

Total Laparoscopic Roux-en-Y Cholangiojejunostomy for the Treatment of Biliary Disease

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ABSTRACT

Background and Objectives: Roux-en-Y cholangiojejunostomy (RCJS) has been widely used in biliary bypass surgeries, but in most reported literature, an assisted mini-incision was needed, and studies reporting total laparoscopic Roux-en-Y cholangiojejunostomy (TLRCJS) are rare. The goal of this study was to investigate how to treat hepatic portal bile duct diseases and perform jejunojunctionostomy and cholangiojejunostomy totally laparoscopically. We evaluated the feasibility of TLRCJS in treating biliary tract diseases.

Methods: TLRCJS were performed in 103 patients from January 2000 to August 2011. There were 28 cases of recurrent choledocholithiasis combined with stricture of the common bile duct (CBD) after several stone extractions, 3 patients with iatrogenic bile duct injury, 24 patients with choledochal cyst, 36 patients with hepatic portal cholangiocarcinoma, and 12 patients with cancer of the pancreatic head and periampullary cancer. All surgeries were performed through 5 trocars. First, laparoscopic surgery on the CBD was performed according to the original disease. The CBD was opened and stones were extracted in choledocholithiasis patients. In iatrogenic injury patients, strictured CBD was resected and repaired. Dilated CBD or choledochal cyst with tumor was transected. In patients with malignant jaundice, the CBD was opened longitudinally. At the same time, the bile duct was prepared for cholangiojejunostomy. Second, the positions of the laparoscope and surgeons were altered. The jejunal mesentery and jejunum were transected, and side-to-side jejunojunctionostomy (JJS) was performed. The laparoscope and surgeon positions were exchanged again; the Roux-en-Y biliary limb was lifted close to the residual bile duct; and side-to-side or end-to-side choledochojejunostomy (CJS) was performed. Finally, an abdominal drainage tube was placed.

Results: All the surgeries were performed successfully. The diameter of the residual bile duct ranged from 0.4 to 3.2 cm (average, 0.9 cm). Three patients had postoperative bile leakage and were treated from 1 week to approximately 1 month with abdominal drainage. Postoperative intraperitoneal hemorrhage and stress ulcer of the stomach occurred in 2 patients with biliary tract injury combined with obstructive jaundice. One with intraperitoneal hemorrhage was cured by another laparoscopic surgery. The other patient was cured after 2 days of abdominal drainage, antacids, and hemostatic drug therapy. The follow-up duration of 95 patients was 4 to 93 months (average, 48.3 months). The follow-up rate was 92.2% (95/103). Patients with cancer died of metastasis or cachexia during 14-month follow-up with no postoperative complication. Reflux cholangitis occurred in 3 patients 2, 3, and 5 years after the operation, respectively. No anastomotic stricture or other complication was found in other patients during the follow-up.

Conclusions: TLRCJS is the best and first choice for patients with biliary tract diseases that need biliary-jejunal anastomosis. But it is essential that the surgeon has proficiency in laparoscopic surgeries.

Key Words: Laparoscopy, Roux-en-Y cholangiojejunostomy, Common bile duct stone, Bile duct injury, Congenital choledochal cyst, Hepatic portal cholangiocarcinoma, Cancer of pancreatic head, Periampullary cancer.

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INTRODUCTION

Cholangiojejunostomy is a common surgical procedure for the treatment of biliary tract diseases. Among all surgical cholangiojejunostomy procedures, Roux-en-Y cholangiojejunostomy (RCJS) is considered to have a lower incidence of postoperative cholangitis and recurrent stones.¹ With the development of laparoscopy, laparoscopic RCJS (LRCJS) has become a new choice for the treatment of biliary tract diseases. However, clinical reports on LRCJS have been rare since the first report in an animal experiment.²⁻⁵ In most report literature, an assisted mini-incision was needed for surgery. Because of the expertise and complicated technique

needed in total LRCJS (TLRCJS), reports of large case series pertaining to this surgical procedure are rare.¹⁻⁶

Indications for LRCJS were treatment of bile duct injury, congenital choledochal cyst resection, obstructive jaundice caused by advanced pancreatic head or periampullary carcinoma, and biliary tract reconstruction after cholangiocarcinoma resection. In treating injury of the bile duct, the optimal management was dependent on the timing of recognition of injury, the extent of bile duct injury, the patient's condition, and the availability of experienced hepatobiliary surgeons.⁷ However, for iatrogenic bile duct injury, especially that caused by laparoscopic surgeries, the surgical reconstruction method of RCJS played a crucial role.^{8,9} Since 2004, it has been shown that the excision of cystic dilation of the common bile duct (CBD) combined with Roux-en-Y hepaticojejunostomy done laparoscopically has been effective and safe for the treatment of choledochal cyst.¹⁰ However, most of the methods reported were a combination of intracorporeal and extracorporeal procedures. The reports on TLRCJS were rare.¹⁰⁻¹² In 2011, Urushihara et al. reported total laparoscopic cyst excision in the CBD, but the number of cases was only 8 and they were children.¹³ Jaundice caused by benign and malignant diseases of the biliary tract was also proved to be alleviated by laparoscopic bypass surgeries, with good effects.¹⁴⁻¹⁶

In this study, all surgeries were performed laparoscopically. We evaluated the applicative value of this surgical procedure in treating the following 5 types of biliary tract diseases: recurrent stones combined with CBD stricture after CBD stone extractions, iatrogenic bile duct injury, choledochal cyst, hepatic portal cholangiocarcinoma, and pancreatic head and periampullary carcinoma.

To complete TLRCJS, the surgeon was required to master surgical skills, such as laparoscopic excision of lesions, portal hepatic basin-like bile tract plasty, and cholangiojejunostomy. In 2010, we reported total laparoscopic resection of a type I choledochal cyst in an adult and Roux-en-Y hepaticoenterostomy, with good effects.¹⁷

From January 2000 to October 2011, 103 TLRCJ surgeries were successfully performed in our hospital. They accounted for 0.65% (103/1569) of the laparoscopic biliary tract surgeries during the same period. Here we present our 103 cases of TLRCJ experience over an 11-year period.

PATIENTS AND METHODS

General Data

Our study consisted of 103 patients, among whom 28 (15 men, 13 women) patients aged 56 to 58 (60.5 ± 3.2) years had choledocholithiasis. All of these patients had a history of more than 2 cholangiolithotomies, and the stones recurred more than twice within 2 to 3 years along with abdominal pain, fever, and jaundice. Ultrasonography and magnetic resonance cholangiopancreatography (MRCP) showed the dilated and thickened CBD with a diameter of 2 to 3 cm. Intraoperative exploration showed multiple stones or cast-shaped stones in the CBD with inflammatory stricture of the lower biliary tract. Patients' Child-Pugh liver function scores were A or B.

Three patients (2 men, 1 woman) had iatrogenic bile duct injury. TLRCJS was performed on 2 male patients with postoperative jaundice, 55 and 56 days after the first surgery, respectively. One woman, who had a history of laparoscopic cholecystectomy, presented with right upper quadrant pain and jaundice 2 days after the first surgery. Laparoscopic exploration revealed that the right hepatic duct was completely divided and could not be repaired by end-to-end anastomosis of the hepatic bile duct. Thus, TLYCJS was performed. CBD cyst was diagnosed by the presence of intermittent pain in the right upper quadrant, a mass in the upper abdomen, ultrasonographic examination, and MRCP in 24 patients. Three were female children aged 5, 12, and 12 years, and 3 were young women aged 15, 17, and 19 years. Eighteen patients (6 men, 12 women) were adults aged 30 to 69 years (52.8 ± 11.1). All the cysts were type I choledochal cysts according to the Alonso-Lej classification of sizes ($[2.0 \times 3.0]$ to $[7.0 \times 12.0]$ cm). Stones were found in the cysts of 13 patients, and none of the patients had a history of surgery.

Hepatic portal cholangiocarcinoma was found in 36 patients (27 men, 9 women), manifesting as painless jaundice and pruritus. Their ages were 49 to 85 years (66 ± 7.87). Laboratory results showed carcinoembryonic antigen (CEA) levels of 2.7 to 8.1 $\mu\text{g/L}$ (average, 5.09 ± 1.42 $\mu\text{g/L}$; normal, <5 $\mu\text{g/L}$) and CA₁₉₉ level range of 51 to 298 U/mL (average, 205.97 ± 73.21 U/mL; normal, <27 U/mL). An increased CEA level range of 0.6 to 3.1 $\mu\text{g/L}$ was found in 22 patients. MRCP also indicated a hepatic portal-occupying lesion. Seventeen patients were diagnosed with type I hilar cholangiocarcinoma according to the Bismuth classification. The rest of the patients were classified with type II. Sizes of the tumors were (0.6 \times 0.8) to (1.5 \times 2.1) cm.

Cancer of the pancreatic head and periampullary cancer were found in 12 patients (8 men, 4 women) aged 46 to 65 years (59 ± 5.67). Their complaints were progressive painless jaundice and pruritus. Laboratory tests showed an elevated CEA level range of 5.3 to 9.2 $\mu\text{g/L}$ (average, $7.09 \pm 1.81 \mu\text{g/L}$) in all these patients (normal level, $<5 \mu\text{g/L}$) and a CA₁₉₉ level range of 101 to 298 U/mL ($213.87 \pm 63.31 \text{ U/mL}$; normal level, $<27 \text{ U/mL}$). MRCP, enhanced pancreatic computed tomography, and color Doppler ultrasonography showed pancreatic masses. The sizes of the tumors were (1.8×2.1) to (2.5×3.2) cm. The distribution of the indicated biliary tract diseases and the accompanying diseases of our patients are shown in **Table 1**.

Criteria of case selection and exclusion were as follows:

- A. Patients with recurrent obstruction caused by bile duct stones, or recurrent stones with biliary tract surgery history. Imaging examinations or surgeries confirmed that the proximal bile duct was dilated, or stones were completely extracted by intraoperative choledochoscopy. If patients had severe abdominal adhesions caused by multiple biliary or intestinal tract surgeries, laparoscopic surgery was not recommended.
- B. Children and adults with cystic dilation of the CBD, but this should be evaluated with discretion for patients with malignant lesions.
- C. Patients with obstructive jaundice caused by iatrogenic bile duct injury. The optimal timing of surgery was 3 to 4 weeks after injury. If the local injury was too severe to dissect the bile duct, the surgery was changed to an open procedure.
- D. Patients with upper cholangiocarcinoma types I, II, and III according to the Bismuth classification. Surgeons should be experienced in laparoscopic surgery.

- E. For patients with periampullary carcinoma, the tumor-free bile duct above the duodenum should be left as long as possible.

Surgical Procedure

Instruments and equipment included an integrated operating room, laparoscope imaging system (1288HD) (STRYKER, Johnson & Johnson, New Brunswick, NJ), an ultrasonographic scalpel (GENERATOR300, Johnson & Johnson, New Brunswick, NJ, USA), and stapling apparatus (EC60Endo-GIA, Johnson & Johnson, New Brunswick, NJ, USA).

Positions of Patients, Surgeons, and Trocars

Patients were placed in the supine position or in the reverse Trendelenburg position, or they were tilted slightly to the left. Two monitors were placed on either side of the patient's head. General anesthesia was administered and endotracheal intubation performed. A 10-mm incision was made at the right margin of the umbilicus to place a 10-mm trocar. A pneumoperitoneum was then constructed, and the laparoscope was placed through this trocar. Under the laparoscope, four more trocars were placed below the xiphoid process (12 mm) at the right subcostal margin (5 mm), at the right lumbar (10 mm), and at the left lumbar (5 mm), respectively, to place the surgical instruments (**Figure 1**).

Laparoscopic Treatment of the CBD According to Type of Biliary Tract Disease

First, we dealt with the biliary tract disease. At the same time we prepared the end of the residual bile duct for CJS. During this procedure, the laparoscope was put through the paraumbilical trocar. The assistant holding the laparo-

Table 1.
Types of Biliary Tract Diseases and the Accompanying Diseases of 103 Patients Who Underwent TLRCJS

Types of Biliary Tract Diseases	Number of Cases	Preoperative Classification of Liver Function		Complications			
		Child-Pugh A	Child-Pugh B	CHD	Hypertension	DM	Others
Common bile duct stones	28	23	5	5	4	5	3
Common bile duct cyst	24	24	0	3	9	5	0
Injury of bile duct	3	3	1	2	0	0	0
Upper cholangiocarcinoma	36	26	10	6	2	2	1
Cancer of the pancreatic head and periampullary cancer	12	7	5	5	2	5	1

CHD = coronary heart disease; DM = diabetes mellitus.

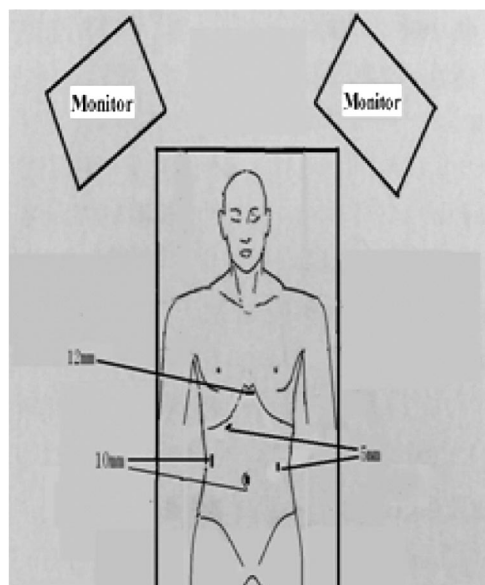


Figure 1. Locations of trocars and monitors. A 10-mm incision was made at the right margin of the umbilicus to place a 10-mm trocar. The laparoscope was inserted into this trocar. Under the laparoscope, the other four trocars were placed below the xiphoid (12 mm) at the right subcostal (5 mm), and the right lumbar (10 mm), and at the left lumbar (10 mm), respectively. Monitors were placed on each side of the patient's head.

scope stood on the left side of the patient and watched the right monitor and the surgeon. The surgeon operated on the hepatic portal area through the right subcostal and subxiphoid trocar. The other assistant stood on the right side and operated the intestinal clamp through the right lumbar trocar.

- (1) For recurrent bile duct stones, the CBD was incised longitudinally and all intrahepatic and extrahepatic bile duct stones were removed with a choledochoscope. The CBD was transected 2 cm distally to the bifurcation of the left and right hepatic ducts. To enlarge the diameter of the anastomosis, the CBD should be cut obliquely or longitudinally.
- (2) For congenital cystic dilatation of the CBD, the hepatoduodenal ligament was incised longitudinally before isolating the dilated choledoch. Bleeding tended to occur near the pylorus, and electric coagulation, ultrasonographic scalpel, or the responsible vascular suture was used to stop it. This avoided damage to the duodenum during this process. Then the left and posterior wall of the CBD was isolated from the left side wall. Careful attention should be given to protecting the portal vein. Then the dilated CBD was transected from the level of maximum diameter, and

the choledochoscope was inserted to confirm that no stones remained. The distal end of the CBD above the superior margin of the pancreas was closed with a double-loop ligation (ENDOLOOP, Ethicon, Cincinnati, OH), and the extra CBD was resected. The proximal CBD end was trimmed, and at least 1.5 cm of CBD was left for cholangiojejunostomy. Resected lesions were removed through the subxiphoid port.

- (3) For injury of the CBD, the hepatic portal area was explored and the proximal end of the bile duct that was injured was confirmed. The CBD was trimmed obliquely, and the anterior wall was incised to enlarge the anastomotic diameter. If the injured position of the bile duct was at a higher level, 0.3 to 0.5 cm of the anterior wall of each hepatic duct was longitudinally incised to enlarge the diameter of the anastomosis.
- (4) For upper cholangiocarcinoma, the hepatoduodenal ligament, as well as internal fibrofatty tissue and lymph nodes, was resected using the ultrasonographic scalpel. After isolating the duodenal segment of the CBD, two Hem-o-lok clips (Weck, Johnson & Johnson, New Brunswick, NJ, USA) were placed on the unaffected bile duct distal to the tumor. The bile duct was transected between two Hem-o-lok clips. The surgeon then lifted the proximal bile duct with his left hand and dissected it with the ultrasonographic scalpel in his right hand. The common hepatic duct or the left and right hepatic ducts were cut, and resected tumor tissue was taken out through the subxiphoid port. Fibroid lymphoid tissue was thoroughly cleared around the portal vein and the common hepatic artery. The caudate lobe of the liver was resected with Ligasure (Covidien, Boulder, CO). Bipolar electrocoagulation was used to stop bleeding of the liver surface.

If the transection was around the bifurcation of the left and right hepatic ducts or a higher level, "basin-like bile duct plasty" was needed to enlarge the diameter of the hepatic bile duct to facilitate the hepaticocholangiojejunostomy (**Figure 2**). There were 3 ways to perform basin-like bile duct plasty (**Figure 2**). (1) For the residual bile duct distal to the bifurcation, and the undilated bile duct after a recent bile duct injury, the diameter of the bile duct was too small to perform CJS. Otherwise, it may be predisposed to have anastomotic stenosis after CJS. In this condition, a 3-mm incision was made on the wall of the bile duct at the 12 o'clock position to enlarge the caliber of the anastomotic stoma. Then CJS was performed using 5-0 absorbable sutures. (2) If the residual hepatic duct was the separated left and right hepatic ducts, the inside wall of

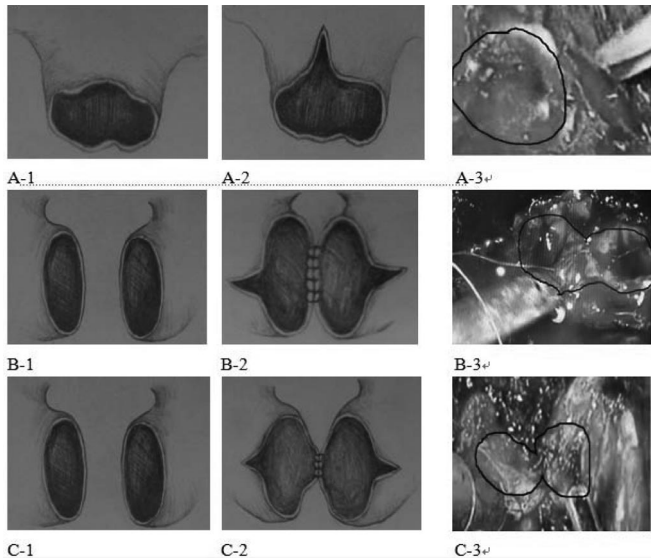


Figure 2. Basin-like bile duct plasty of the hepatic duct. (A) For residual bile duct distal to the confluence of the hepatic duct, a 3-mm incision was made in the side wall of the bile duct to enlarge the diameter of the anastomosis. (B) If the residual ducts were closely located left and right hepatic ducts, the inside wall of each hepatic duct was cut, respectively. Then 5-0 absorbable sutures were used to suture the upper and lower margins of the incision. Finally, each outside wall of the bile duct was cut properly to form a basin shape. (C) If the left and right hepatic ducts were far apart and difficult to bring close together, we resected the hepatic tissue between the ducts. We then sutured the inside wall of each hepatic duct. Finally, we cut each outside wall of the bile duct properly to form a “dumbbell” shape and enlarge the diameter of the anastomotic stoma.

each hepatic duct was cut. Then the inside incisions were sutured with 5-0 absorbable sutures from the upper margin to the lower margin. Finally, the outside wall of each hepatic duct was properly cut to enlarge the diameter of the anastomotic stoma, forming a basin-shaped bile duct. (C) If there was some hepatic tissue between the residual left and right hepatic ducts, combining the sutures between the left and right hepatic ducts was difficult; thus, we had to resect some hepatic tissue between the left and right ducts to decrease the tension. Then the inside walls of the left and right hepatic ducts were sutured with 5-0 absorbable sutures. Finally, the outside walls of the left and right hepatic ducts were properly cut to form a dumbbell-shaped hepatic duct to enlarge the diameter of the anastomotic stoma.

(5) For malignant jaundice caused by advanced pancreatic head or periampullary carcinoma, this sur-

gery was intended to release jaundice. The hepatoduodenal ligament was incised, and the CBD was incised as near as possible to the hepatic portal.

Totally Laparoscopic Roux-en-Y Jejunostomy (TLRJS) and Cholangiojejunostomy (TLCJS)

(1) The laparoscope was inserted into the right lumbar trocar for JJS. The assistant holding the laparoscope was at the right side of the patient. The surgeon was at the left side of the patient and operated via the subcostal trocar with his left hand and the transumbilical trocar with his right hand. The first assistant was at the left side of the patient using the left trocar to lift the greater omentum and the transverse colon with the intestinal clamp. The Treitz ligament and the upper jejunum were then exposed (**Figure 3**). The mesentery of the jejunum was isolated and cut along the line of the mesenteric artery 15 to 20 cm distal to the Treitz ligament. Then the jejunum was transected with Endo-GIA. A hiatus 45 cm away from the end of the distal limb (the biliary limb) and another hiatus 5 cm away from the end of the proximal limb (jejunum limb) at the antimesenteric border were made.

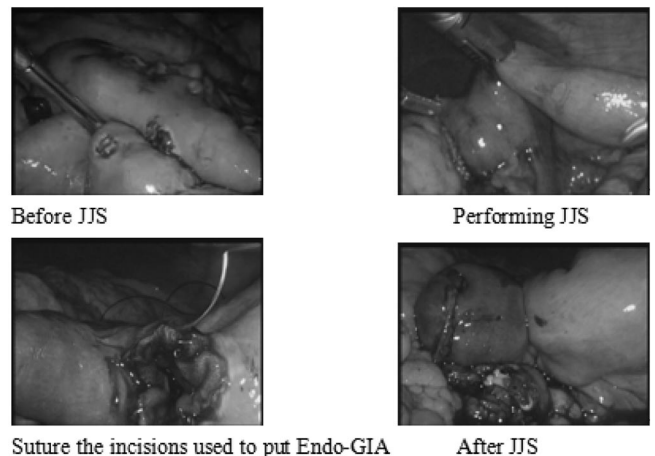


Figure 3. Jejunostomy. Before JJS: This shows that after transaction of the jejunum, a hiatus was made 45 cm from the end of the distal limb (the biliary limb) and another was made 5 cm away from the end of the proximal limb (the jejunum limb) at the antimesenteric border, respectively. During JJS: We placed an Endo-GIA through the two hiatuses of the biliary and jejunum limb and then cauterized it to complete the anastomosis. Suture the incisions used to put Endo-GIA: After removing the stapler, we sutured the residual hiatuses using double-layer sutures. After JJS: This shows the shape of the jejunum after JJS; the left jejunum is the jejunum limb and the right jejunum is the biliary limb.

With a subxiphoid trocar, the Endo-GIA was put through the two hiatuses and was fired to complete the jejunojejunal anastomosis. The stapler was then taken out, and the residual incision was sutured using a double-layer suture.

- (2) The laparoscope was placed via the paraumbilical trocar during CJS. The surgeon and the assistant holding the laparoscope were at the patient's left side. The first assistant was at the patient's right side and lifted the biliary limb close to the proximal end of the residual CBD across the front of the transverse colon. To decrease the tension of the biliary limb, the greater omentum was cut with the ultrasonographic scalpel and put on both sides of the biliary limb. Thus, end-to-side or side-to-side anastomosis was performed with everting sutures between the CBD and the side wall of the biliary limb intermittently or continuously (**Figure 4**), first on the posterior wall, then on the side wall, and finally on the anterior wall. Side-to-side anastomosis was chosen for treating obstructive jaundice caused by pancreatic head and periampullary carcinoma. In cases with upper cholangiocarcinoma, biliary tract injury, cholangiolithiasis, and choledochal cyst, end-to-side anastomosis was chosen. Finally, a peritoneal cavity drainage tube was placed and the surgery was finished.¹⁵

RESULTS

All the surgeries were performed successfully. The diameter of the residual bile duct or hepatic duct ranged from 0.4 to 3.2 cm (average, 0.9 cm). Perioperative conditions are shown in **Table 2**. The complications are listed in **Table 3**. Postoperative bile leakage occurred in 3 patients (2 patients with choledochal cyst and 1 patient with cholangiocarcinoma), and these patients were cured 1 week to 1 month after abdominal cavity drainage. Postoperative intraperitoneal hemorrhage and stress ulcer of the stom-

ach occurred in 2 patients with biliary tract injury and obstructive jaundice. One patient with intraperitoneal hemorrhage was cured after undergoing another laparoscopic surgery. Another patient was cured by abdominal drainage and taking antacids and hemostatic drug therapy for 2 days (**Table 3**).

For 95 patients, the follow-up duration ranged from 4 to 93 months (average, 48.3 months). The follow-up rate was 92.2% (95/103). The follow-up duration of different types of biliary diseases is shown in **Table 4**. Patients with pancreatic head, periampullary cancer, or upper cholangiocarcinoma died of metastasis or cachexia on average 14 months after surgery. No postoperative complications occurred. There was no recurrent choledocholithiasis during follow-up in patients with CBD stones. Three patients had reflux cholangitis 2, 3, and 5 years after their surgery, respectively, and were cured by anti-inflammatory treatment and had no complications of anastomotic stricture. Patients with choledochal cyst had no complications of anastomotic stricture during the follow-up. Three patients with iatrogenic biliary injury had ultrasonographic examination and MRCP during follow-up, and complications of CBD or anastomotic stricture did not occur.

DISCUSSION

RCJS is widely used in the treatment of biliary tract diseases, and laparoscopic RCJS offers a beneficial effect because of its minimal invasion and quick recovery time. To overcome the higher recurrence rate of stones and dissatisfactory long-term outcome after CBD stone extraction, and to explore the surgical solution of choledochal cyst, or obstructive jaundice caused by hepatic portal cholangiocarcinoma, benign stricture of the lower CBD, and periampullary cancer, Shimi et al.,⁶ Schob et al.,⁴ and Cuschieri et al.⁵ reported animal studies on LCJS successively since 1992. Schob et al.¹⁹ reported the clinical application of LCJS in 1994. Hongbing et al.²⁰ initiated the



Suture the posterior wall in CJS. Suture the side wall in CJS. Suture the anterior wall in CJS.

Figure 4. End-to-end anastomosis of CJS. Lift the biliary limb to the location of the residual common bile duct (common hepatic duct). Suture the end of the common bile duct (common hepatic duct) with the side wall of the biliary limb intermittently or continuously. During this anastomosis, everting sutures were used. The order of this suture is first posterior wall, then the side wall, and finally the anterior wall.

Table 2.

Perioperative Conditions of 103 Patients Who Underwent TLRCJS

Types of Biliary Diseases	Number of Cases	Surgical Method	Operative Time (min)	Blood Loss (mL)	Time to Extract the Drainage Tube (d)	Postoperative Stay (d)
Common bile duct stones	28	End-to-side CJS	125.3 ± 23.2	21.1 ± 8.6	2.1 ± 1.3	6.2 ± 2.5
Common bile duct cyst	24	End-to-side CJS	218.3 ± 22.5	25.1 ± 6.1	1.9 ± 1.4	5.4 ± 2.7
Injury of bile duct	3	End-to-side CJS	135.3 ± 3.2	15.6 ± 5.6	2.0 ± 1.1	6.4 ± 2.0
Upper cholangiocarcinoma	36	End-to-side CJS	205.3 ± 23.9	101.1 ± 13.6	2.1 ± 1.8	5.9 ± 2.1
Cancer of the pancreatic head and periampullary cancer	12	Side-to-side CJS	105.3 ± 21.2	20.1 ± 5.6	2.3 ± 1.0	7.2 ± 2.0

Table 3.

Postoperative Complications of 103 Patients Who Underwent TLRCJS

Diseases	No.	Type of CJS	Bile Leakage	Postoperative Bleeding	Stress Ulcer	Reflux Cholangitis
Common bile duct stones	28	End-to-side	0	0	0	3
Common bile duct cyst	24	End-to-side	2	0	0	0
Injury of bile duct	3	End-to-side	0	2	2	0
Upper cholangiocarcinoma	36	End-to-side	1	0	0	0
Cancer of the pancreatic head and periampullary cancer	12	Side-to-side	0	0	0	0

Table 4.

Follow-up Duration of 103 Cases of TLRCJS

Types of Biliary Disease	Number					Total Number
	Follow-up Lost	<6 Months	<12 Months	3 Years	5 Years	
Common bile duct stones	1	0	11	11	6	28
Common bile duct cyst	1	0	5	12	6	24
Injury of bile duct	0	0	0	3	0	3
Upper cholangiocarcinoma	4	0	21	11	0	36
Cancer of the pancreatic head and periampullary cancer	2	2	7	1	0	12

clinical research of LCJS in China and were awarded a preliminary achievement in 1996. However, particular reports on LRCJS were rare because of difficult techniques in laparoscopic lesion resection and cholangiojejunostomy.^{2,3}

In this study, 3 of 103 patients had postoperative bile leakage (2.91%). Neither recurrent stones nor anastomotic stricture occurred in the follow-up. Tang et al.²¹ studied 26 patients in treating iatrogenic cholangitis and periampullary malignant tu-

mor with different procedures of laparoscopic cholangiojejunostomy. Laparoscopic choledochoduodenostomy, Roux-en-Y choledochojejunostomy, and cholecystojejunostomy were performed on 23, 2, and 1 patient, respectively. The postoperative bile leakage rate was 11.5%. Compared with our study, the results indicated that among different methods of CJS, Roux-en-Y CJS had a lower rate of postoperative bile leakage. This was consistent with the report by Han and his group.² Only 1 of

6 patients with recurrent CBD stones and benign biliary tract stricture who underwent TLRCJS had postoperative melena, and no recurrent disease was reported at follow-up.² Postoperative complications of 103 patients are shown in Table 3; they suggest that LYCJS is a safe and effective procedure in treating biliary tract diseases, as long as the surgeon is proficient in laparoscopic technology. Laparoscopic Roux-en-Y CJSs were all performed manually in this study. Because the laparoscope has the local effect of amplification and provides a direct view of the hepatic portal tissues, the laparoscopic procedure is superior to open surgeries in regard to surgical viewing field and performing operations. One patient in our study withstood iatrogenic injury on bifurcation of the hepatic bile duct only 2 days after the first surgery. Although the postoperative period was short, we still successfully completed the reoperation in the case of the undilated bile duct. Postoperative 3-year follow-up showed that the patient had no anastomotic stricture.

The clinical research on TRLCJS was developed in our hospital starting in 2000. Now we report our 11-year experience of performing this difficult surgical procedure.

Positions of Trocars, Monitors, and Surgeons

The principles for the positions of the trocars, monitors, and surgeons were to facilitate performance of laparoscopic JJS and CJS. The 10-mm trocar at the right lumbar should be placed higher than the umbilicus. The paraumbilical trocar and the right lumbar trocar were used to place the laparoscope in different processes. Other trocars were used as passages for the operation. The positions of the surgeons changed twice as described in the surgical methods.

Processing of the Hepatic Portal Bile Duct in Different Biliary Diseases

The dissection of the CBD was an important and high-risk step in this process. Because the CBD tended to bleed, it sometimes makes the surgical field hard to distinguish. In addition, the portal vein was right below the CBD, and this increased the risk of its injury. Surgeons were recommended to repair the CBD with their left hand and perform aspiration with their right hand. A small piece of gauze was put in front of the aspirator. Thus the aspirator, with gauze against its front, was used to separate the CBD from the surrounding tissue. The gauze in front of the aspirator facilitated isolation, and the blood could be removed by the aspirator during isolation, which helped to maintain a clear surgical field.

For patients with iatrogenic bile duct injury, the sooner the surgery was performed, the better the liver function was,

but the surgery was more difficult to perform because of the undilated bile duct. The choice to perform CJS later is advisable, but the possibility of postoperative stress ulcer and abdominal bleeding may increase and, as a result of the obstructive jaundice, the liver function could decline. Two patients with iatrogenic bile duct injury in our study had abdominal bleeding and stress ulcer. Regardless of whether there is bile duct dilation, a drainage tube must be placed through the anastomosis to prevent anastomotic stricture.

For patients with hepatic portal cholangiocarcinoma, the most important step was to resect the tumor-invaded bile duct and to clear the hepatic portal fibrofatty tissue and lymph nodes. Even if the tumor had already invaded the surrounding tissues, isolation of the CBD should also be attempted. Some patients may benefit from this and undergo a palliative resection. The risk in this procedure was the injury to the portal vein and hepatic artery. For patients with early-stage tumor, as long as the surgeon operated meticulously with the ultrasonographic scalpel, the skeletonization of the proper hepatic artery and portal vein was feasible, and it was possible for the lesion to be removed completely (**Figure 5**).¹⁸ If the residual bile duct is at a higher level, basin-like bile duct plasty should be performed to enlarge the diameter of the hepatic bile duct to facilitate the hepaticocholangiojejunostomy and prevent the occurrence of anastomotic stricture.



Figure 5. Skeletonized portal vein and proper hepatic artery. To completely remove the affected lesion, the proper hepatic artery and the portal vein were skeletonized after removing fibrofatty tissue and lymph nodes.

Jejunal Transection and Performance of JJS

Jejunal transection was chosen 15 to 20 cm away from the Treitz ligament, where the mesenteric vessels consist primary hemal arch and some straight vessel branched from the arch. If we isolated the mesentery along the line of the straight vessel to the mesenteric root, the bleeding volume could be decreased dramatically. Injuries of the straight vessel could lead to necrosis of the proximal jejunum. The hemostasis of the mesentery after mesentery isolation was important to prevent postoperative intraperitoneal bleeding.

Endo-GIA was used to perform side-to-side JJS (**Figure 3**). After the anastomosis, the residual hiatus was continuously sutured using 3-0 absorbable sutures. Then a continuous seromuscular embedding suture was done using 3-0 Prolene.

None of the 103 patients in this study had postoperative anastomotic leakage of JJS or peritoneal inflammation, even patients with advanced periampullary tumor, who had >600 mL peritoneal drainage postoperatively.

Attention in TLRCJS

Lessening the tension of the anastomosis was a key point in preventing the occurrence of bile leakage. For patients with obesity or cancer of the pancreatic head, we cut the greater omentum and separated it on both sides of the biliary limb.

The size and methods of suturing were chosen according to the diameter of the bile duct in CJS. If the caliber of the bile duct was small, we chose 5-0 absorbable sutures and interrupted sutures. Otherwise, we used 3-0 absorbable sutures and continuous or interrupted sutures. For all anastomoses, we used everting suture.

Reflux Cholangitis

Reflux cholangitis could occur after RCJS because of food reflux. Recurrent retrograde infection of the bile duct could worsen the patient's condition and lead to failure of the surgery. The muscular and nervous tissues of the jejunum around the JJS anastomosis were not continuous, which made the movement of each limb unable to coordinate with each other. Movement disorders happened frequently, and the flow of chyme and bile did not happen smoothly; thus, reflux was unavoidable. To avoid reflux, it was advocated to leave 60 to 100 cm between the end of the biliary limb and the JJS anastomosis, but clinical practice indicated that an extension of the bowel loops could not prevent reflux. The longer the bowel loops were, the easier for the limb to twist and adhere. However, this may

result in intestinal content retention and bacteria implantation and reproduction, which may predispose the patient to reflux cholangitis.²¹ We chose to leave a 45-cm biliary limb after the side-to-side JJS and sutured 3 stitches between the seromuscular layer of the jejunum limb and the biliary limb together to form the Y shape. In the follow-up period, 3 patients (2.91%) had reflux cholangitis 2, 3, and 5 years after the operation, respectively. In addition, as long as the anastomotic diameter was large enough, reflux cholangitis would not occur. Although chyme had an opportunity to flow back into the bile duct, it could not remain there.

Patient Complications

Patient complications in this study are summarized in **Table 3**.

Bile Leakage. Bile leakage was one of the main complications after CJS, which could possibly lead to subphrenic abscess or peritoneal inflammation. Once it occurs in a small bile duct, it might cause anastomotic stricture and contribute to surgery failure. Fortunately, postoperative bile leakage (3/103, 2.9%) occurred in only 3 patients, all of whom received fluent drainage and were cured 1 week to 1 month after the surgery.

To prevent bile leakage, the following should be noted.

- (1) An active perioperative treatment of anemia or hypoproteinemia used to improve general condition. This was important for the recovery of anastomosis.
- (2) Anastomotic-free tension was another essential factor. The intestinal mesentery should be isolated to the mesenteric root as far as possible to ensure appropriate mobility of the biliary limb. In addition, the greater omentum should be separated if necessary.
- (3) Check for bile leakage after suturing. The posterior wall of the CBD was the commonest position for bile leakage because its deep anatomical position increased the difficulty of the operation.
- (4) Drainage tubes were necessary around the anastomosis. Two drainage tubes were placed in the front and back of the anastomosis through the right lower quadrant. Subphrenic abscess and inflammation could be effectively avoided by an appropriate drainage, even if bile leakage occurred.

Gastrointestinal Bleeding and Peritoneal Bleeding. Factors including biliary tract inflammation, obstructive jaundice, anesthesia, and surgical trauma could lead to stress ulcer and peritoneal bleeding. Postoperative stress ulcer

and peritoneal bleeding simultaneously occurred in 2 patients (1.9%) in this study. Both of the patients had iatrogenic bile duct injury and underwent reoperation 55 and 75 days after the first surgery. Their complication was a result of serious damage to liver function caused by a long-term obstructive jaundice. Antacids and hemostatic and gastric mucosal protective drugs were usually helpful in such patients. One patient was cured by conservative treatment, and the other underwent laparoscopic hemostatic treatment. The optimal timing of surgical repair for a patient with bile duct injury is 3 to 4 weeks after injury.

CONCLUSIONS

It is feasible to perform JJS and CJS totally laparoscopically without assisted mini-incision. TLRCJS was successfully performed for postoperative recurrent CBD stones, upper cholangiocarcinoma, pancreatic head, or periampullary carcinoma, injury, or cyst of CBD. It is essential to have the required instruments and technology to perform this surgery. In addition, surgeons should master the proper skills, including isolating (or separating) the bile duct, extracting the stones, dissecting the dilated choledochal cyst, resecting the bile duct tumor, clearing the hepatic portal fibrofatty tissue and lymph nodes, resecting the caudate lobe, and resecting the left or right half of the liver laparoscopically.

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