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Primary Closure Following Laparoscopic Common Bile Duct Exploration Combined with Intraoperative Choledochoscopy and D-J Tube Drainage for Treating Choledocholithiasis

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Background: This study aimed to assess the clinical short-term results of a primary closure following laparoscopic common bile duct exploration (LCBDE) combined with intraoperative choledochoscopy and D-J tube drainage for choledocholithiasis treatment.

Material/Methods: Twenty-five patients (14 women and 11 men) who underwent LCBDE with primary duct closure and D-J tube drainage for choledocholithiasis were retrospectively enrolled. The D-J tube (4.7F×14 cm) was removed using a duodenoscope if there was no bile leakage. Before discharge, patients were examined for blood amylase. After discharge or D-J tube removal, all patients were routinely assessed for complications.

Results: Mean operating time was 135±46 min (range, 78–195 min). Mean intraoperative blood loss was 71±24 mL (range, 25–110 mL). Total hospital stay was 6–9 days (mean, 8.04±1.37 days). Two patients experienced intraoperative bile leakage, which was stopped with re-suturing. None of these patients experienced postoperative bile leaks. Three patients had slight elevation of serum amylase before discharge but without pancreatitis signs. The successful clearance rate of stones was 100%. During 1-year follow-up, no recurrence or severe complications occurred.

Conclusions: A primary closure following LCBDE combined with intraoperative choledochoscopy and D-J tube drainage is safe and feasible for choledocholithiasis treatment.

MeSH Keywords: Blood Loss, Surgical • Choledocholithiasis • Laparoscopy

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Background

Choledocholithiasis is the presence of gallstones in the common bile duct (CBD) and constitutes the dominating etiology of nonmalignant biliary obstruction [1]. Choledocholithiasis develops in 8–20% of patients suffering from this common disorder, of which 5% are asymptomatic [2]. Although CBD stones may be asymptomatic, they are responsible for considerable morbidity and mortality because of complications such as cholangitis, acute pancreatitis, and hepatic dysfunction [3]. Therefore, paying attention to the detection and management of CBD stones is mandatory.

The management of CBD stones remains debatable, although both endoscopic and laparoscopic techniques have evolved significantly with considerable refinement of equipment and technique [4]. T tube drainage after choledochotomy is a traditional surgical treatment for choledocholithiasis [5]. The T tube has been proven to be an effective method for postoperative biliary decompression, which is essential in avoiding spasm or edema of Oddi's sphincter [6,7]. However, T tube usage is not exempt from complications, such as bile leakage after T tube removal, tract infection, electrolyte and nutritional disturbances, cholangitis, or acute renal failure from dehydration due to inadequate water ingestion, particularly in elderly patients [7,8]. In addition, the patients have to carry bile drainage equipment for several weeks before removal, causing significant discomfort in patients and affecting their work [9]. The disadvantage of T tube drainage led several authors to perform primary closure of the duct immediately after exploration [10,11]. On the other hand, laparoscopic CBD exploration (LCBDE) has all the advantages of minimal access surgical procedures and is currently considered to be as effective as endoscopic retrograde cholangiopancreatography (ERCP) [11]. LCBDE is now an accepted treatment modality for single-stage management of CBD stones in qualified patients [12].

The internal double J (D-J) stent, also known as the retrograde ureteric stent, has become an integral part of the urological armamentarium [13]. The D-J stent is a thin, hollow, flexible tube, and has 2 "J-shaped" (curled) ends, with one anchored in the renal pelvis and the other inside the bladder. Additionally, the D-J tube has multiple side-holes that allow urine to drain freely from the upper collecting system of the kidney, down through and around the stent, and into the bladder [14]. The D-J stent, as a main option for temporary urinary diversion, allows good urinary drainage from the kidney to the bladder, and is generally safe and well tolerated. The usage of D-J stenting is associated with decreased incidence of urinary fistula and ureterostenosis [15]. In this context, we suggested that the D-J stent drainage may be used as an alternative to T tube drainage. However, few studies have investigated whether the D-J tube could be an alternative to the placement of a T tube and be used in the primary closure after LCBDE.

In the present study, we conducted a retrospective study to assess the short-term clinical results of primary closure following LCBDE combined with intraoperative choledochoscopy and D-J tube drainage. In particular, the D-J stents used in this study were 4.7F×14 cm, a size commonly used in pediatric urology.

Material and Methods

Patients and data collection

Patients who underwent LCBDE with primary duct closure for choledocholithiasis in our hospital between April 2010 and April 2015 were enrolled in this study. Choledocholithiasis was diagnosed and confirmed preoperatively by B-type ultrasonography (US), computed tomography (CT), and/or magnetic resonance cholangiopancreatography (MRCP). Patients were included in the study if they met all of the following criteria: 1) inner diameter of CBD ≥0.7 cm, 2) 1–3 stones with diameter of 0.3–1.2 cm, 3) sphincter of Oddi in good condition, and 4) no history of upper abdominal surgery. Patients were excluded from recruitment into the study if they had confirmed intrahepatic multiple stones or primary sediment calculus; suppurative cholangitis; stenosis of the bile duct; or biliary pancreatitis. Thus, a total of 25 patients met the eligibility criteria and were included in the study. A total of 17 patients had a CBD diameter >10 mm and 8 patients had a CBD diameter <10 mm. The range of CBD diameters was 0.7–2.0 cm. None of the patients had acute suppurative obstructive cholangitis at the time of admission. Only 3 had already undergone a previous cholecystectomy and 1 patients had previously undergone partial intestinal resection. Symptoms such as fever and abdominal pain were identified in 5 cases preoperatively. Nine patients had jaundice and they were given an anti-inflammatory agent and liver-protective drugs for treatment. Ethics approval was obtained from the local Ethics Committee and all patients signed written informed consent prior to participation into the study.

Operative technique

The operations were performed under general anesthesia. The procedure was initiated with the standard 4-trocars technique as a laparoscopic cholecystectomy [16]. An operating laparoscope (Olympus CHF-P60, Japan) was employed. The cystic artery was clipped and cut off. The gallbladder bed was isolated and the gallbladder was left *in situ*. We used needle aspiration of bile to identify the CBD. A 0.6-cm to 1-cm longitudinal incision was made at the anterior surface of the CBD, through which a choledochoscope (Olympus, HF-10) was inserted into

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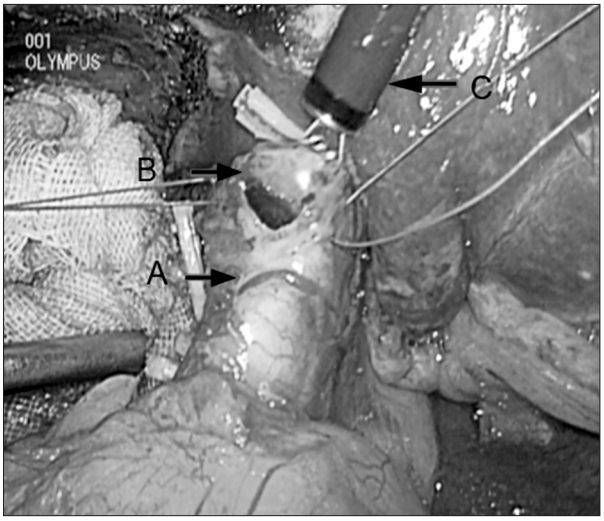

Figure 1. Stones were retrieved during the choledochoscopy. A. Common bile duct (CBD). B. Choledocholithiasis. C. Choledochoscopy.

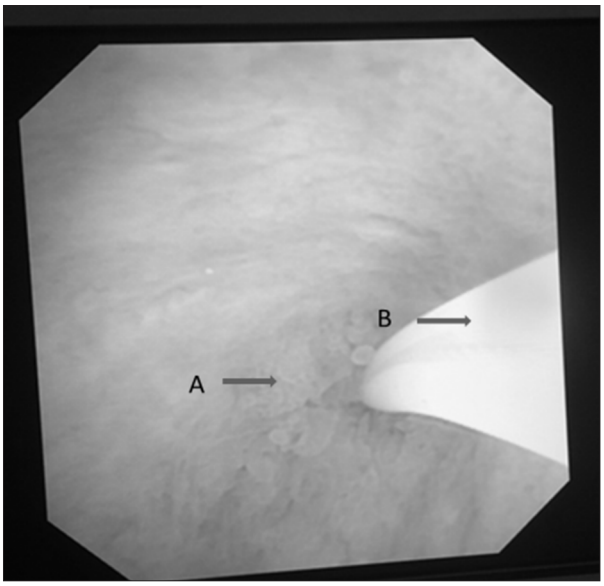

Figure 2. The D-J tube was advanced into the duodenal papilla under the direct view of choledochoscopy. A. Duodenal papilla. B. D-J tube.

the CBD and maneuvered proximally and distally in the biliary tree. Any stone encountered during the choledochoscopy was retrieved with a stone basket. Biliary lithotripsy was used, if necessary, to fragment large stones (Figure 1). The stones were all retrieved and the intrahepatic/extrahepatic bile duct clearance was confirmed with choledochoscopy. Then, a guide wire was advanced through the working channel of the choledochoscope into the duodenum. We used the guide wire to support the circle head at both ends of the D-J stent (4.7F×14 cm, Bard Medical, Covington, GA, USA) into a straight tube, and then pushed the D-J tube into the CBD from the side of

Figure 3. Abdominal X-rays of a patient at 2 days after the operation. The D-J tube shadow (indicated by an arrow) is visible in the middle abdomen.

the choledochoscope. Then, the D-J tube and the guide wire were advanced into the duodenum (Figure 2) through the duodenal papilla using the choledochoscopy grasping forceps. After the tube had been positioned in place using the grasping forceps, the guide wire was withdrawn from the CBD. Two ends of the D-J tube were spiral in the duodenum and CBD (Figure 3). The choledochotomy was primarily closed with interrupted Vicryl (polyglactin, absorbable) 4-0 sutures. To reduce the risk of bile leak from the choledochotomy, suture closure should be carried out delicately and steadily. After cholecystectomy was completed, a peritoneal drain was placed in the subhepatic space. The D-J tube was removed using a duodenoscope (OLYMPUS, JF-240) if there was no bile leakage. Bile leak was noted intraoperatively and postoperatively. After primary suture closure, the location at the biliary suture was repeatedly wiped with gauze. If the gauze was dyed yellow, the corresponding suture position was reinforced using 0-5 PDS absorbable sutures. Bile fistula was assessed by observing the nature and amount of drainage fluid.

Discharge and follow-up

Patients could drink water on the first day postoperatively. Before discharge, we examined the blood amylase. After

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Table 1. Intra-operative and post-operative clinical data.

	D-J tube drainage (n=25)
Operating time (min)	135±46
Intraoperative blood loss (ml)	71±24
Gastrointestinal ventilation time (h)	51.8±12.5
Total hospital stay (d)	8.04±1.37
Postoperative hospital stay (d)	4.7±1.9
Cost of treatment (CNY)	26540±3776
Postoperative complications	
Bile leakage (%)	0
Elevation of serum amylase (%)	3 (12%)
Retained stone (%)	0
Recurrence of CBD stones (%)	0
Bile duct stenosis (%)	0

CNY – Chinese Yuan Renminbi.

discharge or D-J tube removal, all patients were routinely assessed for complications. B-ultrasonography (US) examinations were carried out at 1 to 12 months in the outpatient clinic to check residual or recurrent common bile duct stones, with MRCP used when indicated. Magnetic resonance imaging was used to check for stenosis of the bile duct or other severe complications in every patient.

Statistical analysis

Data were analyzed using the SPSS statistical software package version 20.0 (SPSS, Chicago, Illinois). The results of continuous variables are expressed as median (range). The cost of treatment was calculated and reported in Renminbi yuan (CNY; USD 1=CNY 6.9). Differences were considered statistically significant at P values less than 0.05.

Results

During the study period, 25 patients (14 women and 11 men) with the median age of 45.5±6.3 years (1 patient was >65 years old) underwent a primary closure following LCBDE combined with intraoperative choledochoscopy and D-J tube drainage. The mean body mass index (BMI) of these patients was 24.3±3.8 kg/m^2. The intraoperative and postoperative clinical data are shown in Table 1. The mean operating time was 135±46 min (range, 78–195). The mean intraoperative blood loss was 71±24 mL (range, 25–110 mL). All patients were allowed to walk on the first postoperative day. The mean time of recovery of gastrointestinal functions (gastrointestinal ventilation time) was 51.8±12.5 h (range, 33–74 h); the main features of recovery of gastrointestinal functions included anus exhaust and auscultating bowel sounds. Total hospital stay was 6-9 days, with the mean of 8.04±1.37 days. The mean postoperative hospital stay was 4.7±1.9 days. The mean cost of treatment was 26 540±3776 CNY. Two patients experienced intraoperative bile leakage at the suture, which was stopped with re-suturing. None of the patients experienced postoperative bile leak. The D-J tube was removed using the duodenoscope (OLYMPUS, JF-240) at 3 d after the operation if there was no bile leakage. Three patients experienced slight elevation of serum amylase before discharge, but without symptoms of pancreatitis. These 3 patients with elevated serum amylase received somatostatin to reduce secretion of pancreatin. The successful clearance rate of stones was 100%. During 1-year follow-up, no recurrence or bile duct and other severe complications occurred.

Discussion

Gallstone disease is now a very common indication for abdominal surgery. Complete removal of CBD stones and preventing sphincter of Oddi dysfunction are 2 significant objectives of surgery [17]. There are many reports of complications with T tube drainage, including bile leakage after T tube removal, tract infection, electrolyte and nutritional disturbances, cholangitis, or acute renal failure from dehydration due to inadequate water ingestion, particularly in elderly patients [5, 18]. Several reports showed primary closure of the duct immediately after exploration. However, primary closure of the CBD could lower incidence of biliary fistula due to high biliary pressure, which may result in biliary stricture [19].

In this study, we performed LCBDE and ensured duct clearance by choledochoscopy. Then, the primary closure and D-J tube drainage were carried out. After CBD exploration for choledocholithiasis, intraductal drainage with a T tube is standard practice. However, the complications of using a T tube outweigh its benefits [20,21]. Fielding et al. showed that primary closure can be safely performed in patients without distal obstruction, and clearance of the duct is easy in these patients [22]. However, bile leakage through the choledochotomy site may occur due to compression of the CBD from edema of the ampulla of Vater and bowel paralysis [23]. We believe that intraductal drainage is still needed in patients with primary closure of the CBD. One of the highlights of our study is the use of a common D-J stent (4.7F×14 cm), which is commonly used in pediatric urology. This D-J tube used is shorter, smaller, and more flexible than D-J tubes used for adult patients. The biliary stents have projections or "barbs" at each end, which are not conducive to removal postoperatively using duodenoscopy. In this study, we

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used the guide wire to support the circle head at both ends of the D-J stent into a straight tube, and then pushed the D-J tube into the CBD from the side of the choledochoscope. Then, the D-J tube and the guide wire were advanced into the duodenum through the duodenal papilla using the choledochoscopy grasping forceps. After the tube had been positioned at the appropriate place using the grasping forceps, the guide wire was withdrawn from the CBD. The 2 ends of the D-J tube are spiral in the duodenum and CBD. The D-J tube can be removed using a duodenoscope 3 d after the operation if there is no bile leakage. The average length of hospital stay was 8.04±1.37 days. The total length of hospitalization of the patients was significantly lower than that of patients who had undergone a traditional operation. However, the operation time with the surgical approach in this study was not significantly shorter than with the traditional laparoscopic T tube drainage approach (data not shown). The method was successful in all 25 patients, and there were no postoperative complications. In the 3 patients with elevated serum amylase, we assumed that the edema of the duodenal papilla resulted in a mild increase of serum amylase. These 3 patients with elevated serum amylase were treated with somatostatin to reduce secretion of pancreatin. In addition, placement of the D-J tube is done endoscopically, so we considered that the surgical technique was safe.

CBD exploration followed by D-J tube drainage and primary closure consists of major biliary surgery, which needs higher laparoscopic skills. Mechanical damage of the bile duct should be reduced and soft, and elaborate suturing is required [24]. In addition, the drain fluids generated during the surgery should be carefully cleared [25]. Indications for use of a D-J tube include no bile duct stenosis, no hepatolithiasis using US, CT, and MRCP, and no residual stones after exploration by choledochoscopy.

This study has a number of limitations. First, the cohort included was relatively small due to the new surgery approach and the limited number of qualified patients. More clinical data should be collected in future studies. Second, the retrospective nature of the study may have potential biases, including surgeon preference and case selection. Nevertheless, there were few complications in the patients with a primary closure following LCBDE combined with intraoperative choledochoscopy and D-J tube drainage. The main purpose of this report is to describe a new and improved surgical procedure. Further studies comparing clinical data between the surgical procedure in this study and conventional T tube placement and primary suture surgery will be conducted in our future work.

Conclusions

The present series adds to the limited data providing evidence that a primary closure following LCBDE combined with intraoperative choledochoscopy and D-J tube drainage is safe and feasible for choledocholithiasis treatment. Our report also underscores the need for further studies with larger cohorts.

Conflict of interest

None.

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