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**Doskhanov M.**

<https://orcid.org/0000-0002-8578-8567>

**Khajiyeva A.**

<https://orcid.org/0000-0002-4431-4488>

**Baimakhanov B.**

<https://orcid.org/0000-0002-9839-6853>

**Kaniyev S.**

<https://orcid.org/0000-0002-1288-0987>

**Seisembaev M.**

<https://orcid.org/0000-0002-6964-0685>

**Ospan Z.**

<https://orcid.org/0000-0001-6803-5806>

**Teipov S.**

<https://orcid.org/0000-0003-2376-0355>

# FIRST EXPERIENCE OF LAPAROSCOPIC HEPATICOJEJUNOSTOMY FOR BILE DUCT STRICTURES

**Doskhanov M.<sup>1</sup>, Khajiyeva A.<sup>1,2</sup>, Baimakhanov B.<sup>1,2</sup>,  
Kaniyev S.<sup>1,2</sup>, Seisembaev M.<sup>1</sup>, Ospan Z.<sup>2</sup>, Teipov S.<sup>2</sup>**

<sup>1</sup> Syzganov National Scientific Center of Surgery, Almaty, Kazakhstan.

<sup>2</sup> «Kazakh National Medical University named after S.D. Asfendiyarov» NC JSC, Almaty, Kazakhstan.

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**Author for correspondence:**

**Doskhanov Maxat**

PhD, Head of the Department of  
Hepatopancreatobiliary Surgery and  
Liver Transplantation, «NSCS named  
after A.N. Syzganov», Almaty,  
E-mail: max8616@mail.ru

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The authors declare no potential  
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Bile duct injury, cholecystectomy,  
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## Abstract

**Background.** Bile duct injury is a potentially life-threatening condition characterized by high morbidity and mortality, which occurs as a result of erroneous manipulation during surgical intervention, such as incorrect identification of the ducts, improper clipping, or thermal injury. The aim of the study is to investigate the effectiveness of laparoscopic hepaticojejunostomy in patients with post-cholecystectomy bile duct injuries and compare it with traditional open techniques.

**Materials and Methods.** A retrospective analysis of the results of laparoscopic and open hepaticojejunostomy in patients with bile duct injuries from 2017 to 2023 was conducted.

**Results.** Laparoscopic surgery was performed on 28 patients, while open surgery was performed on 57 patients. Statistically significant differences were noted in the presence of external biliary fistula, diameter of the anastomosis, duration of the operation, postoperative complications, and postoperative period. There were no significant differences in the frequency of intraoperative complications.

**Conclusion.** The laparoscopic approach in treating bile duct strictures classified as Strasberg E1 - E2 is safe and effective.

## Өт жолдарының тарылуы кезіндегі лапароскопиялық гепатикоеюностомоздың алғашқы тәжірибесі

**Досханов М.О.<sup>1</sup>, Хаджиева А.А.<sup>1,2</sup>, Баймаханов Б.Б.<sup>1,2</sup>, Каниев Ш.А.<sup>1,2</sup>,  
Сейсембаев М.А.<sup>1</sup>, Оспан Ж.Р.<sup>2</sup>, Теипов Ш.М.<sup>2</sup>**

**Хаталысатын автор:**

**Досханов М.О.**

PhD, Гепатопанкреатобилиарлық  
хирургия және бауырды  
трансплантаттау бөлімшесінің  
меңгерушісі, «А.Н. Сызғанов  
атындағы ҰҒХО», Алматы қ.,  
Қазақстан  
E-mail: max8616@mail.ru

<sup>1</sup> «А.Н.Сызғанов атындағы Ұлттық ғылыми хирургия орталығы» АҚ, Алматы, Қазақстан

<sup>2</sup> «С.Ж. Асфендияров атындағы Қазақ ұлттық медицина университеті» КеАҚ, Алматы, Қазақстан.

## Тұжырым

**Өзектілігі.** Өт жолдарының зақымдануы - хирургиялық ота кезінде түтіктерді дұрыс анықтамау, дұрыс емес кесу немесе термиялық әсер ету сияқты дұрыс емес

манипуляция нәтижесінде пайда болатын жоғары сырқаттанушылық пен өліммен сипатталатын өмірге қауіп төндіретін жағдай. Зерттеудің мақсаты-холецистэктомиядан кейінгі өт жолдарының зақымдануы бар науқастарда лапароскопиялық гепатикоюноанастомозды қолданудың тиімділігін зерттеу және оны дәстүрлі ашық әдіспен салыстыру.

**Материал және әдістер.** 2017-2023 жж. өт жолдарының зақымдануы бар науқастарда лапароскопиялық және ашық салынған гепатикоюноанастомозының нәтижелеріне ретроспективті талдау жүргізілді.

**Нәтижелер.** 28 науқасқа лапароскопиялық ота жасалды, ашық әдіспен – 57 науқас. Сыртқы өт жыланкөзінің болуында, анастомоз диаметрінің мөлшерінде, операцияның ұзақтығында, операциядан кейінгі асқынуларда, операциядан кейінгі кезеңде статистикалық маңызды айырмашылықтар байқалды. Интраоперациялық асқынулардың жиілігінде елеулі айырмашылықтар болған жоқ.

**Қорытынды.** Страсберг E1 - E2 классификациясы бойынша өт жолдарының тарылуын емдеудегі лапароскопиялық тәсіл қауіпсіз және тиімді екенін айқын көрсетіп отыр.

**Мүдделер қақтығысы:**

авторлар мүдделер қақтығысының жоқтығын мәдімдейді

**Түйінді сөздер:**

өт жолдарының зақымдануы, холецистэктомия, лапароскопиялық гепатикоюноанастомия, гепатикоюноанастомоз.

## Первый опыт лапароскопического гепатикоюноанастомоза при стриктурах желчных протоков

Досханов М.О.<sup>1</sup>, Хаджиева А.А.<sup>1,2</sup>, Баймаханов Б.Б.<sup>1,2</sup>,  
Каниев Ш.А.<sup>1,2</sup>, Сейсембаев М.А.<sup>1</sup>, Оспан Ж.Р.<sup>2</sup>, Теипов Ш.М.<sup>2</sup>

<sup>1</sup> АО «Национальный научный центр хирургии им. А.Н. Сызганова», Алматы, Казахстан.

<sup>2</sup> НАО «Казахский национальный медицинский университет им. С.Д. Асфендиярова», Алматы, Казахстан.

### Аннотация

**Фон.** Повреждение желчных протоков – потенциально опасное для жизни состояние, характеризующееся высокой заболеваемостью и смертностью, которое происходит вследствие ошибочной манипуляции во время хирургического вмешательства, такого как неправильная идентификация протоков, неправильное клипирование или термическое воздействие. Целью исследования является изучение эффективности применения лапароскопического гепатикоюноанастомоза у пациентов с постхолецистэктомическими повреждениями желчных протоков и сравнить его с традиционной открытой техникой.

**Материал и методы.** Проведен ретроспективный анализ результатов лапароскопического и открытого гепатикоюноанастомоза у пациентов с повреждениями желчных протоков за 2017 - 2023 гг.

**Результаты.** Лапароскопически оперировано 28 пациентов, открытым способом – 57 пациентов. Отмечены статистически значимые различия в наличии наружного желчного свища, размерах диаметра анастомоза, в длительности операции, послеоперационных осложнений, послеоперационного периода. Отсутствовали значимые различия в частоте интраоперационных осложнений.

**Заключение.** Лапароскопический подход при лечении стриктур желчных протоков по классификации Страсберга E1 - E2 безопасен и эффективен.

**Автор для корреспонденции:**

Досханов М.О.

PhD, заведующий отделением Гепатопанкреатобилиарной хирургии и Трансплантации печени, ННЦХ им. А.Н. Сызганова, г. Алматы, Казахстан, E-mail: max8616@mail.ru

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**Ключевые слова:**

Повреждение желчных протоков, холецистэктомия, лапароскопическая гепатикоюноанастомия, гепатикоюноанастомоз.

### Introduction

Bile duct injury (BDI) occurs as a result of erroneous manipulation during surgical intervention, such as incorrect identification of ducts, improper clipping, or thermal injury.<sup>1</sup> Cholecystectomy is the leading cause, and the frequency of bile duct injury varies from 0.1 to 0.2% after open cholecystectomy (OC) and 0.2-0.6% after laparoscopic cholecystectomy (LC).<sup>2</sup> This is a potentially life-threatening condition characterized by a high morbidity ranging from 2.3 to 23% and a mortality rate from 0.07 to 0.17%.<sup>3</sup> BDI has a significant impact on the physical and psychological quality of life of patients.<sup>4,5</sup> This is especially relevant for patients diagnosed with post-operative benign strictures of the bile ducts.<sup>6</sup> Surgical treatment of injuries to the extrahepatic bile ducts remains one of the most pressing issues in clinical surgery. Depending on clinical manifestations, surgical treatment methods include: percutaneous transhepatic cholangiostomy (PTBD), endoscopic retrograde cholangiopancreatography with placement of plastic stents (ERCP), and the definitive method of defect correction - reconstructive hepaticojejunostomy surgery with a Roux-en-Y loop.

Incorrect treatment can lead to serious complications, including recurrent cholangitis, secondary biliary cirrhosis, portal hypertension, and liver failure, significantly impacting the patient's quality of life.<sup>7</sup>

Bilioenteric anastomosis remains the gold standard for treating established strictures of the bile ducts, with excellent outcomes and a success rate exceeding 90% upon long-term follow-up.<sup>8</sup> According to reports from experienced centers, hepaticojejunostomy is performed when endoscopic retrograde cholangiopancreatography (ERCP) and

percutaneous transhepatic cholangiostomy (PTC) are ineffective, and it can be done via open or laparoscopic approaches. Laparoscopic reconstruction is increasingly recognized in the treatment algorithm for bile duct injuries associated with cholecystectomy, offering an effective treatment option in specialized centers for selected patients.<sup>9,10,11</sup>

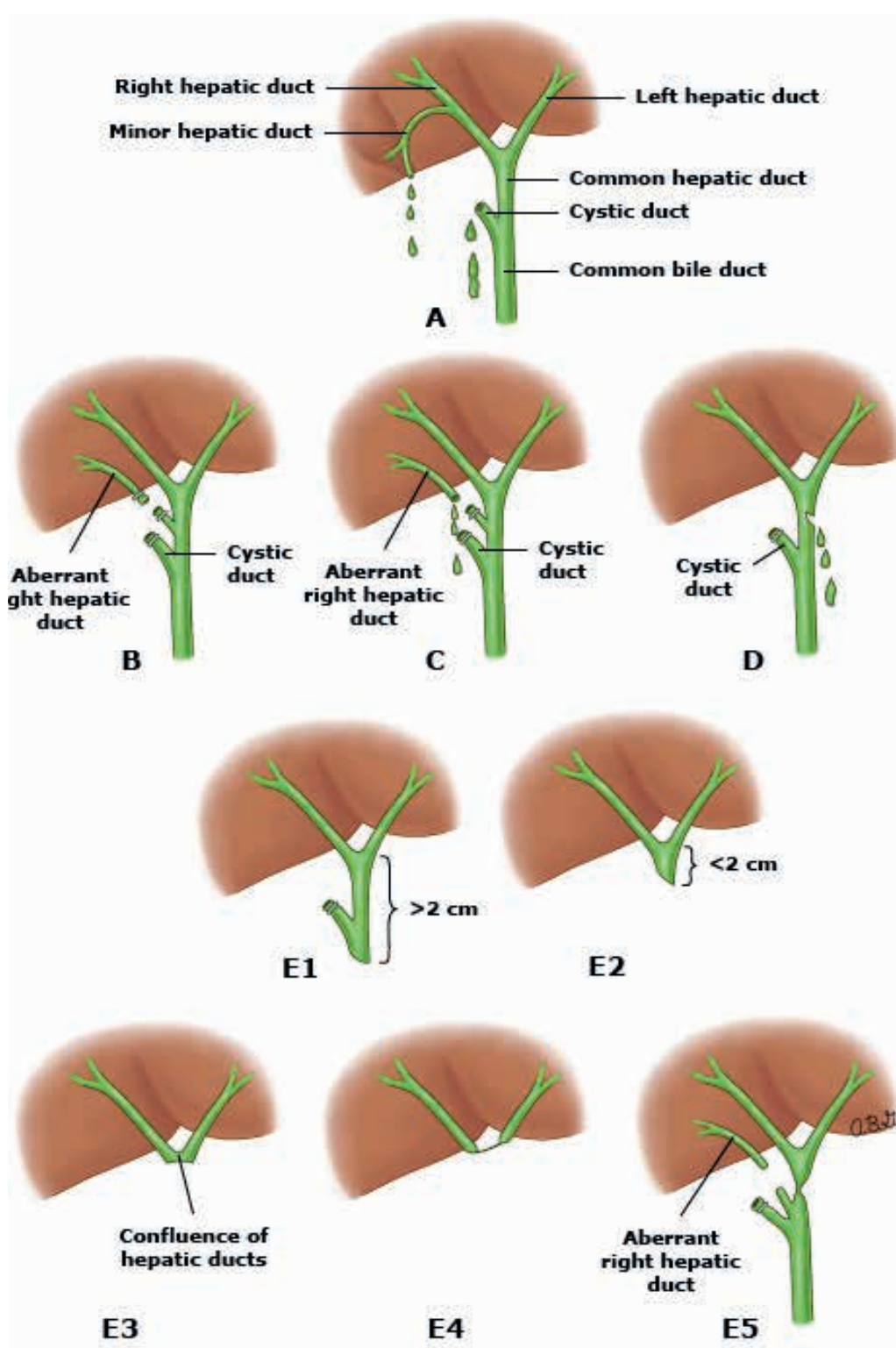
The aim of the study is to investigate the effectiveness of employing laparoscopic hepaticojejunostomy in patients with post-cholecystectomy bile duct injuries and to compare it with traditional open techniques.

### Materials and methods

The aim of the study is to investigate the effectiveness of employing laparoscopic hepaticojejunostomy in patients with post-cholecystectomy bile duct injuries and to compare it with traditional open techniques.

Depending on the method of surgical treatment, patients (n=85) were retrospectively divided into 2 groups. The first group consisted of patients who underwent laparoscopic hepaticojejunostomy (n=28), and the second group consisted of patients who underwent traditional open hepaticojejunostomy (n=57). All patients had previously undergone laparoscopic or open cholecystectomy at external medical institutions and were referred to our center with bile duct injuries. The study was approved by the local ethics committee. Written informed consent was obtained from all patients preoperatively.

For the purpose of differential and topical diagnosis, a comprehensive examination was conducted, including general clinical and biochemical laboratory methods, ultrasonography, fistulography, and MR cholangiography. Bile duct lesions were classified according to the Strasberg-Bismuth classification. (Figure 1)



**Figure 1.**  
Strasberg classification of bile  
duct injury 1995

The laparoscopic procedure was performed with the patient in the supine position with legs apart (French position). A five-port technique was used for laparoscopic access. After trocar placement, abdominal cavity organs were revised, and adhesiolysis was performed in the subhepatic space. Mobilization of

the hepatoduodenal ligament (HDL) was carried out with the isolation of the common hepatic duct (CHD) and subsequent transection below the confluence to prepare the site for hepaticojejunostomy.

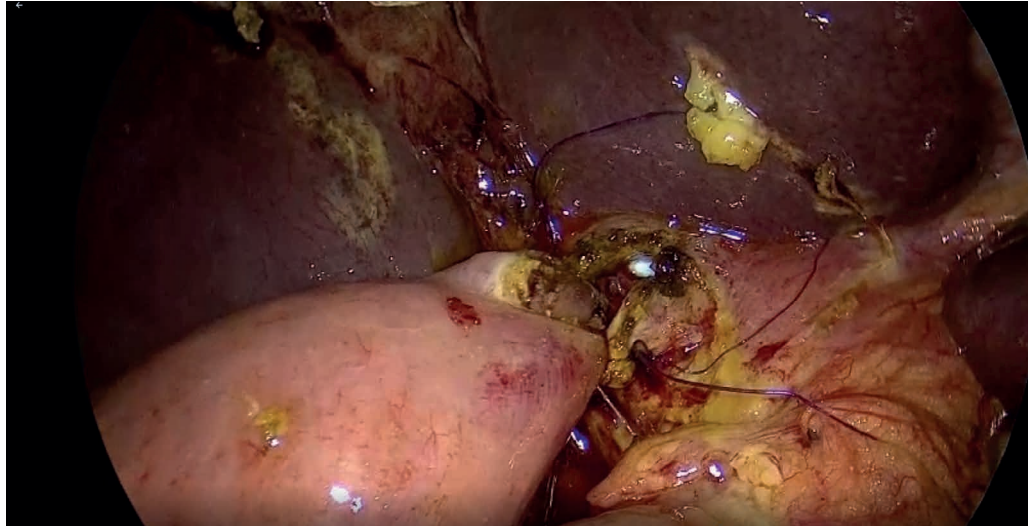
Then, the jejunum was isolated 40-60 cm from the Treitz angle and transected with a stapling device (Endo GIA

45mm). At a distance of 80 cm on the isolated Roux limb behind the ileocecal bowel, it was brought to the liver hilum. The anastomosis was created using atraumatic PDS 5/0 or 4/0 sutures, either continuous or interrupted. Subsequent-

ly, an interintestinal anastomosis was formed using a stapling device (Endo GIA 45mm) in a side-to-side fashion. For monitoring the integrity of the anastomosis, a drainage tube was left in the subhepatic space and in the pelvis.

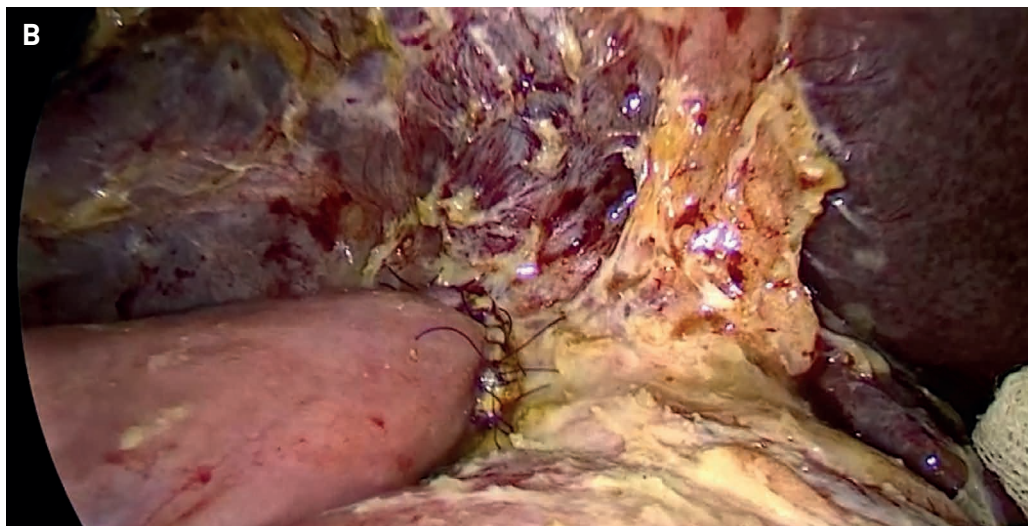
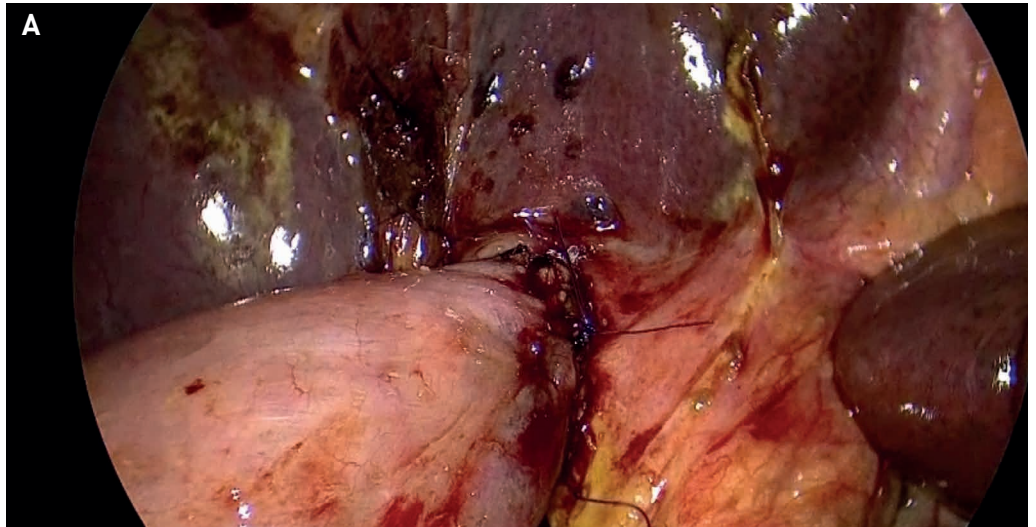
**Figure 2.**

Laparoscopic view of anastomosis between the posterior wall of the biliary ducts and the posterior wall of the intestine



**Figure 3.**

Laparoscopic view of anastomosis between the anterior wall of the biliary ducts (A) and the posterior wall of the intestine (B).



### Statistical analysis

Data were analyzed using IBMSPSS Statistics software (IBMSPSSInc.). Numerical variables were expressed as mean  $\pm$  SD and categorical variables as numbers and percentages. Nonparametric statistics were performed for dataset analysis. Between-group comparisons were assessed for numerical variables, and the Chi-square test was used for categorical variables. P value  $\leq 0.05$  was considered statistically significant.

### Ethical approval

This study was conducted in strict accordance with the principles outlined in the Helsinki Declaration. Before commencing the research, approval was obtained from the Local Bioethics Committee of the «National Scientific Surgery

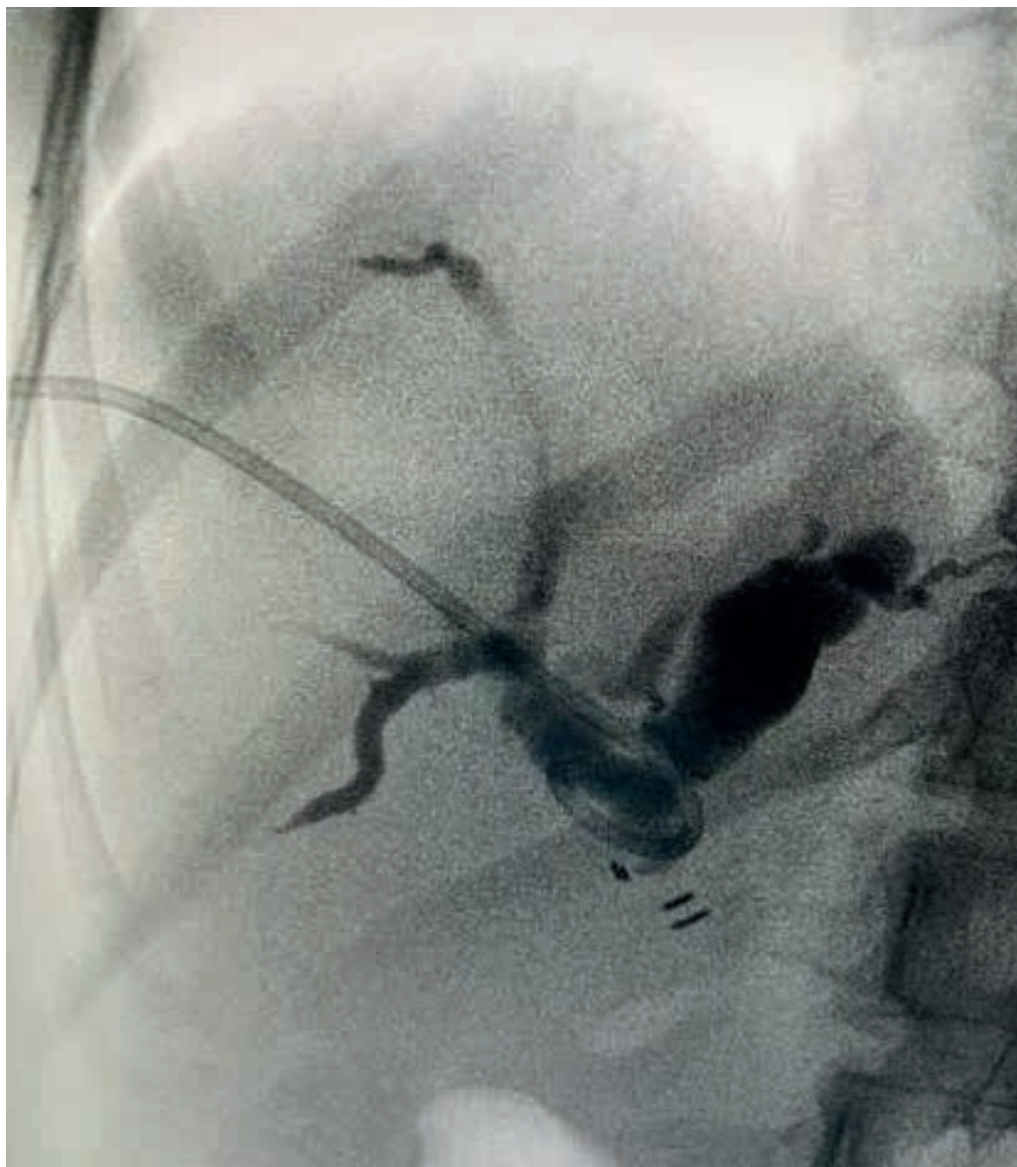
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### Results

The cause of iatrogenic injuries to the extrahepatic bile ducts was cholecystectomy - 28 patients. Among them, open cholecystectomy (OC) was performed in 14 (50%) cases, while laparoscopic cholecystectomy (LC) was performed in 14 (50%) cases.

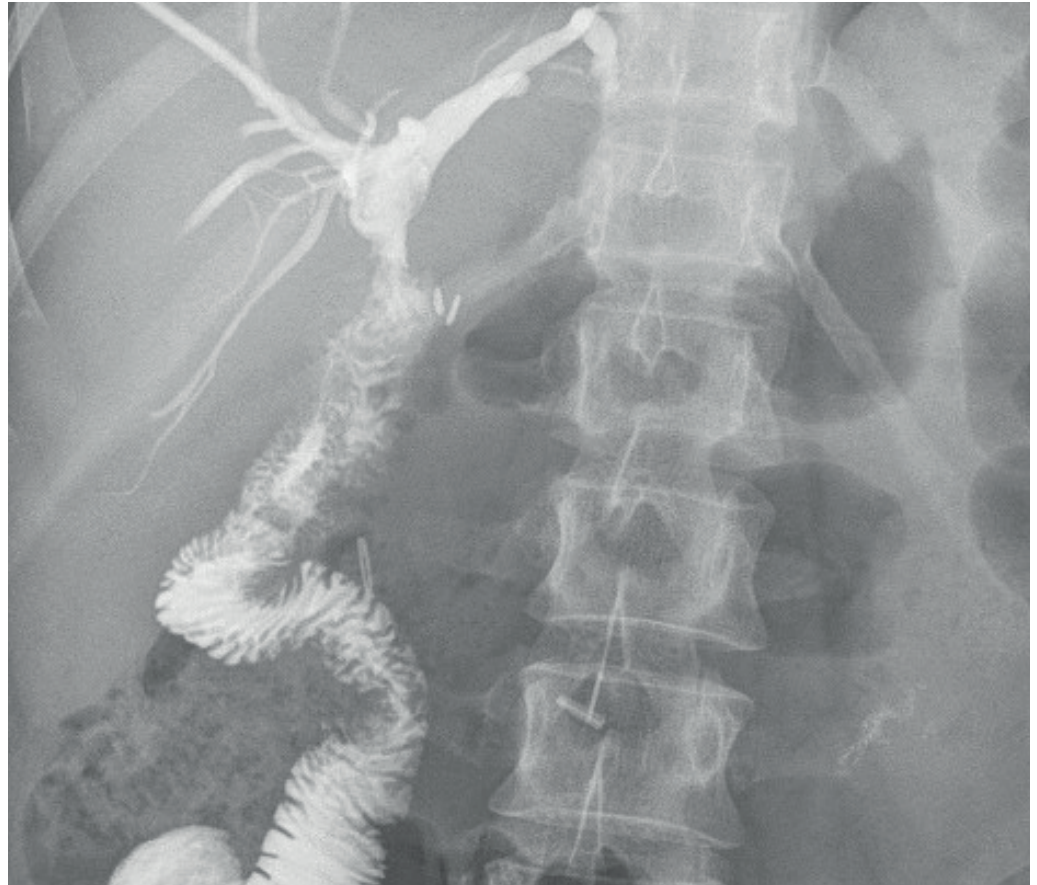
During the postoperative period, all patients underwent scheduled follow-up examinations at 1, 3, 6, and 12 months.

In the first group, two-stage surgical treatment was performed in 10 (35.7%) cases. In the second group, it was performed in 41 (71.9%) cases. During the first stage, percutaneous transhepatic cholangiography was carried out under ultrasound and X-ray control.



**Figure 4.** Percutaneous transhepatic cholangiography. The orange arrow indicates the injury site of the common hepatic duct (Type E2 by Strasberg)

**Figure 3.** Percutaneous transhepatic cholangiography performed 1 month after laparoscopic hepaticojejunostomy.



The first stage of the operation was completed with external drainage of the extrahepatic bile ducts to alleviate bile hypertension and stabilize the patients' general condition. The second stage involved laparoscopic or open hepaticojejunostomy on the Roux-en-Y limb.

A statistical difference was found upon comparison, with the second group having more patients with external bile fistulae than the first group ( $p < 0.05$ ).

There were no intraoperative complications observed in either the first or second groups.

**Table 1.** General clinical characteristics of patients with bile duct injury according to Strasberg classification E1-E2.

Characteristic	Hepaticojejunostomy		t-statistics	Chi-squared	P value
	Open	Laparoscopic			
Number of patients	57 (67.1%)	28 (32.9%)	-		-
Average age (yr)	45.6 ± 10.5 (26-67)	47.3 ± 11 (21 - 72)	0.691	-	0.491
Gender (male)	13(15.3%)	6(7.1%)	-	0.236	0.627
Strasberg classification E1	34(40.0%)	14(16.5%)	-	2.420	0.120
Strasberg classification E2	23(27.1%)	14(16.5%)	-	0.536	0.464
External biliary fistula	41(48.2%)	10(11.8%)	-	4.315	0.038*
Anastomosis size (cm)	1.08 ± 0.18 (0.8 - 1.6)	1.24 ± 0.19 (0.9 - 1.7)	3.782*	-	0.0002*
Duration of the operation (min)	269 ± 61.06 (120-435)	372.3 ± 106.7 (120 - 560)	5.675*	-	0.0001*

Intraoperative blood loss (ml)	93.6±70.1 (50-700)	69.2 ± 31.2 (20 - 150)	1.754	-	0.083
Postoperative bed days	11.1± 4.49 (6-31)	6.7 ± 1.7 (3 - 10)	4.989*	-	0.0001*
Laparoscopic cholecystectomy	31(36.5%)	14 (16.5%)	-	1.787	0.181
Open cholecystectomy	28 (32.9%)	14 (16.5%)	-	1.231	0.267

\*t -test statistical significance; P≤0.05 was considered statistically significant

When comparing postoperative complications, a statistically significant difference was observed. Complications were more common in the second group than in the first group (p<0.05). In the postoperative period, one patient (1.7%) developed a stricture of the hepaticoenterostomy (HEA) two years after the open HEA procedure, and considering the HEA stricture, the patient underwent biliary stenting. Four patients (7.1%) were diagnosed with postoperative ventral hernia, which subsequently required reoperation for postoperative ventral

hernia repair. Eight patients (14.1%) experienced wound infection in the postoperative period. There were no cases of mortality recorded.

The average postoperative hospital stay in the first group was 6.7 ± 1.7 days (range: 3 - 10), while in the second group, it was 11.1 ± 4.49 days (range: 6-31). A statistically significant difference was found when comparing the number of postoperative hospital days. Postoperative hospital days were higher in patients in the second group compared to those in the first group (p<0.05).



**Figure 6.** Comparison between patient postoperative wounds after (A) laparoscopic and (B) open hepaticojejunostomy

Complications	Hepaticoejunostomy		OR	95 % CI	Z statistic	P value
	Open	Laparoscopic				
Total complications	15(17.6%)	1 (1.2%)	9.64 <sup>o</sup>	[1.2;77.3]	2.13*	0.03*
Bleeding	1 (1.2%)	0	1.51	[0.06;38.3]	0.251	0.802
Hepatic Subcapsular Biloma	1 (1.2%)	1 (1.2%)	0.48	[0.03;8.01]	0.509	0.611
Anastomosis stricture	1 (1.2%)	0	1.51	[0.06;38.3]	0.251	0.802
Wound Suppuration	8 (9.4%)	0	9.79 <sup>o</sup>	[0.54;175.98]	1.547	0.122
Ventral hernia	4 (4.7)	0	4.79 <sup>o</sup>	[0.25;92.24]	1.039	0.299

**Table 2.** Postoperative complications

\*z-test statistical significance; P≤0.05 was considered statistically significant;  
<sup>o</sup> OR>1 means that the event is directly related and has a chance of occurring in the first group.



## Discussion

Hepaticojejunostomy on an isolated Roux-en-Y loop is the most commonly performed surgical procedure in the treatment of BDI after multiple attempts to restore bile duct patency using endoscopic retrograde cholangiopancreatography (ERCP) and percutaneous transhepatic cholangiostomy. The majority of available literature on the surgical treatment and outcomes of post-cholecystectomy bile duct injuries involves open surgical intervention,<sup>8</sup> as BDI is typically associated with severe adhesion formation in the subhepatic space, posing technical challenges.<sup>12,13</sup> Currently, laparoscopic and robotic methods have become widely adopted in specialized centers equipped with appropriate medical equipment and experienced hepatobiliary surgeons. The outcomes of laparoscopic and robotic approaches for creating hepaticojejunostomy in patients with scar strictures can be comparable to those of open methods. Additionally, they offer several advantages such as better cosmetic results and faster recovery in the postoperative period.<sup>7,10,14</sup>

In our center, robotic technology is not available. However, the possibilities of using laparoscopic access in abdominal surgery, such as gastropancreaticoduodenal resections, liver resections, and intestinal anastomoses, have prompted us to propose laparoscopic repair of bile duct injuries after cholecystectomy. In our study, patients who underwent laparoscopic hepaticojejunostomy met the criteria for laparoscopic hepaticojejunostomy proposed by *Gupta et al.*: type E1-2 injuries according to the Strasberg classification, with a duct diameter of more than 3 mm.<sup>15</sup> Despite its technical complexity, the laparoscopic approach offers advantages over open access in terms of better intraoperative visualization, allowing for precise execution of a wide anastomosis. Literature also includes data on the application of the laparoscopic method of hepaticojejunostomy in patients with complex bile duct injuries classified as Strasberg E3-E4. However, for these injuries, we did not utilize the laparoscopic method due

to the lack of conditions for precise technique execution. In cases of complex bile duct injuries, we recommend an open approach for creating hepaticojejunostomy to avoid a higher incidence of complications.<sup>14</sup>

The duration of volumetric laparoscopic surgeries is significantly longer compared to traditional open surgery.<sup>16,17</sup> The analysis of intraoperative parameters demonstrated that the duration of laparoscopic hepaticojejunostomy is statistically significantly longer than open hepaticojejunostomy ( $p < 0.05$ ). This could be associated with technical difficulties such as an unstable operative field, limited degree of freedom of movement, and challenges in complex suture placement.<sup>2,10</sup>

Complications of hepaticojejunostomy include bile leakage, anastomotic insufficiency, cholangitis, adhesive intestinal obstruction, postoperative ventral hernia, and surgical site infection. In our study, we found a significantly higher incidence of postoperative complications in the open hepaticojejunostomy group, which was 9 times greater than in the laparoscopic group ( $p < 0.05$ ). Analysis of postoperative complications in the open surgery group revealed a predominance of wound infection, attributed to repeated entries into the abdominal cavity via open methods within 3-6 months. The absence of large incisions in laparoscopic surgeries helped reduce complications related to the surgical wound (infection, hernias).

The results presented in the study confirm the benefits of minimally invasive approaches in the treatment of bile duct injuries. These benefits include excellent cosmetic outcomes due to the absence of a large incision, shorter postoperative recovery times, which are attributed to quicker removal of the safety drain and cessation of analgesic use.

It is important to emphasize that the performance of laparoscopic hepaticojejunostomy should be conducted in surgical centers equipped with the necessary experience and highly skilled specialists.<sup>12</sup> This requirement is due to the complexity of minimally invasive

surgeries. Expanding the practice of this technique contributes to improving the effectiveness of treatment for patients with scar strictures of the bile ducts after cholecystectomy.

**Limitation** In our study, there are several limitations. Firstly, a small number of patients suitable for laparoscopic hepaticojejunostomy were included. Secondly, insufficient professional expertise of operating surgeons also limits the performance of this operation in other centers. Thirdly, the study was limited to data from only one center, which may have affected the reliability of the results. Nevertheless, based on our data, we believe that laparoscopic hepaticojejunostomy is safe and effective.

**What's known?** Given the prevalence of cholecystectomy worldwide, bile duct injury represents a significant potential burden on healthcare, as it can lead to disability.

**What's new?** The absence of a negative effect of the minimally invasive approach on the number of postoperative complications and on long-term treatment outcomes compared to traditional open surgery confirms the prospects for expanding the use of laparoscopic surgery in the treatment of bile duct injuries after cholecystectomy.

## Conclusion

Thus, the application of the laparoscopic approach in selected patients with bile duct strictures (classified as Strasberg E1-E2) is safe and effective. It significantly reduces postoperative complications and shortens the length of hospital stay, providing better cosmetic outcomes for patients and enabling quicker rehabilitation.

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