

Original Article/Biliary

Laparoscopic common bile duct exploration with primary closure is safe for management of choledocholithiasis in elderly patients

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ABSTRACT

Background: Laparoscopic common bile duct exploration (LCBDE) is one of the minimally invasive options for choledocholithiasis. Primary closure of the common bile duct (CBD) upon completion of laparoscopic choledochotomy is safe in selected patients. The present study aimed to evaluate the feasibility and safety of primary closure of CBD after LCBDE in patients aged 70 years or older.

Methods: A total of 116 patients (51 males and 65 females) who suffered from choledocholithiasis and underwent primary closure of the CBD (without T-tube drainage) after LCBDE from January 2003 to December 2017 were recruited. They were classified into two groups according to age: group A (≥ 70 years, $n = 56$), and group B (< 70 years, $n = 60$). The preoperative characteristics, intraoperative details, and postoperative outcomes of the two groups were evaluated.

Results: The mean operative time was 172.02 min for group A and 169.92 min for group B ($P = 0.853$). The mean hospital stay was 7.40 days for group A and 5.38 days for group B ($P < 0.001$). Bile leakage occurred in two patients in group A and one in group B (3.57% vs 1.67%, $P = 0.952$). There were no significant differences in the rates of postoperative complications and mortality between the two groups. At median follow-up time of 60 months, stone recurrence was detected in one patient in group A and two in group B (1.79% vs 3.33%, $P = 1.000$). Stenosis of CBD was not observed in group A and slight stenosis in one patient in group B (0 vs 1.67%, $P = 1.000$).

Conclusion: Primary closure of the CBD upon completion of laparoscopic choledochotomy is safe and feasible in elderly patients ≥ 70 years old.

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Introduction

Choledocholithiasis (stones in common bile duct) is one of the complications of cholelithiasis (gallstones) and hepatolithiasis. Though stones can frequently pass through the common bile duct (CBD) into the duodenum, some stones may be too large to pass through the CBD and may cause an obstruction. This obstruction will lead to jaundice, acute pancreatitis or ascending cholangitis [1]. Choledocholithiasis is a relatively common disease in elderly patients. Previous researches have demonstrated that its prevalence increases with age [2–4]. This increased incidence results in more hepatobiliary system surgeries for senior and high risk patients.

The therapeutic strategies of choledocholithiasis vary widely, ranging from laparotomy operation, laparoscopic surgery, percutaneous intervention and endoscopic retrograde cholangiopancreatography (ERCP). Laparoscopic common bile duct exploration (LCBDE) is one of the minimally invasive options for management of choledocholithiasis [5–7]. In addition, primary closure of the CBD without a T-tube drainage has been promoted as a safe alternative to T-tube placement in the CBD after laparoscopic choledochotomy, which may further minimize the surgical injury and dramatically improve the patients' quality of life after operation [8–10]. With increasing age, it is well documented that the prevalence of comorbidity increases. However, there are few studies that document on the safety and efficacy of adopting primary closure approach for elderly subjects. The present study aimed to evaluate the feasibility and safety of primary closure of CBD after LCBDE in patients aged 70 years or older, in comparison with a group of younger patients.

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Methods

From January 2003 to December 2017, 116 patients (51 males and 65 females; age range, 13–92 years) with choledocholithiasis underwent primary closure of the CBD without T-tube drainage upon completion of LCBDE at the Department of Hepatobiliary Surgery, Sun Yat-sen Memorial Hospital of Sun Yat-sen University, Guangzhou, China. The medical records of these patients were retrospectively reviewed. The diagnosis of choledocholithiasis was defined by abdominal ultrasonography, magnetic resonance cholangiopancreatography (MRCP) or computed tomography (CT) scan: the abdominal ultrasonography and MRCP were performed routinely on each patient, while CT is an alternative for the patients who had contraindications for MRCP. The CBD diameter and characteristics of intra-CBD calculi (including number of stones and maximum diameter of stones) were evaluated by the above examinations. The informed consents of patients were obtained. These patients were classified into two groups according to their age. The elderly group (group A) included 20 males and 36 females who were 70 years or older ($n=56$), while the younger group (group B) included 31 males and 29 females who were younger than 70 years ($n=60$). All procedures were performed under general anesthesia by two surgeons. Referring the standards of previous studies [11–13], our indications for primary closure of the CBD were as follows: (1) the diameter of CBD was larger than or equal to 8 mm; (2) calculus were extracted thoroughly both in the CBD and intrahepatic bile duct; (3) the inflammation and edema of CBD wall was mild; (4) the distal CBD and duodenal papilla were expedite, and Oddi's sphincter functioned well; and (5) absence of tissue defect and extensive injury to the blood supplying arteries of the CBD.

Operative technique for LCBDE

The conventional laparoscopic cholecystectomy was implemented initially by 3-port configuration. The subumbilical port was for the camera using a 10-mm trocar at first, then one epigastric port (10-mm) was created in between the right midclavicular and the standard epigastric port which was just below the subcostal margin for choledochoscope exploration. After the gallbladder was dissected away from the liver using a 5-mm harmonic dissector (Ultracision harmonic scalpel; Ethicon Endo-surgery, Cincinnati, OH, USA), another trocar (5-mm) was inserted in the left subcostal area as an assistive port. Those patients who already had cholecystectomy previously would undergo LCBDE directly using the 4-port configuration as above.

If the diameter of cystic duct was less than 5 mm, LCBDE would be performed via transcholedochal approach as our previous study [14]. Briefly, the anterior surface of the CBD was dissected longitudinally by surgical scissors and then choledochotomy was done with an incision of 8–12 mm according to the size of the calculus. Then choledochoscope (Olympus, Tokyo, Japan) was inserted for CBD exploration. The diameters of different parts of our choledochoscope are 4.90 mm (front part), 5.40 mm (flexible part) and 5.85 mm (overall insertable part). In the majority cases, the choledochoscope was able to enter into the left and right hepatic duct and could observe the secondary intrahepatic bile duct. It even could enter into the secondary intrahepatic bile duct when the biliary system had dilatation. The calculus in the CBD and visible intrahepatic bile duct were extracted with the help of basket, suction, and/or electro-hydraulic lithotripsy. After retrieving all the accessible bile duct stones, the choledochoscope can also observe the condition of distal CBD and Oddi's sphincter. The status of the distal CBD and function of Oddi's sphincter would be inspected meticulously to check whether obstruction of the outlet of CBD had occurred. Primary closure of the CBD was allowed only if the following conditions were fulfilled: contraction and peristalsis of

Oddi's sphincter was observed directly by choledochoscope, and choledochoscope was able to enter into duodenum without significant resistance; if not, a ureteric catheter (5 Fr) was introduced to pass through choledochoscope into the lower segment of CBD, and it should pass through the Oddi's sphincter smoothly into duodenum. When these conditions were met, the incision was closed by continuous suture, using 5-0 polydioxanone suture.

While the diameter of cystic duct was more than 5 mm, transcystic approach was employed for LCBDE [14]. Firstly, a balloon dilator was used to dilate the cystic duct, or an appropriate longitudinal incision was made on the cystic duct. Then choledochoscope was inserted into the CBD through the cystic duct. After extracting the bile duct stones, the cystic duct was closed with clips or suture.

After the surgery was completed, patients were transferred into intensive care unit (ICU) or general ward depending on their intraoperative vital signs, autonomous respiration and consciousness recovery. One rubber drainage tube was placed into the subhepatic site for all patients routinely, which was removed on the 2nd or 3rd day after operation, when drainage was less than 20 mL/day. The patients were discharged when they met the following standards: (1) the vital signs and laboratory tests were at stable situation and patients were able to proceed off-bed activities autonomously; (2) their appetite and excretion were at a good condition; and (3) wound healing was uneventful with no evidence of suppuration or dehiscence.

Follow-up

Patients were followed up regularly for abdominal ultrasound and relevant blood tests at 6-monthly interval. The median follow-up time for both groups was 60 months.

Statistical analysis

The statistical results were described as mean \pm standard deviation (SD). Patient demographics, preoperative risk factors, operative results and postoperative complications were analyzed using Student's *t*-test, Chi-squared analysis or Fisher's exact test where appropriate. Analysis was calculated using Statistical Package for the Social Sciences (SPSS, version 22.0) software. A *P* value of <0.05 was considered statistically significant.

Results

Patient characteristics

The two groups were comparable in terms of sex, body mass index, clinical parameters, history of abdominal surgery, history of cholecystectomy, diameter of CBD, number of calculus in CBD, and maximum diameter of calculus (Table 1). The mean age of patients in group A and group B was 78.02 years and 49.98 years, respectively ($P < 0.001$). In regard to preoperative risk factors, e.g. cardiovascular disease, pulmonary disease and ASA (American Society of Anesthesiologists) scores, group A had significantly higher comorbidities than group B ($P < 0.05$, Table 2).

Intraoperative details

For group A, five patients underwent transcystic approach and 51 underwent transcholedochal approach; for group B, four patients underwent transcystic approach and 56 underwent transcholedochal approach ($P=0.914$). The mean operative time was 172.02 min for group A and 169.92 min for group B ($P=0.853$). Mean intraoperative blood loss in group A was 49.14 mL and in group B, 26.50 mL ($P=0.029$), while three patients in group A

Table 1
Demographic data and clinical characteristics of patients.

Characteristics	Group A (n = 56)	Group B (n = 60)	P value
Sex (M/F)	20/36	31/29	0.084
Age (yr)	78.02±6.46	49.98±13.15	< 0.001
Body mass index (kg/m ²)	22.38±2.76	23.09±2.30	0.135
Obstructive jaundice	18 (32.14%)	12 (20.00%)	0.136
Acute cholangitis	14 (25.00%)	7 (11.67%)	0.062
History of pancreatitis	9 (16.07%)	10 (16.67%)	0.931
History of abdominal surgery	13 (23.21%)	11 (18.33%)	0.517
History of cholecystectomy	6 (10.71%)	4 (6.67%)	0.656
Diameter of CBD (mm)	15.34±4.51	15.20±3.94	0.860
Solitary/multiple stones	28/28	29/31	0.858
Maximum diameter of stones (mm)	10.25±5.06	9.58±5.29	0.478

CBD: common bile duct.

Table 2
Preoperative risk factors.

Comorbidities	Group A (n = 56)	Group B (n = 60)	P value
Diabetes mellitus	8 (14.29%)	5 (8.33%)	0.310
Cardiovascular disease	29 (51.79%)	13 (21.67%)	0.001
Pulmonary disease	7 (12.50%)	0	0.015
Renal insufficiency	3 (5.36%)	0	0.218
ASA score	2.91±0.55	2.25±0.47	< 0.001

ASA: American Society of Anesthesiologists.

Table 3
Operative details and postoperative complications.

Variables	Group A (n = 56)	Group B (n = 60)	P value
Operative time (min)	172.02±60.64	169.92±61.09	0.853
Blood loss (mL)	49.14±75.08	26.50±24.76	0.029
Blood transfusion	3 (5.36%)	0	0.218
ICU observation	10 (17.86%)	5 (8.33%)	0.127
Hospital stay (d)	7.40±2.96	5.38±2.82	< 0.001
Remnant stone	1 (1.79%)	1 (1.67%)	1.000
Recurrent stone	1 (1.79%)	2 (3.33%)	1.000
Bile leakage	2 (3.57%)	1 (1.67%)	0.952
CBD stricture	0	1 (1.67%)	1.000
Pneumonia	3 (5.36%)	1 (1.67%)	0.562
Acute cardiovascular event	1 (1.79%)	0	0.483
Fever	2 (3.57%)	1 (1.67%)	0.952
Urinary retention	1 (1.79%)	0	0.483
Mortality	1 (1.79%)	0	0.483

ICU: intensive care unit; CBD: common bile duct.

needed intraoperative blood transfusion but none in group B ($P=0.218$). Ten patients in group A and five in group B were transferred to ICU for anesthesia recovery and early postoperative care after surgery ($P=0.127$). The mean postoperative hospitalization was 7.40 days for group A and 5.38 days for group B ($P < 0.001$).

Complications

Postoperative complications related to the surgical technique had no statistical differences between the two groups (Table 3). Remnant stones were observed due to persistent upper abdominal pain and confirmed by MRCP in one patient in each group, respectively (1.79% vs 1.67%, $P=1.000$), which were removed by endoscopic sphincterotomy (EST). No patient developed pancreatitis after surgery in both groups. In group A, bile leakage occurred in two patients on postoperative day 1 and day 2, respectively, while this also occurred in one patient in group B on postoperative day 3 (3.57% vs 1.67%, $P=0.952$). All patients with bile leakage recovered after drainage and lavaging without requiring reoperation.

There were no significant differences in the rates of postoperative systemic complications (including pneumonia, acute cardiovascular event, fever and urinary retention) between the two groups ($P > 0.05$, Table 3). Three patients in group A and one patient in group B had pneumonia (5.36% vs 1.67%, $P=0.562$), and they all

covered through medical treatment. Fever occurred in two patients in group A and one in group B (3.57% vs 1.67%, $P=0.952$). Urinary retention was noted in one patient in group A but none in group B (1.79% vs 0, $P=0.483$). One patient in group A had acute cardiovascular event who died on postoperative day 1, while there was no cardiovascular event or mortality in group B, but these differences did not reach statistical significance (1.79% vs 0, $P=0.483$).

Follow-up

During the subsequent follow up period of both groups, recurrence of calculus was noted in one patient in group A (50 months) and two in group B (55 and 58 months, respectively) ($P=1.000$). Slight stricture of the CBD was observed for one patient in group B but none in group A ($P=1.000$). The patient in group B with slight CBD stenosis had an abnormal bilirubin increase on POD 4, and subsequent ERCP confirmed that the middle segment of CBD was slightly stenosed; a 10F (7 cm) biliary stent was implanted into the CBD immediately and it was successfully removed 3 months later.

Discussion

LCBDE is one of the minimal invasive surgical technologies for patients with choledocholithiasis [5–7]. LCBDE during laparoscopic cholecystectomy enables surgeon to manage two problems while rendering patients to undergo anesthesia only once, with favorable success rate and low morbidity [7,15]. Traditionally, the CBD is routinely closed with T-tube drainage for at least two weeks after open or laparoscopic choledochotomy, in order to decrease the pressure in bile duct and minimize the risk of postoperative bile leakage, at the same time providing a backup percutaneous access for cholangiography and extraction of retained calculus. However, insertion of a T-tube also has potential risks of several complications, such as fluid and electrolyte disturbances, biliary obstruction by T-tube, bile leakage, and localized pain [16]. Furthermore, CBD stenosis has been showed as a late complication after T-tube removal [17]. And the presence of a T-tube is not capable to completely avoid postoperative bile leakage [16]. Moreover, living with T tube for several weeks could bring nonnegligible inconvenience to the daily life, extra abdominal scar, certain financial and psychological burden for the patients, which might severely impact the patients' quality of life. In this new era of laparoscopic surgery, therapeutic methods tend to be more and more minimally invasive, with a concept of reducing trauma, hastening the patient's recovery and reducing the need for hospitalization. T-tube insertion seems to weaken the advantages of laparoscopic surgery.

In the past few years, many studies have compared LCBDE with and without T-tube drainage [9, 18–22]. These researches indicated that primary closure of CBD for selected patients was safe and effective for management of choledocholithiasis [19–22]. In our previous study which compared primary closure with T-tube draining approach, no postoperative mortality was observed in both

groups [14]. The length of hospital stay was significantly shorter in the primary closure group, with similar rates of bile leakage and CBD stenosis rates in both groups. No other significant differences were noted between the two groups, including operative time, remnant stones and stone recurrence. A recent systematic review and meta-analysis by Yin et al. reported that among the patients undergoing LCBDE for choledocholithiasis, primary closure of the CBD alone was superior to T-tube drainage both in efficacy and safety [8].

Choledocholithiasis is a common disease for elderly patients [23,24]. However, aging is associated with some considerable challenges: an increase in prevalence of comorbidity, such as diabetes mellitus, cardiovascular disease and pulmonary disease; poorer tolerance for surgical trauma and anesthesia because of the functional decline of multiple organs; and slow postoperative recovery [25]. There are scanty studies reporting the safety and efficacy of LCBDE with primary closure of the CBD in elderly patients.

The present study showed that the elderly group had higher incidences of cardiovascular disease and pulmonary disease, as well as higher ASA scores. These implied that the elderly patients might confront with higher potential risks than the younger ones for laparoscopic surgery and general anesthesia. As for the demographic data and clinical presentations, age did not cause any significant impact. On the positive side, our study demonstrated that there were no significant differences between the elderly and younger groups, both in terms of operative time, ICU stay, perioperative mortality and systemic complications including pneumonia, acute cardiovascular event, fever and urinary retention. Although the hospital stay for the elderly patients was slightly longer than the younger patients, the main reason might be that recovery progress was slower in elderly patients, and we tend to be more cautious when giving permission for their discharge. Due to the development of anesthesia technology and vital organ support treatment, the supervision and management of comorbidity are becoming more and more meticulous and efficacious. We had comprehensive evaluation scheme for every patient before the surgery, especially for the elderly patients, and we all routinely carried out electrocardiogram, echocardiography, chest radiograph, hematological examinations for serum biochemicals, liver function, renal function, and coagulation function. Surgery was performed for the senile patients only under the premise that all these examinations were at a good level. Thus, the risks of organ dysfunction or systemic complications for the elderly patients are controllable and comparable with the younger ones in our study.

There were no significant differences in aspects of the morbidities related to the surgical technique, including remnant stone, bile leakage, CBD stenosis and recurrent stone. Remnant stones were observed in one patient in each group, respectively. Both patients had multiple choledocholithiasis before surgery, so we speculate that some small calculus or fragments of bigger calculus might be flushed into the upper intrahepatic bile duct, which were located in the blind spot of choledochoscope and could not be removed; these stones would translocate along with bile excretion to the distal CBD after operation, and eventually caused incarceration and the abdominal pain. The difficulty of LCBDE with primary closure seems to not correlate with aging. On the basis of increasing laparoscopic surgery cases, the surgeons in our institution had gain more experience with the hepatopancreatobiliary surgery, including exhaustive analysis of the anatomy of important structure, choice of the operation approach, controlling hemorrhage and management of other unexpected situations during the operation. These all contributed to the standardization and proficiency of surgical procedures, and finally reflected in the consistent outcomes of patients with different conditions.

Despite the fact that the elderly patients had more intraoperative blood loss than the younger patients, the mean value

(49.14 mL) was still at a low level which would have a negligible effect on the intraoperative hemodynamics. Besides, the proportions of patients needing blood transfusion in two groups had no statistical differences, so it is reasonable to consider that the intraoperative blood loss of these two groups were at a relatively safe level. Therefore, we believe the safety and effectiveness of LCBDE with primary closure in the elderly patients are feasible.

Nevertheless, a study by Cai et al. [21] reported that primary closure of CBD after LCBDE is not applicable to all patients with choledocholithiasis. The use of primary closure is contraindicated for patients with acute obstructive suppurative cholangitis (AOSC) or outlet stenosis of CBD as they need continuous decompression and drainage. On the other hand, patient with a very thin CBD has relative contraindication for primary duct closure as the risk of bile leakage is high [19]. In our study, bile leakage was noted in two patients in the elderly group and one patient in the younger group, but this difference was not statistically significant. The cause of bile leakage may be the very thin wall thickness of the CBD in these patients. Additionally, the operative techniques of choledochotomy and suturing are also important parts for prevention of bile leakage. It should be noted that the incision was suggested to locate at the junction part of CBD, cystic duct and common hepatic duct, where there were less vascular distributions, and this might further reduce bile duct injury by electrocoagulation for the hemorrhagic spot. We employed a special technique by routinely adding interrupted sutures on the surface of the choledochotomy site, upon completion of the closure of the choledochotomy site with continuous or interrupted suture. This has helped to decrease the tension, which may have contributed to the reduction in bile leakage. Besides, patients with suspected biliary tumor or previous history of biliary surgeries are not recommended to perform primary closure.

This study was not perspective randomized, thus it was difficult to make direct comparison between the elderly patients and younger patients. However, as the two groups did not have significant differences in demographic data, and history of acute cholangitis or pancreatitis, and had similar postoperative courses with respect to morbidities and mortalities, the comparison of the two groups in terms of operative process, perioperative effectiveness and hospital stay was a fair comparison. We should also point out that surgeons must be cautious when making the operation plans, especially the young surgeons who are not very experienced in controlling operation chances and adaptations. During the period of this study, our hospital had treated 13,312 patients with cholecystolithiasis, 1753 with choledocholithiasis, and 2188 with hepatolithiasis. The surgeons have improved their skills on the basis of this number of cases. Explicit indications and intensive training of laparoscopic skills are the priority among priorities, and surgeons should attach great importance to these aspects in order to further improve the surgical outcomes.

In conclusion, primary closure of the CBD is a safe and feasible option in suitable elderly patients after laparoscopic choledochotomy. As the operative time, ICU stay, perioperative mortality and morbidities did not increase in the elderly patients ≥ 70 years old, age alone is not considered a barrier that affects the surgical treatment.

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Contributors

ZHW proposed the study. WX and HZJ performed the research and wrote the first draft. WX and ZJY collected and analyzed the data. All authors contributed to the design and interpretation of

the study and to further drafts. WX and HZ] contributed equally to this article. ZHW is the guarantor.

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Ethical approval

This study was approved by the Ethics Committee of Sun Yat-sen Memorial Hospital of Sun Yat-Sen University (SYSEC-KY-KS-2019-047).

Competing interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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