Primary Closure Following Laparoscopic Common Bile Duct Reexploration for the Patients Who Underwent Prior Biliary Operation

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Abstract To assess feasibility of primary closure following laparoscopic common bile duct reexploration for the patients who underwent prior biliary operation, we retrospectively studied 50 patients with recurrent or residual common bile duct (CBD) stones who underwent laparoscopic biliary reoperation between June 2008 and June 2013. Endoscopic sphincterotomy (EST) was treated for all these patients and validated failed. They were divided into two groups. Primary closure following laparoscopic common bile duct exploration (LCBDE) was performed in 25 cases (group A); LCBDE plus T-tube drainage was performed in others (group B). The items of operation were compared. The duration of the operation in group A was shorter than that in group B (141 ± 85 vs 158 ± 71 min, $p < 0.05$), as was postoperative hospital stay (16 ± 2.3 vs 23 ± 2.3 h, $p < 0.05$) and the times of postoperative gastrointestinal function recovery (16 ± 2.3 vs 23 ± 2.3 h, $p < 0.05$). Just one duodenum was damaged in group B. Postoperative clinically significant bile leakage occurred in two patients in group A and one case in group B. The median follow-up was 18 months. No postoperative pancreatitis,

postoperative bleeding, bile peritonitis after T-tube removal, stricture of bile duct, and death occurred in the two groups. Just two cases in group B were verified residual stones after 1 month. Primary closure following laparoscopic common bile duct reexploration for the patients who underwent prior biliary operation appears to be a minimally invasive, safe, feasible, and effective procedure when done by expert laparoscopic surgeons.

Keywords Primary closure · Laparoscopic common bile duct reexploration · CBD stones · Prior biliary operation

Introduction

In the last two decades, laparoscopic surgery was contraindicated for patients undergone any prior abdominal surgery, especially, biliary surgery. But with the development of laparoscopic equipment and technique involving intracorporeal suturing, it has been possible to extend the advantage of minimal access surgery to patients with prior operations. Chiappetta et al. reported laparoscopic bile duct reexploration for retained bile duct stones is safe, with minimal morbidity, and a high success rate in duct clearance [1]. The same result also reported from China, laparoscopic biliary tract reoperation has a reasonable operating time, low conversion rate, low intraoperative and postoperative complication rate, and short postoperative hospital stay. Especially, it is a first choice of treatment for patients who have failed in endoscopic sphincterotomy (EST) [2]. Based on the experiences with over 360 laparoscopic common bile duct explorations (LCBDE), in particular with 120 primary closures, we have attempted laparoscopic biliary tract reoperation for patients with residual or recurrent common bile duct (CBD) stones after prior biliary operation including laparoscopic cholecystectomy (LC), open

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cholecystectomy (OC), LCBDE, and open common bile duct exploration (OCBDE) [3]. The aim of this study was to assess the feasibility, efficacy, safety, and patients' short-term outcomes after laparoscopic primary closure of the CBD compared with T-tube drainage.

Materials and Methods

Patients and Methods

This study was a retrospective analysis carried out between June 2008 and June 2013. It was approved by the Ethics Committee of the Affiliated Yixing Hospital of Jiangsu University (Yixing, China) and written informed consent was obtained from each of the participants. A total of 50 patients underwent prior biliary surgery with recurrent or residual choledocholithiasis were divided into two groups and each group consisted of 25 patients. All these patients suffered from the cholecystolithiasis or choledocholith and underwent prior biliary operation (LC/OC/LCBDE/OCBDE). And EST was treated for all these patients and validated failed. Thus, primary closure (group A) and T-tube drainage (group B) following laparoscopic common bile duct reexploration performed were performed. We excluded the patients with intrahepatic bile duct stones or extrahepatic bile duct stricture. For the patients suffered from multiple biliary tract surgery, another OCBDE, or choledochojejunostomy was chosen. The inclusion and exclusion criteria were created, as shown in Table 1. All procedures were performed by the same consultant surgeon. The clinical demographic details and the biochemical findings are shown in Table 2. There were no significant differences between two groups.

Operative Technique

Laparoscopic common bile duct reexploration was performed using a standard four-port technique. We used a 30 video-laparoscope (Stryker, Kalamazoo, MI, USA) placed through a 10-mm umbilical port. A 10-mm port was placed in the subxiphisternum and two 5 mm ports in the right abdomen. The 10-mm port subxiphisternum was used to accommodate the operating choledochoscope (Olympus, Tokyo, Japan). If the previous scar was near from the umbilicus (about 3 cm), the open (Hasson) technique was used to establish pneumoperitoneum. Adhesions under the umbilical incision were dissected using blunt dissection. To approach the hepatic-duodenal ligament, we also recommend the following as this procedure: freed the lateral parietes and then began dissection on the right side along the lateral inferior border of the liver, dissecting the adhesions on the right side of hepatic round ligament down to the hepatic-duodenal ligament. After dissected adhesions around the middle CBD, touching the stones or needle aspiration of bile from the duct were used to identify the CBD (Fig. 1). And then a longitudinal supraduodenal choledochotomy was undertaken using microscissors. Next, a 5-mm fiberoptic choledochoscope was inserted through the 10-mm port subxiphisternum to check the biliary duct and remove the stones by wire basket. Sometimes, in order to confirm the stone clearance, holmium laser was adopted to break the stones through the choledochoscope. Then, the fragments were retrieved with a basket or flushed out through the papilla under direct vision.

After all stones were retrieved and clearance of the intrahepatic/extrahepatic bile duct was confirmed by choledochoscopy, the choledochotomy was closed with interrupted 4/0 Vicryl sutures (Johnson&Johnson, New Brunswick, NJ, USA) in group A. For patients in whom we used T-tube drainage (group B), the T-tube was placed in the choledochotomy and secured with the same sutures. A suction

Table 1 Inclusion and exclusion criteria for the study

Inclusion criteria	Exclusion criteria
Suffered from the cholecystolithiasis or choledocholith and underwent prior biliary operation (LC/OC/LCBDE/OCBDE)	Clinical, radiologic, or biochemical evidence of pancreatitis
Demonstration of recurrent or residual CBD stones by USG, MRCP, or ERCP	Patients who were considered unfit for general anesthesia
EST was treated and failed	Evidence of cirrhosis, intrahepatic bile duct stone, liver mass or abscess, neoplasm
Inclusion criteria of primary closure (group A)	The patients converted to open surgery
① Ensured all CBD stones are retrieved, confirming their clearance by choledochoscopy;	
② Little inflammation or edema in the wall of CBD or sphincter of Oddi.	
Group B: The others who cannot fit ① or ② were subjected to T-tube drainage approach	

Table 2 Clinical and demographic details of patients in the two groups. There was no statistically significant difference ($p = \text{NS}$) for any of the parameters measured

Parameter	Group A ($n = 25$)	Group B ($n = 25$)
Gender (M/F)	14/11	15/10
Age (year)	48.3 (30–72)	50.7 (35–82)
Jaundice	15	18
History of pancreatitis	3	6
Prior surgery LC	9	9
OC	6	7
LCBDE	5	5
OCBDE	5	4
Diameter of CBD (mm)	11.4 (10–25)	13.3 (9–26)
Number of removed stones	1.47 (1–3)	2.54 (1–5)

drain tube was placed in the subhepatic space near the CBD incision in all patients. The T-tube was then led outside the body from the right upper quadrant in group B (Fig. 2). It was ligated 2 weeks after the operation and removed 4–6 weeks later after the routine tubogram and choledochoscopy at the outpatient department (OPD).

Follow-up

All patients were routinely assessed for complications at least 6 weeks after discharge or T-tube removal. B-

Ultrasonography (US) examination and liver function tests (LFTs) were performed in every patient. The median follow-up was 18 months.

Statistical Analysis

Statistical analysis was performed using the SPSS 16.0 software (SPSS, Chicago, IL, USA). Variables were considered statistically significant with $p < 0.05$.

Results

In the past 5 years, we performed 50 relaparoscopic explorations of the CBD and there was no perioperative death. Demographic and clinical characteristics did not differ significantly between study groups (Table 2). The mean operating time was shorter in group A (141 ± 85 min) than in group B (158 ± 71 min) ($p < 0.05$). The times of postoperative gastrointestinal function recovery was shorter in group A (16 ± 2.3 h) than in group B (23 ± 2.3 h) ($p < 0.05$). The postoperative hospital stay was shorter in group A (5.3 ± 1.4 days) than in group B (6.7 ± 4.3 days) ($p < 0.05$). There was no difference in intraoperative blood loss (109 ± 39 vs 111 ± 38 mL, $p > 0.05$), postoperative hepatic function after 2 weeks ($p > 0.05$). Postoperative clinically significant bile leakage occurred in two patients in group A (8 %) and one case in group B (4 %) and was no different. Keeping the suction drain tube

Fig. 1 Stomach and omentum majus often adherent to the abdominal wall (a). Surgeon should be careful to dissect adhesions. In many instances, the upper edge of the duodenum is tented sharply cephalad into the hepatic hilum and could be regarded as a critical “landmark” (b,c). The CBD always lies beneath the upward duodenum (d)

Fig. 2 Fiberoptic choledochoscope was inserted to check the biliary duct from the 10-mm port subxiphisternum (a). And then the stones were removed by wire basket (b). The T-tube was placed in the choledochotomy and interrupted sutured with 4/0 Vicryl sutures (c), and then, effective drainage tubes were put in subhepatic suction. For patients in group A, after ensured all CBD stones are retrieved, primary closure was performed (d)

which is placed in the subhepatic space drainage unobstructed, using broad-spectrum antibiotic and providing nutrition support, these three patients were recovered within 7 to 10 days without reoperation. Just one patient's duodenum was damaged in group B and was repaired by laparoscope. No postoperative pancreatitis, postoperative bleeding, bile peritonitis after T-tube removal, stricture of bile duct, and death occurred in the two groups during the mean follow-up of 18 months. Only two people in the group B found residual stones after one month, and suffered from two to three times stone removals

by choledochoscope through the sinus tract of the T-tube. The postoperative clinical variables of the patients are shown in Table 3.

Discussion

Choledocholithiasis develops in about 5–15 % of patients with gallbladder stones and is the second most frequent complication of cholecystolithiasis [4]. Especially, primary CBD

Table 3 Comparison of clinical outcomes between groups A and B

Outcome measures	Group A (n = 25)	Group B (n = 25)	p
Operating time (min)	141 ± 85	158 ± 71	<0.05
Intraoperative blood loss (mL)	109 ± 39	111 ± 38	NS
Interval between surgery and recovery of GI function (h)	16 ± 2.3	23 ± 2.3	<0.05
Postoperative hospital stay	5.3 ± 1.4	6.7 ± 4.3	<0.05
Postoperative hepatic function after 2 weeks			
AST (U/L)	35.6 ± 7.5	29.7 ± 13.4	NS
ALT (U/L)	48.4 ± 8.6	52.3 ± 13.3	NS
TB (μmol/L)	19.6 ± 3.3	20.3 ± 5.1	NS
Intraoperative gastrointestinal injury	—	1	NS
Bile leakage	2	1	NS
Stricture of bile duct	—	—	NS
Recurrence/retained stone	—	2	NS

NS no significance

stones, which are more common in East Asia, are brown-pigmented and are formed in the bile duct as a consequence of bile stasis and infections [5]. These patients often suffered from obstructive jaundice, cholangitis, or pancreatitis, sometimes even death. It has been proven that if the recurrent stones cause symptoms or in the presence of certain risk factors, they should be removed [6]. During an era of LC, the management of CBD stones especially recurrent stones remain controversial. With the development of equipments and technique, surgeons have more options for the treatment of choledocholithiasis, including OCBDE, EST, and LCBDE.

EST is considered the procedure of choice for patients with retained or recurrent stones, and should be attempted before pursuing biliary tract reoperation. However, EST has many contraindications, such as number of stones, presence of tortuous ducts, or presence of periampullary duodenal diverticula, and varies depending on institutional and individual techniques and experiences. Especially, EST disturbed the anatomy of the sphincter of Oddi which has been postulated to cause stasis of bile and recurrent stone formation [7]. With the emphasis on the sphincter of Oddi, more and more scholars performed surgery approaches.

With the development of a minimally invasive concept, the health attention of the people and together with the advances in laparoscopic instrumentation and skills, increasingly recurrent or retained CBD stones can be treated by laparoscopic surgery. Over these years, randomized controlled trials showed superior outcome with LCBDE compared with endoscopic or OCBDE treatment for CBD stones. It is associated with a high stone clearance rate ranging from 84–97 %, a postoperative morbidity rate of 4–16 %, and a mortality rate of approximately 0–0.8 % [8, 9].

Of the 50 cases in our study, there was no perioperative death. Just one duodenum was damaged in group B and was repaired by laparoscope. No postoperative pancreatitis, postoperative bleeding, bile peritonitis after T-tube removal, stricture of bile duct, and death occurred in the two groups during the mean follow-up of 18 months. We encountered three clinically significant bile leakages. All of the three patients were treated by drainage and recovered without reoperation. Just only two cases in group B were verified residual stones after 1 month, and suffered from two to three times removing stones by choledochoscope through the sinus tract of the T tube. The incidence of nonfatal postoperative complications was 10 % (5/50, a patient with concomitant postoperative residual stones and bile leakage) and showed a decreasing trend with the increasing experience. There were four such complications in the first 15 cases (27.7 %) compared with only one in the last 35 cases (2.9 %). This may be due to the preoperative patient optimization and meticulous operative technique used.

The results above proved that laparoscopic common bile duct reexploration is safe and feasible. In our last experience

and some meta-analyses concluded that primary closure of the CBD was feasible and safe. Comparing primary closure with T-tube drainage during laparoscopic techniques showed a significant reduction in hospital stay and duration of operation with comparable complication rates [3, 10, 11]. In our setting, we achieved statistically significant shortening of the operating time and length of hospital stay together with recovery time of GI function for patients with primary closure versus those with T-tube drainage. These data indicated primary closure following laparoscopic common bile duct reexploration for the patients with prior biliary surgery was also feasible choice. In our opinion, the indications for laparoscopic bile duct reexploration following primary closure are similar as LCBDE [12]: (1) Presence of choledocholithiasis without evidence of intrahepatic bile duct stones; (2) diameter of the CBD is >1 cm; (3) little inflammation or edema in the wall of CBD or sphincter of Oddi; (4) ensure all CBD stones are retrieved totally.

The major concern that has prevented surgeons from using a laparoscopic approach when performing a repeated biliary tract surgery was the risk of injury to organs. Especially, bile duct injury remains the most serious complication of biliary surgery. Thus, preoperative imaging studies were important, especially magnetic resonance cholangiopancreatography (MRCP). MRCP is well recognized to have high sensitivity and specificity (over 90 %) for the detection of CBD stones [13, 14]. In addition, it provides excellent anatomic detail of the biliary tract, the number, size, and location of stones. In the present study, all of the 50 patients have been performed B-type ultrasonography, MRCP, or CT, which were critical to reduce the risk of bile duct and vessel injury.

Careful anatomy and good separation techniques were also important to prevent organ damage. By using Harmonic® to dissect adhesions, the operative time can be reduced, thus decreasing blood loss. Once the porta hepatis has been explored, dense adhesions are usually found during reoperation in the healed fossa and near the common bile duct. In many cases, the upper edge of the duodenum is tented sharply cephalad into the hepatic hilum. In our opinion, the upward duodenum could be regarded as a critical “landmark.” The CBD always lies beneath the upward duodenum (Fig. 1). When the duodenum was detached down from the hepatic hilum, the CBD can be identified by touching the stones or needle aspiration of bile.

Biliary complication is a major criterion for measuring the safety of LCBDE with primary closure, the two major concerns were late bile duct stricture and bile leak [11]. Bile duct stricture following LCBDE was rare but with poor prognosis and regardless of whether the duct was explored via the transcystic or the trans-CBD route [15]. Extrahepatic bile duct is a fibromuscular duct and repaired mainly through fibrous scar tissue healing. Excessive suture was the main reason for bile duct stricture [16]. We have no postoperative biliary

strictures among 50 patients at a mean follow-up for 18 months. In our opinion, meticulous mucosa-to-mucosa suturing of the bile duct and appropriate patient selection were the effective measures to reduce postoperative biliary stricture complications.

Comparing bile duct stricture, the prognosis of bile leak was much better. In our study, we observed a small volume of bile was drained from the drainage tubes in many patients (about over 60 %) during the first 3 days. The patients often have no clinical symptoms such as abdominal pain, fever, anorexia, nausea, and vomiting. As long as keeping effective drainage, the bile leakage could generally phase out. These cases were diagnosed subclinical bile leaks. But if with persistent abundant drainage and clinical symptoms, it should be diagnosed clinically significant bile leakage. We experienced three (6.7 %) clinically significant bile leakage. This is comparable to the bile leak rates of 2.0–4.5 % reported by others [12]. Fortunately, the transudative bile was completely drained by the suction catheter without localized or extensive peritonitis. All of these patients were treated by drainage and recovered without reoperation. The main reasons for bile leak might be (1) moderate edema of the wall of the CBD and the sphincter of Oddi and (2) repeated puncture bile duct wall lead to pinhole leak.

Sophisticated suturing skill is importance to prevent postoperative bile leakage or stenosis. In our last study, we recommend (1) interrupted suture with absorbable 4/0 sutures, which may reduce the recurrence of stones and stenosis of the CBD. (2) Avoided repeated puncture bile duct wall, and, the pitch and margins were about 2 mm and 1.5 mm respectively. The suture properly tightened to just close bile duct wall. (3) Put effective drainage tubes in subhepatic section and near the choledochotomy site. (4) Intraoperative endobiliary stent placement is an effective way to reduce bile leakage [3, 16]. During the conservative treatment process, if the volume of bile in the drain had increased and choledochotomy site patients started to develop signs of extensive biliary peritonitis, they would undergo another laparoscopic operation. Additional sutures would be needed if there is a leak from the choledochotomy site [17].

Stone clearance and recurrence rate are important follow-up indicators to determine the long-term efficacy of surgery. There was no recurrent stone in the primary closure group (group A). This may be due to the preoperative patient optimization and sample size. Large sample, prospective studies are required to further confirmed. Two cases in group B were verified residual or recurrent stones after one month and suffered from two to three times removing stones by choledochoscope through the sinus tract of the T tube. The reasons may be the following: (1) The CBD stones were not removed fully. Actually, in our country, patients suffering from choledocholithiasis differ from western patients in the high incidence of intrahepatic duct stones. It is difficult to

remove all of the stones during the operation. (2) The two people underwent prior open common bile duct exploration followed T-tube drainage. MRCP showed bile angular deformity, Pavel et al. [18] reported oblique common bile duct defines a new entity of bile duct abnormality, which is associated with chronic cholestasis, hampers an efficient stone removal and predisposes to recurrence of bile duct stones. In our opinion, if multiple CBD stones and obvious inflammation or edema in the wall of CBD were found during intraoperative, choledochoscope combining with cholangiography might improve stone clearance rate. T-tube drainage should best be performed.

In summary, primary closure following laparoscopic common bile duct reexploration for the patients who underwent prior biliary operation has a reasonable operating time, low intraoperative and postoperative complication rate, and short postoperative hospital stay. Given these results, it appears to be a minimally invasive, safe, feasible, and effective procedure when done by expert laparoscopic surgeons.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflicts of interest. The authors alone are responsible for the content and writing of the paper. This work was approved by the Institutional Review Board (IRB) of the Affiliated Yixing Hospital of Jiangsu University.

References

1. Chiappetta Porras LT, Nápoli ED, Canullán CM, Quesada BM, Petracchi JE, Oría AS (2008) Laparoscopic bile duct reexploration for retained duct stones. *J Gastrointest Surg* 12:1518–1520
2. Li LB, Cai XJ, Mou YP, Wei Q (2008) Reoperation of biliary tract by laparoscopy: experiences with 39 cases. *World J Gastroenterol* 14:3081–3084
3. Zhang K, Zhan F, Zhang Y, Shen ZH, Shen ZW, Zhang M, Yang XJ (2014) Relaparoscopic common bile duct exploration for management of choledocholithiasis. *Chin J Hepatobiliary Surg* 20:265–268
4. Hungness ES, Soper NJ (2006) Management of common bile duct stones. *J Gastrointest Surg* 10:612–619
5. Tazuma S (2006) Epidemiology, pathogenesis, and classification of biliary stones (common bile duct and intrahepatic). *Best Pract Res Clin Gastroenterol* 20:1075–1083
6. Collins C, Maguire D, Ireland A, Fitzgerald E, O'Sullivan GC (2004) A prospective study of common bile duct calculi in patients undergoing laparoscopic cholecystectomy: natural history of choledocholithiasis revisited. *Ann Surg* 239:28–33
7. Anderson MA, Fisher L, Jain R, Evans JA, Appalaneni V, Ben-Menachem T, Cash BD, Decker GA, Early DS, Fanelli RD, Fisher DA, Fukami N, Hwang JH, Ikenberry SO, Jue TL, Khan KM, Krinsky ML, Malpas PM, Maple JT, Sharaf RN, Shergill AK, Dominitz JA (2012) Complications of ERCP. *Gastrointest Endosc* 75(3):467–473

8. Grubnik VV, Tkachenko AI, Ilyashenko VV, Vorotyntseva KO (2012) Laparoscopic common bile duct exploration versus open surgery: comparative prospective randomized trial. *Surg Endosc* 26:2165–2171
9. Lu J, Cheng Y, Xiong XZ, Lin YX, Wu SJ, Cheng NS (2012) Two-stage vs single-stage management for concomitant gallstones and common bile duct stones. *World J Gastroenterol* 18:3156–3166
10. El-Geidie AA (2010) Is the use of T-tube necessary after laparoscopic choledochotomy? *J Gastrointest Surg* 14:844–848
11. Wu X, Yang Y, Dong P, Gu J, Lu J, Li M, Mu J, Wu W, Yang J, Zhang L, Ding Q, Liu Y (2012) Primary closure versus T-tube drainage in laparoscopic common bile duct exploration: a meta-analysis of randomized clinical trials. *Langenbeck's Arch Surg* 397(6):909–916
12. Cai H, Sun D, Sun Y, Bai J, Zhao H, Miao Y (2012) Primary closure following laparoscopic common bile duct exploration combined with intraoperative cholangiography and choledochoscopy. *World J Surg* 36:164–170
13. Guarise A, Baltieri S, Mainardi P, Faccioli N (2005) Diagnostic accuracy of MRCP in choledocholithiasis. *Radiol Med* 109:239–251
14. Trivedi PJ, Tse D, Al-Bakir I, D'Costa H (2012) Appropriate patient selection in the management of common bile duct stones: when not to do ERCP. *ISRN Surg* 2012:286–365
15. Khaled YS, Malde DJ, de Souza C, Kalia A, Ammori BJ (2013) Laparoscopic bile duct exploration via choledochotomy followed by primary duct closure is feasible and safe for the treatment of choledocholithiasis. *Surg Endosc* 27:4164–4170
16. Zhang K, Wang HW, Wu HR, Yao HH (2006) Feasibility of using endobiliary stent for laparoscopic exploration of common bile duct. *Chin J Hepatobiliary Surg* 12:21–23
17. Jameel M, Darnas B, Baker AL (2008) Trend towards primary closure following laparoscopic exploration of the common bile duct. *Ann R Coll Surg Engl* 90:29–35
18. Strnad P, von Figura G, Gruss R, Jareis KM, Stiehl A, Kulaksiz H (2013) Oblique bile duct predisposes to the recurrence of bile duct stones. *PLoS One* 8:e54601