhosis and portal hypertension [6].

With the development and implementation of minimally invasive techniques, the possibilities for diagnosing and treating BDA strictures have significantly extended. Antegrade X-ray surgical interventions are used, such as balloon dilation with transhepatic drainage and retrograde biliary stenting using balloon enteroscopy [9, 10].

In 2010, V.N. Filizhanko et al. in Moscow Regional Research and Clinical Institute named after M.F. Vladimirskiy developed and patented an original method to performing reconstructive surgery implying a modified biliodigestive anastomosis with the formation of a gastroenteroanastomosis, for obtaining a possible subsequent direct endoscopic access to BDA [11, 12].

**The aim** of the paper was to present the immediate and long-term results of treatment and follow-up of patients with iatrogenic bile duct injuries operated on according to the developed method.

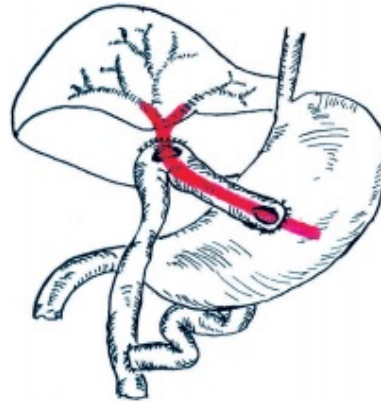
## **Material and methods**

### ***Surgical technique of reconstructive surgery***

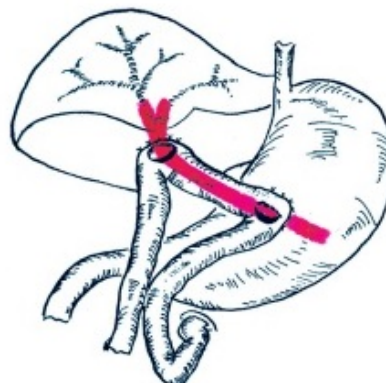
An upper-median laparotomy was performed under general anesthesia with intubation. Thorough dissection and adhesiolysis were

performed to clear the subhepatic space and detect the proximal part of the common bile duct. After detection of the bile duct, intraoperative cholangiography was performed, which assessed the condition of the intrahepatic bile ducts and clarified the level of injury. Further, the scar tissue was excised; and the bile duct/ducts were prepared for the formation of an anastomosis.

We used two modifications of our technique (Figs. 1 and 2): the formation of a BDA on the excluded loop of the small bowel by Roux in 9 cases (34.6%) and the formation of a BDA on the excluded loop with the Braun entero-enterostomy in 17 cases (65.4%).

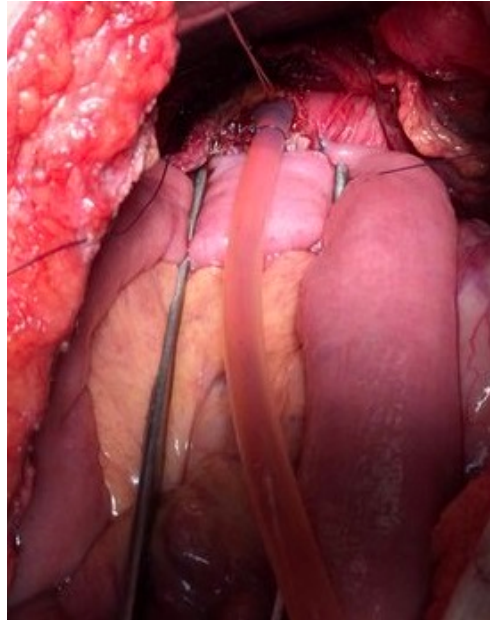


**Fig. 1. Biliodigestive anastomosis on the excluded small bowel loop by Roux**



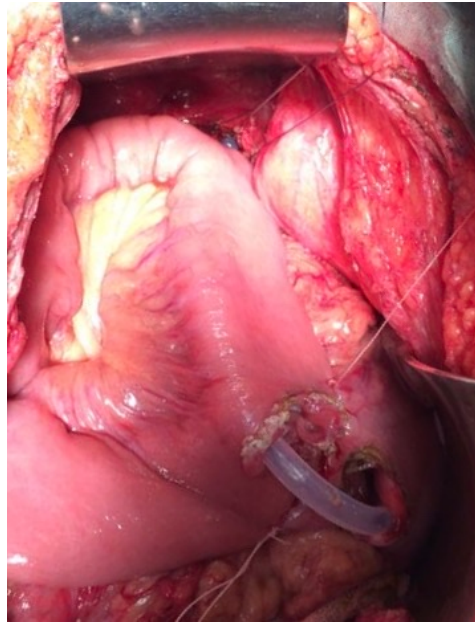
**Fig. 2. Biliodigestive anastomosis on the excluded loop with the Braun entero-enterostomy**

After the posterior wall of the BDA was formed, a Y-shaped drainage was installed in the lobular bile ducts (Fig. 3)



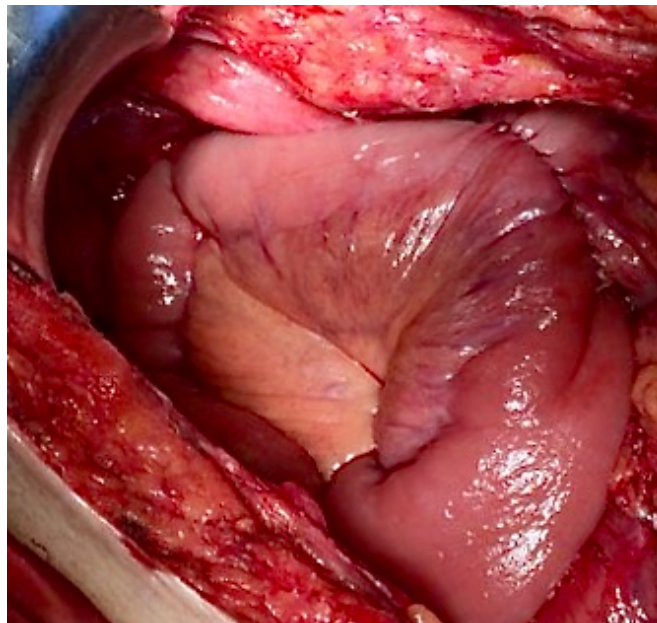
**Fig. 3. Installation of Y-shape drainage in the bile ducts after the formation of the back wall of the biliodigestive anastomosis**

Then, at a distance of about 15-20 cm from the BDA, a two-row gastroenteroanastomosis was formed with the blind end of the Roux loop or with the adductor loop of the small intestine, depending on the chosen modification of the surgical technique. In this case, the distal end of the Y-shape drainage was inserted into the stomach cavity (Fig. 4).



**Fig. 4. Formation of gastroenteroanastomosis with the placement of the distal tip of the drainage tube into the stomach**

Next, the front wall of the BDA was formed (Fig. 5).



**Fig. 5. Final view of reconstructive surgery**

Before suturing the abdominal cavity, the safety drainage was left in the subhepatic space.



In the period from 2010-2018, 26 patients were operated on, using to this method, including 8 men and 18 women. It should be noted that in some patients the treatment was attempted in the same medical facility where cholecystectomy had been performed and the bile duct injury diagnosed. As a rule, surgeons performed laparotomy and drainage of the abdominal cavity, in rare cases they performed external drainage of the bile ducts. Later, these patients were transferred to the Moscow Regional Research and Clinical Institute n.a. M.F. Vladimirskiy for reconstructive surgery.

At the initial admission to the hospital, a patient medical history was studied, a clinical examination was undertaken, and laboratory tests were performed: blood hematology, blood biochemistry testing, and a coagulogram. Abdominal ultrasonography (USG), trans-drainage cholangiography, endoscopic retrograde cholangiography, and magnetic resonance cholangiopancreatography (MRCPG) were also performed, if indicated. As a rule, a two-stage treatment was performed due to the presence of biliary peritonitis or an unformed biliary fistula in patients.

Early postoperative complications were assessed using the Clavien–Dindo classification [13].

All patients were re-hospitalized for follow-up examination 3-6 months after reconstructive surgery, and at a later time they were followed-up on an outpatient basis at least once a year. Long-term results were evaluated clinically, as well as using laboratory and instrumental diagnostic methods (USG, fibrogastroenteroscopy with examination of the BDA zone, MRCPG).

### ***Statistical methods***

Statistical analysis was performed using the STATISTICA 13.3 software. Quantitative variables were described using the median values



(Me), lower and upper quartiles (Q1-Q3), minimum and maximum values. Nominal data were described as absolute values and percentages.

## Results

The age of patients in the study group was  $55 \pm 13.1$  years old. All of them were hospitalized Moscow Regional Research and Clinical Institute n.a. M.F. Vladimirskiy and other medical institutions of the Moscow region at different time periods after bile duct injury, the median was 23 [13;58.5] (0-251) days. The type of primary surgery was laparoscopic cholecystectomy in 18 cases (70%), open cholecystectomy in 8 cases (30%).

At admission, we first performed debridement surgery with external drainage of the bile ducts. Reconstructive surgery was impractical due to marked inflammation-induced abnormalities in the area of the hepatico-duodenal ligament.

The median time period from the primary surgery till the reconstructive surgery was 143 [43;273] (5-952) days.

Intraoperative data on the injury type and the BDA forming technique with the reconstructive surgery are shown in Table 2.

**Table 2. Type of injury and the options to form a biliodigestive anastomosis**

Type of injury by S.M.Strasberg classification	Number of patients	Options of forming BDA		Number
Type E4	3	Bihepaticojejunostomy on a loop with an interintestinal Braun anastomosis + gastroenteroanastomosis		15
Type E3	10			
Type E2	2			
	11	Hepaticojejunostomy	On Roux loop + gastroenteroanastomosis	9
			On a loop excluded according to Braun + gastroenteroanastomosis	2

Complications in the early postoperative period developed in 3 (11.5%) patients.

Two patients (grade II complications) experienced gastrointestinal bleeding on the 3rd and 6th days after surgery, respectively. In the first case, the source of bleeding was not identified; in the second case, the source was an acute ulcer in the area of gastroenteroanastomosis. In both cases, the bleeding was stopped conservatively, no surgical intervention was required.

One patient (grade IIIb complication) experienced an eventration of the postoperative wound at physical exertion on day 13, which required secondary suture placement.

The median length of hospital stay after reconstructive surgery was 15 days [12.3;20] (7-26).

Repeated hospitalization after reconstructive surgery took place after 4.3 [3.8;5.7] (3-16) months. Fiberoptic gastroenteroscopy was performed to remove the Y-shape drainage. After removing the internal drainage, the BDA area was examined with an assessment of its condition. In one case, a patient was admitted 86 days after the reconstruction with mechanical jaundice (bilirubin level being 117 mmol/L, alkaline phosphatase 814 U/L). Fiberoptic gastroenteroscopy revealed an obturated draining tube. It was removed, the bile ducts were cleansed, and an 8Fr stent was inserted into the right lobular duct. After 2 months, the stent was removed. At outpatient follow-up, the laboratory parameters were within the normal range of values.

An endoscopic removal of the Y-shape draining tube was successful in 23 cases (88%). In 3 cases, the Y-shape drain removal and the BDA examination were not performed due to stenosis of gastroenteroanastomosis (we attribute this complication to the fact that at the stage of mastering the technique, the Y-shape drainage was not drawn

into the stomach lumen). These patients required surgical intervention in the extent of laparotomy, enterotomy and removal of internal drainage. The postoperative period was uneventful.

Subsequently, one of these patients required repeated surgical interventions. At 9 months after the reconstructive operation, the patient was hospitalized due to complaints of fever, and dark urine. Laboratory tests showed the level of bilirubin 55 mmol/L, alkaline phosphatase 399 U/L. At MRCPG, a bile duct dilatation up to 10 mm was detected in the area of the confluence of the lobular ducts, and calculus of 5 mm in diameter was visualized in the right lobular duct. Laparotomy, enterotomy, and calculus removal from the right lobular duct were performed. Postoperative period was without complications. The patient was discharged from hospital in satisfactory condition. However, after 9 months, he was re-hospitalized for cholelithiasis, cholangitis, and mechanical jaundice. MRCPG findings: moderate biliary hypertension, cholelithiasis, pneumobilia, a marked adhesion process in the liver hilum. Laboratory tests showed the level of bilirubin of 58 mmol/L, alkaline phosphatase 1033 U/L. Surgical intervention: laparotomy, enterotomy, cleansing of the bile ducts. An additional side-to-side entero-enteroanastomosis was formed below the existing one to avoid entering food into the Roux-loop. At discharge, the level of bilirubin was 20 mmol/L, alkaline phosphatase 459 U/L. At present, 117 months after reconstructive surgery, no findings of cholelithiasis or BDA stricture have been identified based on an outpatient examination results.

The long-term outcomes were assessed using the Grading Scale proposed by J. Terblanche et al. for patients who underwent EBD surgery (Table 3) [14].

**Table 3. The number of patients distributed according to the grading scale by J. Terblanche et al. (1990)**

<b>Grading by the Scale of J. Terblanche et al.</b>	<b>Number of patients, %</b>
Grade I: no biliary symptoms	11 (44%)
Grade II: transient symptoms, currently no symptoms	7 (28%)
Grade III: clearly related symptoms requiring a drug therapy	3 (12%)
Grade IV: recurrent, correction-required stricture or its associated death	4 (16%)

Long-term treatment outcomes were traced in 25 (96%) patients. One patient was excluded from the study, as she is being followed-up in another medical center.

The median follow-up period was 90 months [81.5; 110] (42-129).

Excellent results were noted in 11 (44%) cases. A good result was seen in 7 patients (28%) who had minor complaints; but during the entire follow-up period no clinical signs of pathology were observed, their liver function was kept normal with normal levels of bilirubin, transaminases, alkaline phosphatase, gamma-glutamyl transpeptidase in blood serum. Satisfactory results were noted in 3 people (12%) who had complaints of occasionally experiencing heaviness in the right hypochondrium, transient fever, and biochemical abnormalities associated with the episodes of cholangitis. These patients underwent an examination with water-soluble contrast passage through the gastrointestinal tract in order to examine and exclude the entering of gastric contents through the formed gastrojejunoanastomosis. The examination showed no contrast entering into the bile ducts. Unsatisfactory results were observed in 4 (16%) patients in whom BDA strictures were formed.

If complications developed in the long-term period, the patients were hospitalized. The standard examination included laboratory tests, abdominal USG and endoscopic examination of the BDA zone.

Endoscopic interventions using the formed gastroenteroanastomosis in the long-term period were performed in 7 patients; their types are presented in Table 4.

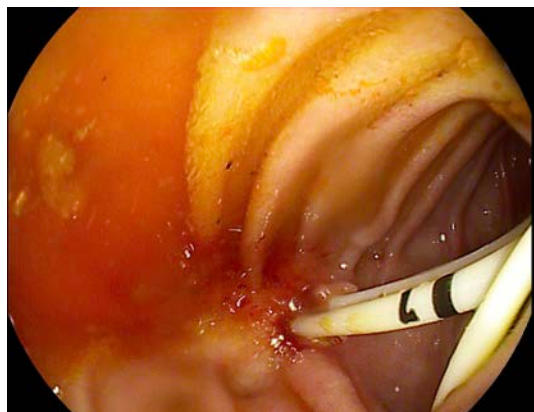
**Table 4. Type and number of endoscopic interventions**

Indications to surgery	Number of patients	The type of endoscopic correction
Cholelithiasis, cholangitis	3	Sanitation of the bile ducts
BDA stricture, obstructive jaundice, cholangitis	4	Balloon dilatation, bile duct stenting

In all cases, technical success of endoscopic correction has been achieved. Three patients were diagnosed with cholelithiasis. After endoscopic lithoextraction, the bile ducts were cleansed. Subsequently, no findings of cholelithiasis relapse were identified.

BDA stricture was diagnosed in 4 patients in the period from 11 months to 5 years after reconstructive surgery.

One patient developed BDA stricture at 24 months after surgery. Endoscopic bile stenting was started through the formed gastroenteroanastomosis. Planned hospitalizations to replace stents were undertaken every 4-6 months. The duration of stenting was 30 months with a gradual increase in stent diameters (7Fr-8Fr-2\*7Fr-2\*8Fr) (Fig. 6)



**Fig. 6. Endoscopic view of the biliodigestive anastomosis stenting**

At 29 months after the endoscopic treatment has been completed, BDA function is good, and the bilirubin level is normal.

Another patient was diagnosed with BDA stricture 15 months after surgery. Balloon dilation and stenting were performed for 12 months. However, 14 months after stent removal, the BDA stricture relapse occurred. Balloon dilation and stenting were resumed. The entire period of the stent indwelling was 31 months with a gradual increase in stent diameters (8Fr-2\*7Fr-2\*8Fr) at each scheduled stent replacement. Currently, 5 months have passed since the completion of repeated endoscopic treatment. The BDA function and bilirubin level are normal. During the entire follow-up period, 2 patients died. The first of them underwent reconstructive surgery in 2010. He was the first patient in our cohort who did not come to scheduled follow-up visits. Signs of cholangitis and remitting jaundice began to bother the patient 2 years after surgery, but he did not seek medical help. He was hospitalized in 2015 in extremely severe condition with signs of secondary biliary cirrhosis, liver failure, severe jaundice (total bilirubin was 269 mmol/L). Endoscopic stenting of the BDA was performed, and extracorporeal detoxification methods were used. The fatal outcome occurred in the course of progressive liver failure.

The second patient underwent reconstructive surgery in October 2012. BDA stricture was diagnosed in September 2013. Endoscopic cleansing of the bile ducts and subsequent stenting of the BDA were performed. Scheduled stent replacements took place every 18 months. The patient died in 2017 due to a cause unrelated to recurrent BDA stricture.

## **Discussion**

Treatment of BDA strictures can be performed using minimally invasive X-ray surgery or by performing a repeated surgery. However, surgical treatment aimed at BDA revision is often difficult and presents a serious problem for the surgeon due to marked scarring-associated alterations. Percutaneous transhepatic interventional treatment may be effective, but represents an invasive intervention, with the risk of developing specific complications, especially in patients with impaired liver function [9, 15]. Endoscopic treatment of BDA strictures, from our point of view, seems to be the least invasive approach compared to the above mentioned ones. However, the altered anatomy in the presence of an excluded by Roux loop of 80 cm long poses a serious difficulty for accessing the BDA using a standard endoscope [10, 16].

There are reports of providing endoscopic access to BDA by using a shorter excluded by Roux loop of 20 cm long instead of the generally accepted 80 cm. So, S. I. Felder et al. used this method in 70 patients. Seven patients, including those 4 after liver transplantation, developed BDA stricture, and all patients successfully underwent endoscopic cholangiography. Four of them required dilation and/or extraction of calculi, which were performed endoscopically in all cases. The authors note that they did not observe reflux-cholangitis cases [17].

There is a method of reconstruction, in which, after the BDA formation, the surgery is completed with the subcutaneous formation of a parietal jejunostomy, through which the Y-shape drains are temporarily drawn out. Subsequently, with the development of late complications (cholelithiasis, BDA stricture), in the scar area where drains were removed, a 3-4 cm long incision is made, the blind end of the excluded jejunal loop by Roux is opened between two holders, and an endoscope is inserted into the lumen, through which the necessary manipulations are



performed [18]. However, these endoscopic interventions are traumatic, as they require surgical intervention with opening the intestinal lumen and, as a result, a postoperative rehabilitation is needed.

In the literature, we found a description of four series in which reconstructive surgery on the bile ducts was supplemented by the creation of a gastroenteroanastomosis in various modifications. As in our study, none of the cases showed clinical or endoscopic signs of biliary gastritis or reflux cholangitis [16, 19-21].

In a retrospective assessment of our two modifications of forming BDA and gastroenteroanastomosis, we came to the conclusion that it is preferable to use a standard-length small bowel loop excluded by Roux, as a more physiological technique, and in addition, facilitating an endoscopic access to the BDA zone.

The problem of iatrogenic injuries of the bile ducts, and that of strictures of biliodigestive anastomosis after reconstructive surgery, remain relevant. The presented analysis of the immediate and long-term results of the proposed original technique demonstrates the efficacy and safety of the reconstruction with the possibility of the dynamic endoscopic control and, if necessary, the treatment of postoperative complications in the form of cholelithiasis and strictures of biliodigestive anastomosis, including, inter alia, multiple repeated endoscopic interventions. The presence of an additional gastroenteroanastomosis does not lead to clinically significant gastroenterobiliary reflux and cholangitis, and does not negatively affect the quality of life of patients.

## **Conclusions**

1. Forming a biliodigestive anastomosis with the formation of a gastroenteroanastomosis is an alternative method of reconstructive

surgery for injuries of extrahepatic bile ducts and is characterized by safety and reproducibility with an incidence of postoperative grade II-IIIb complications making 11.5%.

2. Endoscopic access to a biliodigestive anastomosis through a gastroenteroanastomosis in the long-term period is technically feasible in 100% of cases.

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