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Research Article

Biliary reconstruction and Roux-en-Y hepaticojejunostomy for the management of complicated biliary strictures after bile duct injury

Han Liu, Sheng Shen, Yueqi Wang, Houbao Liu*

Department of General Surgery, Zhongshan Hospital, Fudan University, Shanghai-200032, China

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***Correspondence:**
Dr. Houbao Liu,
E-mail: HoubaoLiu2014@163.com

ABSTRACT

Background: There are controversies over the optimal surgical strategy for the management of complicated biliary strictures after Bile Duct Injury (BDI). The purpose of this study is to investigate the efficacy of biliary reconstruction and Roux-en-Y hepaticojejunostomy (RYHJ) for this condition.
Methods: Included in this single-center retrospective clinical study were 10 patients with the diagnosis of BDI-associated biliary strictures between July 2010 and July 2013.
Results: The 10 patients included 6 women (60%) ranging in age from 26 to 64 years with a mean of 48.6 years. They were patients who failed in repeated conservative, interventional, endoscopic therapies in other hospitals. The interval between the initial operation causing BDI and this operation in our hospital was less than 3 months in 2 patients, less than 6 months in 2 patients, and more than a year in 3 patients. According to the Strasberg classification of BDI, there were 3 cases of type E2, 1 case of type E3, 6 cases of type E4, one patient with type E2 also had right hepatic duct injury besides common bile duct injury. All the 10 patients received biliary reconstruction and RYHJ based on their bile duct conditions. The non-traumatic technique was used in all cases, knowing that the diameter of the bile duct reconstructed was about 1.5 to 3cm. Two patients received segment I hepatectomy; 3 patients received biliary supporting tube placement during operation, which was removed 6 months after operation; and 3 patients received reconstruction of the hepaticojejunostomy anastomosis. All patients recovered well after a mean length of postoperative hospital stay of 9.2 days (range 7 to 13 days). By July 2013, the patients has been followed up for a mean of 19.9 months (range 4 to 36 months), during which no incisional complication, hemorrhage, bile leak, biliary re-stricture, acute pancreatitis, acute cholangitis, or cystic artery pseudoaneurysm occurred in any patients. The level of serum total bilirubin and conjugated bilirubin remained within the normal range.
Conclusions: According to the Strasberg classification and the bile duct condition, appropriate biliary reconstruction and RYHJ for BDI-related biliary strictures can bring good outcomes.

Keywords: Reconstruction, Roux-en-Y hepaticojejunostomy, Biliay strictures, Bile duct injury

INTRODUCTION

Bile Duct Injury (BDI) remains to be a serious complication of biliary surgery. The reported incidence of major BDI is about 0.5%[1-5] and is still on the rise with the advent of laparoscopic techniques, seriously affecting the patient's quality of life.[6,7] There are controversies over optimal strategy for surgical management of BDI, especially for biliary strictures after BDI. Biliary reconstruction and Roux-en-Y hepaticojejunostomy (RYHJ) are believed to be the choice of treatment in most cases,[3,8-12] but few reports have specifically analyzed the outcomes. The purpose of this study was to determine the

efficacy of biliary reconstruction and RYHJ for complicated biliary strictures after BDI.

METHODS

Included in this study were 10 patients with biliary strictures after BDI who received biliary reconstruction and RYHJ in the department of general surgery of Zhong Shan hospital (Shanghai, China) between July 2010 and July 2013. All the 10 patients had a clear history of BDI and presented with typical clinical symptoms. The diagnosis was confirmed by magnetic resonance cholangiopancreatography (MRCP) and Computed Tomography (CT). Additionally, the Strasberg classification was used to describe the type of BDI. After evaluation of the overall condition of the patients, biliary reconstruction and RYHJ was performed. All patients were instructed to come back for clinical examinations and auxiliary examinations including blood routine, liver function test, ultrasound, CT or MRCP at 1 month, 6 month, 1 year and annually afterward (Table 1). The patients who were indwelled with a biliary supporting tube (T-tube) were required to come back for T-tube cholangiography and electronic choledochoscopy at 6 month after surgery.

Table 1: The general follow-up information.

Follow-up examinations	Preoperation	Time after operation							
		1 day	4 days	7 days	1 month	6 months	1 year	2 years	3 years
Clinical symptoms	●	●	●	●	●	●	●	●	●
Blood routine	●	●	●	●	●	●	●	●	●
Liver function	●	●	●	●	●	●	●	●	●
Ultrasound	●	○	○	○	●	○	●	●	●
CT	●	○	○	○	○	○	●	○	○
MRCP	●	○	○	○	○	●	○	●	●
T-tube cholangiography [a]	○	○	○	○	○	●	○	○	○
Electronic choledochoscopy [a]	○	○	○	○	○	●	○	○	○

a: T-tube cholangiography and electronic choledochoscopy were performed only in patients indwelled with a biliary T-tube.

RESULTS

Patient demographics

The general preoperative information of all patients is summarized in Table 2. They included 6 women (60%) ranging in age from 26 to 64 years with a mean age of 48.6 years. All patients had a clear history of BDI associated with cholecystectomy. BDI occurred during Laparoscopic Cholecystectomy (LC) in 4 patients, and Open Cholecystectomy (OC) in 6 patients. Intraoperative repair was attempted in 3 of the 10 patients but in vain.

Table 2: Preoperative evaluation of the 10 patients.

Patient No.	Sex	Age (years)	Symptoms	Treatment before	Reason of BDI	The interval time	Strasberg classification
1	Male	45	Jaundice, Abdominal pain	Conservative	OC	2 months	E4
2	Female	33	Jaundice, Abdominal pain	Conservative	LC	1 months	E2[a]
3	Female	55	Jaundice, Abdominal pain	Conservative	OC [b]	10 months	E4
4	Male	64	Jaundice, Abdominal pain	Operation again	OC	9 months	E4
5	Male	48	Jaundice	PTCD	OC	5 months	E2
6	Female	26	Jaundice, Abdominal pain, Fever	Operation again, 2 PTCD, 2 ERCP	LC [b]	5 months	E4
7	Male	37	Jaundice	Conservative	LC	1 year	E4
8	Female	54	Jaundice, Fever	Conservative	OC	1 year	E4
9	Female	63	Jaundice	Conservative	OC [b]	7 months	E2
10	Female	61	Jaundice, Abdominal pain, Fever	Operation again, PTCD with stent many times	OC	6 years	E3

a: The patient had injuries to the right hepatic duct and common bile duct.
b: Failed biliary repair in the first operation.

Jaundice was the main symptom in all 10 patients, in addition to abdominal pain in 6 patients and fever in 3 patients. Conservative, interventional and endoscopic treatments had been attempted in all patients but in vain, including conservative treatment in 6 patients; Percutaneous Transhepatic Cholangio-Drainage (PTCD) in one patient; cholangiojejunostomy in one patient 5 days after the initial operation; Endoscopic Retrograde Cholangio-Pancreatography (ERCP) and PTCD in one patients who received choledochoduodenostomy in the initial operation. The remaining patient underwent re-operations at 2 weeks and 4 months after the initial operation and multiple episodes of PTCD with plastic stent placement during a 6-year postoperative period before this decisive operation. All patients had a clear history of BDI secondary to benign biliary surgery. The interval between the initial operation causing BDI to this operation was less than 3 months in 2 patients, less than 6 months in 2 patients, less than a year in 3 patients and more than a year in 3 patients.

All patients underwent CT and MRCP scans before this operation to evaluate the biliary tree. According to the Strasberg classification of BDI, there were 3 patients with type E2 lesions, including one patient with injuries to the right hepatic duct and common bile duct (Figure 1); one patient with type E3 lesion, and 6 patients with type E4 lesions.

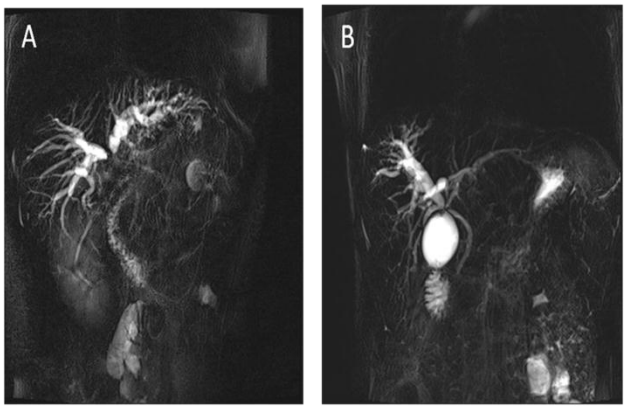

Figure 1: (A) MRCP in a 45-year-old male (Patient No.1) with BDI strictures at hilar bile duct with obvious dilation of the intrahepatic bile duct and separation between left and right hepatic bile duct. (B) MRCP in a 37-year-old male (Patient No.7) with BDI strictures at hilar bile duct with obvious dilation of the left intrahepatic bile duct and a small gallbladder left.

Surgical reconstruction

The general intraoperative information of all patients is summarized in Table 3.

Table 3: Intraoperative information of the 10 patients.

Patient No.	Reconstruction suture (Vicryl)	Anastomosis suture (Vicryl)	Opening diameter (cm)	Additional operations	Biliary supporting tube (T-tube)
1	5/0	5/0	1.5	Hepatectomy of segment I	Yes
2	5/0	5/0	1.5	No	Yes
3	4/0	3/0	2	No	No
4	5/0	4/0	1.5	No	Yes
5	4/0	4/0	2.5	No	No
6	4/0	3/0	2	No	No
7	4/0	3/0	3	Hepatectomy of segment I	No
8	4/0	4/0	3	New hepaticojejunostomy with repair of duodenum	No
9	4/0	3/0	3	Repeated hepaticojejunostomy	No
10	4/0	4/0	3	Repeated hepaticojejunostomy	No

The goal of surgery included complete resection of the strictured bile duct, appropriate reconstruction of the healthy bile duct, and an end to side, wide, mucosa-mucosa hepaticojejunostomy without tension and with a 60 cm long antecolonic Roux-en-Y limb. Given the biliary thin-wall, non-traumatic suture needles and distances and techniques were selected carefully in reconstruction to avoid injury to the normal bile duct. Operative exploration included exposure of the strictured bile duct and assessment of the biliary anatomy. After complete resection and exposure of the adjacent healthy bile duct, reconstruction was performed in two stages: a new back wall was sutured interruptedly by the adjacent posterior wall and a wide trumpet-shaped opening constructed by the anterior wall.

The bile duct was explored by using intraoperative electronic choledochoscopy if available. A T-tube was indwelled after hepaticojejunostomy in cases where the diameter of the intrahepatic bile duct was less than 1cm and the wall was thin.

Of the 10 patients undergoing bile duct reconstruction, 7 patients used 4/0 absorbable vicryl, the opening of the bile duct was 3 cm in 4 patients, and 2 cm in 3 patients. The remaining 3 patients used 5/0 absorbable vicryl due to their fine and thin bile ducts, ranging in diameter from 0.5 cm to 0.8 cm with a mean of 0.6 cm, and the opening was 1.5 cm. A T-tube was indwelled in these 3 patients. In hepaticojejunostomy, 4 patients used 3/0 absorbable vicryl, 4 patients used 4/0 absorbable vicryl and 2 patients used 5/0.

Two patients had hepatectomy of segment I in order to expose the healthy and normal bile duct. Two patients had repeated hepaticojejunostomy after exposure of the anastomotic area and a new biliary reconstruction. One patient had a new hepaticojejunostomy with a duodenum repair after choledochoduodenostomy.

All the surgical procedures were performed by one experienced biliary surgeon.

All absorbable vicryl were the product of Johnson & Johnson.

Outcomes

All patients recovered well, with a mean length of postoperative hospital stay of 9.2 days (range 7 to 13 days). No patient was lost to follow-up.

All patients were instructed to come back for clinical examination and auxiliary examination including blood routine, liver function tests, ultrasound, CT or MRCP at 1 month, 6 month, 1 year and annually afterward. Serum Total Bilirubin (TB) and Conjugated Bilirubin (CB) remained normal during the follow-up period (Table 4). No surgery-related complications including incisional complication, hemorrhage, bile leak, biliary re-stricture, acute pancreatitis, acute cholangitis, or cystic artery pseudoaneurysm occurred in any patient. The 3 patients with a T-tube placement underwent cholangiography and electronic choledochoscopy at 6 months after surgery. As no stricture was founded, tube was removed (Figure 2).

The mean follow-up period was 19.9 months (range 4 to 36 months), during which no malpractice claims was declared.

Table 4: Serum total bilirubin (TB) and conjugated bilirubin (CB) in the 10 patients before and after operation. Normal range: TB 3.4-20.4 μmol/L, CB 0.0-6.8 μmol/L.

Patient No.	Preoperation	Time after operation							
		1 day	4 days	7 days	1 month	6 months	1 year	2 years	3 years
1	191.9/161.4	204.9/174.7	123.5/106.5	122.8/104.4	15.2/5.1	8.6/3.5	7.3/2.4	None	None
2	91.0/69.1	62.7/48.2	42.0/31.1	Discharged	14.3/7.0	10.8/5.4	8.4/2.3	None	None
3	406.8/318.5	262.7/219.8	114.1/100.5	103.2/80.4	19.3/8.2	9.4/4.3	8.2/3.1	9.5/5.7	None
4	124.7/105.1	95.8/79.8	130.4/102.4	Discharged	19.5/7.7	11.0/6.4	7.2/3.3	7.6/2.5	9.3/4.3
5	24.6/13.3	62.5/17.5	39.9/19.6	18.4/7.6	11.1/5.4	7.1/2.0	7.7/3.1	None	None
6	214.9/176.2	214.7/185.5	141.4/119.9	84.1/75.4	14/6.2	8.6/3.5	None	None	None
7	89.3/77.8	42.3/34.4	35.2/30.2	30.2/24.9	12.1/5.6	13.8/5.6	None	None	None
8	64.3/54.6	25.7/20.7	18.9/14.9	Discharged	13.4/9.3	None	None	None	None
9	163.9/131.8	164.3/139.6	127.6/104.5	70.7/56.6	17.8/9.9	10.9/6.4	7.1/2.9	6.2/2.5	5.0/1.7
10	27.1/19.8	37.1/30.9	19.2/8.9	18.3/13.7	11.9/6.1	8.3/4.3	7.9/3.6	None	None

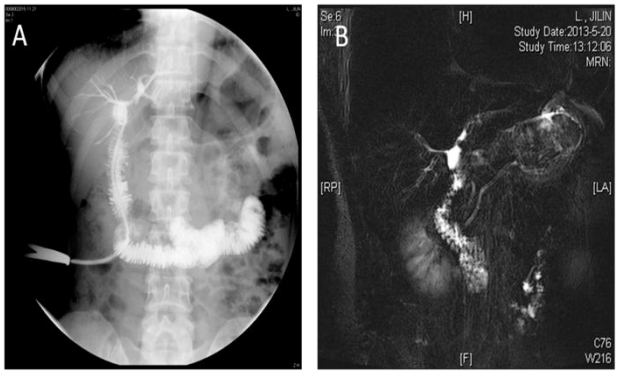

Figure 2: (A) T-tube cholangiography in a 45-year-old male patient (No.1) at 6 months after surgery, showing adequate bile drainage. (B) MRCP in a 45-year-old male patient (No.1) at 6 months after surgery, showing adequate bile drainage.

DISCUSSION

Biliary stricture is likely to occur in cases without proper management of BDI, may be causing such severe complications as repeated strictures, cholangitis or impairment to liver function.[2-5,8-12] Few studies have reported a standard treatment for biliary strictures after BDI, and most surgeons treated this condition according to their own experience and preference.[3,13-15]

Patients always missed proper treatment in the initial operation or in the early postoperative time. It is still disputed when these patients explore a decisive operation.[14-19] Bismuth and Strasberg reported that delayed repair at least 3 months or repair in time significantly reduced the re-stricture rate,[17,18] but other studies showed different results, saying that repair in 4 or 6 weeks may be better.[8,20] In our study, we chose

individualized time depending on the biliary condition. Surgery should be performed as early as possible in patients who have cholangitis with good conditions provided inflammation is well controlled. Given the inflammatory edema state, the impaired liver function and the high bile leakage or re-stricture rate after surgery, PTCD should be performed first in patients who have jaundice with TBIL >256 mol/L or have serious suppurative cholangitis. In our study, 3 of the 10 patients underwent PTCD before the decisive operation, the timing of which depended on the downtrend of TBIL and the control of inflammation, generally from 4 to 6 weeks after drainage, which is similar to some studies reported.[8,20]

The purpose of operation is to relieve stenosis, including complete resection of the strictured bile duct and adequate internal drainage. Therefore, preoperative evaluation of the biliary tree and comprehensive intraoperative exploration are important prerequisites for a successful operation.[8,9,21,22] It is essential to choose an appropriate surgical modality based on meticulous assessment of the biliary structure by an experienced biliary surgeon.[1,16] Strasberg classification remained to be a preoperative evaluative recommendation for BDI, and also for strictures after BDI.[17,18,23] According to the region of strictures, proper operation is needed to expose the normal bile duct without inflammation and scar. The technical difficulty is high bile duct strictures, an longitudinal incision of the left hepatic duct may allow for a wider anastomotic stoma,[9,24] and anatomical techniques reported by Strasberg and Jarnagin[25,26] may facilitate exposure of the right hepatic duct. Dissection of the hilar plate was usually performed in patients with type E3 lesions, and an extra hepatectomy of segment I may also be performed in patients with type E4 lesions.

For some BDI recognized during operation or in the early postoperative period, an end-to-end anastomosis of the common bile duct or a primary closure is a proper method of repair,[27-29] especially primary closure performed by an experienced biliary surgeon is strongly recommended for those recognized during operation. However, for most strictures after BDI such as cases in our study, RYHJ is the standard treatment and the long-term clinical success rate is as high as 70-90%.[3,8-12] Some patients who undergo RYHJ for BDI may experience incapacitating biliary symptoms, such as jaundice or recurrent cholangitis.[30] However, in addition to anastomotic strictures, RYHJ failure may be attributed to several other isolated or associated pathogenic factors including intrahepatic calculi, intrahepatic stricture, and improper technical construction of the Roux-en-Y limb.[30,31] The key factor for success is reconstruction and anastomosis. Resection of the strictured bile duct and reconstruction with an end-side RYHJ were performed in the patients of our study. Reconstruction of the high bile duct after a complete resection of strictures is especially difficult in patients with type E3 and E4 lesions. In patients with tyoe E3 lesions, we preserved the continued biliary back wall and constructed a 2-3 cm wide new trumpet-shaped opening by using the anterior wall of the left-right hepatic bile duct. In patients with type E4 lesions, we constructed a new interrupted sutured posterior wall first by using the back wall of the adjacent intrahepatic bile duct, and then constructed an opening for anastomosis. It is sometimes only 1-1.5 cm wide depending on the diameter of intrahepatic bile duct. Given the biliary thin-wall, non-traumatic suture needles and distances and techniques were selected carefully to avoid injury to the normal bile duct. Generally, we sutured interruptedly using 4/0 absorbable vicryl with a needle distance of 0.5mm, or 5/0 or thinner absorbable vicryl when the biliary wall was extremely thin (0.1-0.2 mm). After reconstruction of a new opening, an end-side, mucosa-mucosa hepaticojejunostomy without tension was performed, and the length of the Roux-en-Y limb should be long enough to reduce the reflux cholangitis rate in at least 60cm. We usually used 3/0 or 4/0 absorbable vicryl for anastomosis, although 5/0 absorbable vicryl was also considered in individual cases. The key for prevention of anastomotic fistula is the use of the non-traumatic techniques, including even needle distance, knotting in situ and the knot tieing on the external surface of the anastomosis close to the jejunum.

Some patients may develop complications of anastomotic and intrahepatic strictures after RYHJ for BDI. Management of this complex situation requires careful and expert treatment.[30,31] A new construction is often needed after exposure of the anastomic area and assessment of the biliary anatomy with an electronic choledochoscopy if available. When strictures and inflammation are limited in the anastomic and extrahepatic area, a vertical incision and a horizontal suture are preferred in order to construct a 2-3cm wide anastomotic stoma. However, a complete resection of strictures and a new RYHJ are needed when strictures and inflammation spread to the high bile duct. Sometimes, dissection of the hilar plate or hepatectomy of segment I are needed to expose the normal bile duct. This anastomosis is performed by using 4/0 or 5/0 interrupted, absorbable vicryl according to the biliary condition. Choledochoduodenostomy is an obsolete operation for BDI due to its high reflux cholangitis, anastomotic strictures and even occurrence of cholangiocarcinoma rate reported.[32,33] We should resect the anastomosis and perform a new RYHJ, knowing that RYHJ is associated with few complications as compared with choledochoduodenostomy.

In addition, some patients with complex situations may have an extra hepatectomy in order to achieve a good effect. A study said that hepatectomy is only performed if vascular injury occurs in BDI cases.[34] In our experience, It is needed if hepatatrophy occurs due to strictures of the intrahepatic secondary bile duct or above, vascular injury or a liver abscess, hepatectomy is needed. Certainly, hepatectomy may bring about more complications as compared with routine surgery.

The placement of biliary supporting tube is not routine.[8,9,16,25] The main aim of tube placement is to avoid the development of anastomotic stoma fistula, and reduce the biliary stricture rate by effecting postoperative biliary decompression. In addition, cholangiography and electronic choledochoscopy could be performed through this tube. In our study, T-tube placement was not used as a routine practice except in cases where the intrahepatic bile duct was extremely fine or cholangitis occurred. We usually chose a T-tube that fits well with the bile duct with short arms in the intrahepatic bile duct and drainage outside through the jejunal wall. There is still controversy over the timing of tube removal, ranging from 2 months to 1 year after surgery.[8-10,25,35,36] We generally removed the tube 6 months after surgery, depending on condition of the bile duct during surgery, the bile duct as shown by cholangiography and electronic choledochoscopy 6 months after surgery and the general condition of the patient (Figure 2).

Operation is the only decisive treatment for biliary strictures after BDI at present, although endoscopic and interventional therapies are also a good treatment for some patients with strictures simply on the common bile duct or common hepatic duct.[37-41] Two other cases treated in our hospital received either endoscopic or interventional treatment by placement of a plastic stent after assessment of the bile duct. Both patients recovered during a 2-year follow-up period. Studies reported no significant difference in long term efficacy between surgery and stent placement via the endoscopic or interventional approach.[10,42] But knowing that endoscopic or interventional treatment is associated with the need for repeated stent replacement, higher costs, more complications and lower success rates, we chose the surgical strategy in most patients. For patients receiving endoscopic or interventional treatment, close follow-ups are necessary to decide whether or not a decisive surgery is needed.

It is reported that 20-30% patients may experience re-strictures in long term follow-ups after decisive operation even by experienced biliary specialists.[3,8,9,43] Serious restructure-related complications like cholangitis and biliary cirrhosis may occur in some patients, and therefore long-term follow-up programs should be scheduled. Studies also showed that about two-thirds of the patients developed re-strictures 2-3 years after surgery, and therefore a 5-year follow-up plan is recommended.[43,44] In our study, follow-up observations have lasted 3 years and will be continued, including symptoms, laboratory examination, ultrasound and MRCP, for the sake of assessing the biliary status and discovering possible biliary strictures for proper treatment in time.

CONCLUSIONS

This Bile duct injury remains a major concern on the part of both the patient and the surgeon. Improper management may result in disastrous complications. Strictures, as a serious and complex complication after BDI, require standard and individualized treatment at specialized institutions. Reconstruction and Roux-en-Y hepaticojejunostomy are the choice of treatment for most patients. This article describes our surgical experience with reconstruction and RYHJ in the management of BDI-associated strictures. The 3-year follow-up study has demonstrated that outcomes are so far so good in all 10 patients. However, larger sample studies with longer follow-up observations are needed before it can be recommended as a standard treatment for strictures after BDI.

Authors' contributions

Liu Han and Shen Sheng are co-first authors, and they made equal contributions to the work.

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