

# Postoperative Bile Leakage and Anastomotic Stricture After Roux en Y Hepaticojjunostomy: A Retrospective Analysis of Risk Factors.

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## Research Article

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# **Abstract**

## ***Objective***

To describe the experience and long-term follow-up after Roux-en-Y hepaticojejunostomy and defining potential risk factors for early and late postoperative outcomes, such as bile leakage and anastomotic stricture.

## ***Summary Background data***

Roux-en-Y hepaticojejunostomy is widely used in gastrointestinal surgery. Bile leakage and anastomotic stricture were the most relevant postoperative complications. The risk factors for postoperative morbidity are poorly described.

## ***Methods***

All patients who underwent hepaticojejunostomy between January 2014 - December 2020, were included in this study. Follow up was performed for four years. Multinomial logistic regression was performed, associations between clinical and operative variables were explored, and bile leakage and anastomotic stricture were defined as outcomes at early and late follow-up respectively.

## ***Results***

A total of 199 patients were included in this study. Female patients was 56.28%. Mean age 61.73yo. The mean follow-up period was 54 months. Pancreatic cancer was the most common preoperative diagnosis (52.26%). Bile leakage was observed in 4.02%, and anastomotic stricture in 4.52% after 4 years follow-up. Body mass index (BMI) > 27 kg/m<sup>2</sup> was associated with bile leakage ( $p = 0.0001$  95% CI). A benign diagnosis was associated with an anastomotic stricture. ( $p = 0.003$  95% CI).

## ***Conclusion***

Appropriate technique is the key factor in decreasing both biliary leak and anastomotic stricture after surgery. It seems that a BMI > 27 kg/m<sup>2</sup> is associated with an increased risk of postoperative bile leakage. Oncologic conditions increase postoperative morbidity but do affect biliary leaks or stricture. In addition, benign conditions are associated with a high risk of anastomotic stricture.

# **Introduction**

Roux-en-Y hepaticojejunostomy (HJ) is a frequent and widely used procedure for bile duct reconstruction with acceptable rates of morbidity and high rates of success. [1–5] Since the first description by Dahl in 1909 [1–5], multiple techniques have been described, and the authors have reported different modifications to this technique, such as Winslow et al. [6], Strasberg [7], Hepp, and Couinaud [8, 9]. As well, Felder et al. [10] define short-limb reconstruction in patients who underwent HJ. Most of these

techniques have a success rate of 88 - 92%, with a range of complications that could vary in the range of 7 - 13% [6–10]. Nevertheless, all the cases must be individualized. End-to-side HJ has been considered a cornerstone in hepatobiliary and pancreatic (HPB) procedures such as proximal pancreatectoduodenectomy, cholangiocarcinoma resection, common bile duct reconstruction after iatrogenic injury, chronic pancreatitis derivation procedures, and liver transplantation. [1–5, 12].

Postoperative complications include anastomotic leak, cholangitis, sepsis, biloma, intra-abdominal collection, and anastomosis stricture [12]. Furthermore, numerous risk factors have been described for postoperative complications, such as age, male sex, diabetes mellitus, and the characteristics of the diagnosis (malignant disease or benign disease) [11–14]. Morbidity associated with this procedure could not only be related to increased hospital length, but also, delayed oncologic treatments, decreased functionality, and poor quality of life [11–14]. Despite the repeated use of this procedure in gastrointestinal surgery, risk factors associated with anastomotic leakage or stricture are poorly described, and the general outcomes of these procedures could vary depending on the population analyzed, therefore, establishing potential risk factors remains to be a necessity to prevent early and late morbidity.

This study aimed to describe the experience of an HPB group with Roux-en-Y hepaticojjunostomy (HJ), further portray the postoperative outcomes and define potential risk factors for short/long-term follow-up complications in our HPB center in Bogota, Colombia.

## Methods

### Study population

After the Institutional (Hospital Universitario Mayor Méderi) Review Board's approval and following Health Insurance Portability and Accountability Act (HIPAA) guidelines, a retrospective review of a prospectively collected database was conducted. All patients aged > 18 years who underwent for Roux-en-Y hepaticojjunostomy for any particular reason such as biliary reconstruction after injury, biliary anastomosis after pancreatectoduodenectomy or biliary resection for both benign and malignant diseases between January 2014 and December 2020 were included. Patients with no surgical description or missing data were excluded. Ethical compliance with the Helsinki Declaration and current legislation on research Res. 008430-1993 and Res. 2378-2008 (Colombia) and the International Committee of Medical Journal Editors (ICMJE) were ensured under our Ethics and Research Institutional Committee (IRB) approval.

### Surgical Technique

All the reconstructions were performed at our referral HPB center base institution. As a standardized technique, midline supraumbilical laparotomy was performed in most cases. Dissection of the hepatoduodenal ligament and liberation of the adherences were followed by the Kocher maneuver. The common bile duct was identified, and the hilar plate was dissected to preserve blood supply and

dissected until a safe and healthy bile tissue was exposed. Approximately 20 cm below the ligament of Treitz, the distal jejunum was ascended through the mesocolon, and a transmesocolic end-to-side hepaticojejunostomy was performed with 4 or 5-0 polydioxanone suture in separate stitches, addressing the posterior layer first and finally the anterior layer. Each stitch was placed carefully taking into account the symmetry between sutures and sufficient tissue from both the small bowel and bile duct. Finally, intestinal transit was reconstructed by a side-to-side hand sewn jejunojejunostomy at 60 to 90 cm from the HJ using the technique shown in graph 1. A drain was left for selected cases depending on the diagnosis before surgery, intraoperative conditions, and surgeon criteria.

## Follow-up

Preoperative data included patient demographics, comorbidities, surgical history; other data analyzed were, intraoperative characteristics, postoperative outcomes, and long-term anastomosis stricture follow-up. Follow-up was performed at 6, 12, 18, 24, 30, 36, and 48 months to determine postoperative complications and anastomotic stricture, based on clinical signs and symptoms; cholangio-resonance was also used to confirm the stricture of bilioenteric anastomosis. All patients with anastomotic stricture underwent a multidisciplinary approach with endoscopy and radiological assessment before deciding on a surgical approach. Mortality was determined on the basis of time of death reported in the national database.

## Hepatobiliary group and preoperative assessment

At our institution, the HPB group gathers a multidisciplinary board led by a single HPB surgeon, including an interventionist radiologist, abdominal radiologist, gastroenterologist, anesthesiologist, general surgeon, and general physician. All patients underwent surgical joint prior to surgery to establish the adequate time, and condition of the patient to undergo the surgical procedure. Nutritional assessment and pre-habilitation were performed before the procedure when appropriate. Biliary tract derivation (endoscopic or percutaneous) was performed before surgery in patients with clinical signs of cholangitis, and in all patients older than 65 years old with jaundice by protocol.

## Statistical Analysis

Descriptive statistics are reported in terms of their variable nature. Qualitative analysis was performed in terms of frequencies and percentages, whereas quantitative analysis was performed in terms of mean and standard deviations of normally distributed data and medians and interquartile ranges (IQRs) for non-normally distributed data. Multinomial logistic regression analysis was performed. Qualitative variables were analyzed using chi-squared statistics (Fisher's exact test when appropriate). Quantitative variables were analyzed, based on normality, using Spearman's or Pearson's association's correlation coefficients accordingly. Multinomial logistic regression analysis between qualitative and quantitative variables was performed using the Mann-Whitney test or the t-test for independent samples. For associations between categorical variables, relative risks with 95% confidence intervals were provided, and a statistical value of  $p < 0.05$  was defined as the cut-off point. For associations between continuous and categorical variables, two-sided t-tests were performed.

# Statistical analysis of risk factors

An association between postoperative outcomes (mortality, surgical site infection, postoperative bilioma, re-intervention, anastomotic leak, and bilioenteric anastomotic stricture), and clinical characteristics (type 2 diabetes mellitus, body mass index, previous anastomosis, malignant/benign diagnosis, preoperative cholangitis, and requirement of blood transfusion) was performed in order to explore possible risk factors for complications.

## Results

Preoperative characteristics.

A total of 199 patients underwent Roux-en-Y hepaticojejunostomy as a bilioenteric anastomosis. 56.28% of the participants were female. The mean age was  $61.73 \pm 14.9$  years. The mean BMI was  $23.41 \pm 5.8$  Kg/m<sup>2</sup>. History of hypertension was in 44.7%, type 2 diabetes mellitus in 16.58% of the patients. 51.76% of the cases were classified as III in The American Society of Anesthesiologists (ASA) score. 2.5% of the patients have a history of previous bilioenteric anastomosis. In terms of preoperative laboratory tests, total bilirubin and liver enzymes were analyzed and are described in Table 1 (see Appendix).

Table 1  
Demographic and preoperative characteristics

<b>Variable</b>	<b>Result</b>	
<b>Gender n(%)</b>		
<b>Male</b>	<b>87 (43.72)</b>	
<b>Female</b>	<b>112 (56.28)</b>	
	<b>Mean</b>	<b>SD</b>
<b>Age - years old</b>	<b>61.73</b>	<b>14.93</b>
<b>Body mass index - Kg/m2</b>	<b>23.41</b>	<b>5.86</b>
<b>Preoperative total bilirubine</b>	<b>7.29</b>	<b>7.68</b>
<b>Preoperative AST</b>	<b>114.9</b>	<b>114.2</b>
<b>Preoperative ALT</b>	<b>162.3</b>	<b>188.98</b>
<b>Preoperative alkaline phosphatase</b>	<b>491.06</b>	<b>424.49</b>
<b>ASA</b>	<b>n (%)</b>	
<b>I</b>	<b>24 (12.06)</b>	
<b>II</b>	<b>67 (33.67)</b>	
<b>III</b>	<b>103 (51.76)</b>	
<b>IV</b>	<b>5 (2.51)</b>	
<b>Arterial Hypertension</b>	<b>89 (44.72)</b>	
<b>Type 2 Diabetes Mellitus</b>	<b>33 (16.58)</b>	
<b>Previous Bilioenteric Anastomosis</b>	<b>5 (2.54)</b>	
<b>Preoperative cholangitis</b>	<b>19 (9.55)</b>	
<b>Preoperative endoscopic derivation</b>	<b>35 (17.59)</b>	
<b>Preoperative percutaneous derivation</b>	<b>6 (3.02)</b>	
<b>Etiology n (%)</b>		
<b>Iatrogenic Bile duct injury</b>	<b>40 (20.10)</b>	
<b>Palliative derivation</b>	<b>6 (3.02)</b>	
<b>Pancreatic cancer</b>	<b>104 (52.26)</b>	
<b>Hepatectomy related</b>	<b>1 (0.5)</b>	

Variable	Result
Bile duct tumor	16 (8.04)
Periampullary tumors	31 (15.58)
Anastomosis stricture	1 (0.5)

Pathological conditions were classified as malignant or benign diagnostics; in 22.11% of the patients. Surgery was performed for malignant disease, in the majority of the cases due to pancreatic cancer (52.26%). In benign cases, the most frequent diagnosis was iatrogenic biliary tract injury in 20.10% of the patients and Strassberg E2 injury in 32.42% was the most frequent type. Preoperative biliary tract derivation was performed in 20.60% of the patients; 85.36% of the patients required endoscopic derivation by endoscopic-retrograde cholangiopancreatography (ERCP), and 14.64% of the cases needed percutaneous derivation, summarized characteristics are described in Table 1.

#### Intraoperative characteristics.

End-to-side Roux-en-y hepaticojjunostomy was performed in the majority of the patients (99.5%). Double bilioenteric anastomosis was required after an iatrogenic biliary tract injury in one patient with a high bile duct injury. Mean operative time was  $253.03 \pm 81.29$  minutes; as well mean intraoperative bleeding was  $417.81 \pm 544.5$  cc. In malignant cases intraoperative vascular compromise was detected in 7.18% of the patients, summarized characteristics are described in Table 2.(See appendix)

Table 2  
Intraoperative characteristics

<b>Variable</b>	<b>Result n(%)</b>
<b>Anastomosis</b>	
Conventional Roux-En-Y Hepaticojejunostomy	198 (99.5)
Hepp- Couinaud	1 (0.5)
Vascular compromise	13 (7.18)
Intraoperative chemotherapy	0 (0)
<b>Strassberg classification</b>	
C	1 (2.7)
D	4 (10.81)
E1	8 (21.62)
E2	12 (32.43)
E3	7(18.92)
E4	5 (13.51)
	<b>Mean</b>
Operative time	253.03
Intraoperative Bleeding	417.81
	<b>SD</b>
	81.29
	544.56

Complications and follow-up.

Early postoperative complications were defined as those ones presented in 30 days follow-up. Surgical site infection was detected in 5.03% of the patients. Biloma was present in 3.06% of the cases. Anastomosis leakage was observed in 4.52% ( $n = 9$ ) of the patients. In most of the cases (64.82%) no medical/surgical complications were present; 14.06% ( $n = 27$ ) of the cases required blood transfusion. In terms of re-intervention, 8.54% of the patients required a surgical approach, and 6.53% of the cases percutaneous drainage of intra-abdominal collections was required. Intensive care unit stay (ICU) was required in 8.5% of the patients; in all of the cases due to blood transfusion and hemodynamic support requirement, the mean hospitalization days in ICU was  $4.6 \pm 6.7$  days. Post-operative mortality was 4.52% (2.25% of the cases due to postoperative sepsis, and 2.25% after broncho-aspiration). After 4 years of follow-up, bilioenteric anastomotic stricture was observed in 4.52% ( $n = 9$ ) of the cases. The characteristic are summarized in Table 3 ( See appendix). In most of the cases, anastomotic stricture was present after a benign disease in 15.9%. Re-intervention and mortality rates were higher in malignant disease than in benign etiologies (9.6% and 5.16% versus 4.54% and 2.2%, respectively), a comparison as

summarized in Table 4 ( See appendix). Patients with anastomosis stricture were evaluated in a multidisciplinary board to decide treatment, the majority of patients (90%) required a new hepaticojjunostomy, and 10% of the cases required bile duct dilation. The mean follow-up period was 54 months  $\pm$  14.5. All the anastomosis structures were present after 24 months after the procedure.

Table 3  
Postoperative complications and follow up

Variable	Result
Blood transfusion	28 (14.07)
Surgical site infection	10 (5.03)
Bilioma	6 (3.06)
Anastomotic leak	9 (4.02)
Postoperative complications	
None	129 (64.82)
Pulmonary trombo-embolism	6 (3.06)
Atelectasis	4 (2.01)
Postoperative bleeding	25 (12.56)
Postoperative sepsis	17 (8.54)
Electrolytic impairment	3 (1.51)
Intra abdominal collection	13 (6.53)
Bronco-aspiration	2 (1.01)
Percutaneous drainage	13 (6.53)
Re-intervention	17 (8.54)
Postoperative mortality	9 (4.52)
4 year anastomosis stricture	9 (4.52)

Table 4  
Comparison between malignant and benign disease

Variable	Malignant Disease	Benign Condition
Surgical Site infection	8(5.16)	2 (4.54)
Bilioma	1(0.6)	5(11.36)
Anastomotic leak	8(5.16)	1(2.2)
4 year anastomosis stricture	2 (1.29)	7(15.09)
Blood transfusion	27 (17.41)	1(2.2)
Re-intervention	15( 9.6)	2 (4.54)
Mortality	8(5.16)	1(2.2)

## Risk factor analysis

An association between benign diagnosis prior to surgery showed a statistical relationship with bilioenteric anastomotic stricture ( $p = 0.003$ ; 95% CI), with a 12.54 relative risk of developing this complication. In terms of anastomotic leak, a BMI greater than 27 kg/m<sup>2</sup> had a statistically significant relationship with this outcome. ( $P= 0.0001$  95% confidence interval) with a 3.4 relative risk to present this complication. (See appendix table 5).

## Discussion

Anastomoses between the bile duct and jejunum are frequently performed in hepatobiliary and pancreatic procedures involving malignant diseases such as pancreatic cancer, cholangiocarcinoma, or palliative surgeries; and non-malignant conditions, such as bile duct injuries after cholecystectomy, choledochal cysts, or primary bile duct disease. [15]. The purpose of this study's was to describe the experience of a single HPB surgeon and an HPB surgery group with HJ for any condition, postoperative complications, and long-term follow-up, as well as to establish potential risk factors between clinical conditions and postoperative outcomes.

From the multiple described techniques for bilioenteric reconstruction, hepaticojunostomy is the most frequently performed procedure [15]. Postoperative complications in these conditions can vary between 3-33% [16–20]. Bilioma, anastomotic leak, and cholangitis are considered the most relevant. Anand et al. and Sultan et al. reported bilioma/intra-abdominal collections in a rate between 2-22% respectively [16, 21], In our study, bilioma was documented in 11.36% of the patients. In addition, anastomotic leakage could vary in a range between 14.6 - 19% according to reports in the literature. Compared to our results, we observed a lower rate of this complication, which was present in 4.02% (n= 9) of the cases.

The incidence of cholangitis following HJ is truly unknown, however, according to Okabayasi et al. [14], cholangitis could be present in 7.7% of the patients, similar results to those observed in our population (8.5%, n=17). The preoperative diagnosis of malignant disease shows an increased morbidity and mortality rates after HJ. Antolovic et al. [15] reported an increased rate of bile leak in cases of oncologic conditions, and associated procedures such as liver resection, or pancreatoduodenectomy. In our population, most malignant conditions were related to Whipple procedures, with comparable rates to the ones described in the literature for morbidity such as anastomotic leak (5.16% n = 8), anastomotic stricture (1.29% n = 2) and mortality (5.29% n= 8) [14, 15].

Bile leakage is one of the most relevant complications after HJ, several studies highlight its incidence, and Anastomotic leakage (AL) is mainly reported after PD and reported to occur in 2 to 8% of all patients. Several risk factors have been described, among which BMI appears to be consistently present [22]. De Castro et al. [23] reported a statistical relationship between increased BMI (grade II obesity), increasing 11.32-fold the risk of AL. Supporting these results, this study shows a statistical relationship between AL and increased BMI, however, with a minor cut-off value ( $> 27 \text{ kg/m}^2$ ), this could be explained by differences in cultural and economic issues. [24, 26]

Long-term follow-up must be performed in all patients following HJ independent of the cause, owing to the possibility of anastomotic stricture. The study population had a median follow-up period of 54 months. In the literature larger studies were performed analyzing this complication; Dimou et al. and Tochi et al. [27, 28] reported a 12% stricture rate in 1,883 patients, and 84 patients respectively. Lombardo et al. [29], analyzed anastomotic strictures following Whipple procedure due to benign pathologies and reported an 8% rate. Seeking risk factors for long-term complications such as anastomotic stricture, our statistical analysis demonstrated that patients who underwent HJ due to benign conditions such as bile duct injury and choledochal cyst have an increased risk of presenting with this complication, similar to those reported by Dimou et al. [27]. Follow-up in this group of patients showed that in most of the cases, stricture was present 2 years after the procedure. In our population overall anastomotic stricture rate was 4.52% (n=9); with an increased incidence in benign conditions (n=7). This could be explained by the increased diameter of the bile duct in oncologic conditions. Moreover due to poor prognosis in hepatobiliary tumors these complications could not be present possibly because the patient died before the stricture appeared. [27, 30–31]

The limitations of our study include the retrospective nature of the study design and the increased number of patients with malignant disease compared to benign conditions. However, our study achieved a long-term follow-up; and showed improved outcomes with a standardized technique with a multidisciplinary approach, and management of patients who underwent hepaticojejunostomy independent of the nature of the disease. In addition, we controlled the exposure in terms of the surgical technique, because in all the cases the procedure was performed by the same surgeon.

## Conclusion

Long-term and early complications of HJ remain a topic of concern. Defining potential risk factors such as anastomotic leak, and long-term stricture, is essential for preventing lifelong morbidity. According to our data, the malignant diseases show increased rates of morbidity (surgical site infection, requirement of blood transfusion, and anastomotic leak). However, bilioenteric anastomotic strictures in the follow up period were statistically related to benign diagnosis (iatrogenic bile duct injury, choledochal cyst). In this study, BMI greater than 27 kg/m<sup>2</sup> was related to a statistical relationship with an anastomotic leak. Roux-en-Y hepaticojejunostomy remains to be a safe and feasible procedure for bile duct reconstruction in hepatobiliary procedures. Nevertheless, further studies are required to validate these results.

## Declarations

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To our patients.

### STATEMENTS

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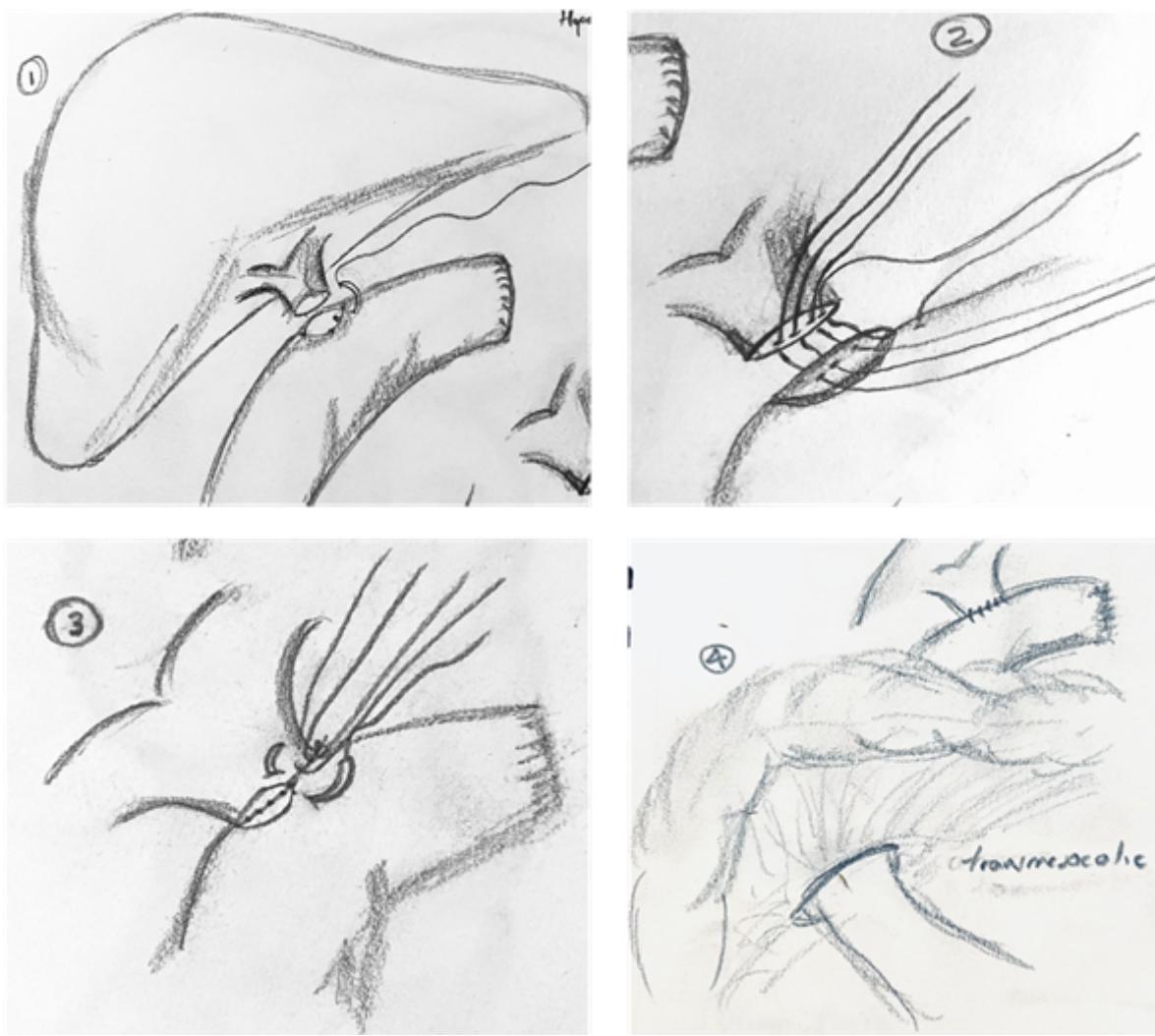
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## Figures



**Figure 1**

**Standardized HJ technique.** 1. Posterior layer anastomosis, performed with polidioxanone 4-0 or 5-0 suture. 2. separate stitches of the posterior layer. 3. anterior layer with separate stitches. 4. final view of the transmesocolic ascended jejunum.

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