Application of laparoscopic cholecystectomy, common bile duct exploration, endoscopic lithotripsy of bile duct stones, and antegrade biliary stenting

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Abstract

Introduction: Primary closure of choledochotomy (PCC) following common bile duct (CBD) exploration is increasingly accepted. However, this technique is associated with complications, primarily bile leaks, especially when retained CBD stones are present. To mitigate these risks and enhance outcomes, we propose a comprehensive procedural approach that includes laparoscopic cholecystectomy (LC), CBD exploration, endoscopic lithotripsy of bile duct stones, and antegrade biliary stenting.

Patients and Methods: From January 2020 to December 2022, a total of 15 patients with cholelithiasis and associated common bile duct stones (CL-CBDS) underwent LC, CBD exploration with endoscopic lithotripsy of bile duct stones, and antegrade biliary stenting at the General Surgery Department of E Hospital.

Results: The average age of the patients was 64.9 ± 12.1 years, with a male-to-female ratio of 8:7. Previous upper abdominal surgery accounted for 13.3% of the cases. The average surgical time in our study was 195.9 minutes, and the mean postoperative hospital stay was 7 days. There were no intraoperative or postoperative complications. The stone clearance rate was 100%. The median follow-up period was one month, with no evidence of residual stones, bile duct stricture, or bile leakage in any of the patients.

Conclusion: LC, CBD exploration with endoscopic lithotripsy of bile duct stones, and antegrade biliary stenting is an effective and safe technique for managing CL-CBDS. This approach avoids complications associated with managing and removing T-tube drainage, provides CBD decompression, and reduces the length of hospital stay.

Keywords: Laparoscopic cholecystectomy, common bile duct exploration, biliary stenting.

Introduction

Choledocholithiasis, the second most common complication of cholecystolithiasis, occurs in 10–20% of patients with symptomatic gallstones.[1] There are various techniques available for managing this condition. Evidence in the literature suggests that single-stage laparoscopic cholecystectomy (LC) combined with common bile duct (CBD) exploration is not only as effective as the two-stage approach of endoscopic retrograde cholangiopancreatography (ERCP) followed by LC, but it also has equivalent postoperative morbidity and mortality rates. Furthermore, this approach reduces the number of procedures required per patient, shortens the length of hospital stay, eliminates the inherent risks associated with ERCP/endoscopic sphincterotomy, and preserves the integrity of the sphincter of Oddi.[1,2]

Debate exists in the literature regarding the optimal method for choledochotomy closure in the laparoscopic era. The most common management options include primary closure of choledochotomy (PCC), T-tube drainage, or PCC following ante-grade biliary stent insertion.[3,4] Studies have shown that PCC reduces hospital stays and avoids complications related to the presence and removal of T-tubes.[2,5] However, PCC does not provide biliary decompression, which can be crucial in cases with retained stones. The Cochrane Collaboration reports an 8% rate of retained stones following single-stage management of choledocholithiasis, with other recent studies indicating an intraoperative clearance failure rate between 3.3% and 11%.[6] The direct visualization of the CBD using a choledochoscope has been shown to reduce the rates of retained common bile duct stones (CBDS), and ante-grade biliary stent insertion prior to PCC theoretically combines the benefits of T-tube decompression with the lower morbidity associated with PCC. Therefore, this study aims to evaluate the outcomes and efficacy of a comprehensive procedural approach that includes LC and CBD exploration with endoscopic lithotripsy of bile duct stones and ante-grade biliary stenting.

Patients and methods

Patients

This prospective study, conducted from 2020 to 2022, involved 15 patients diagnosed with cholelithiasis associated with common bile duct stones (CL-CBDS) who underwent LC, CBD exploration with endoscopic lithotripsy of bile duct stones, and ante-grade biliary stenting. All procedures were performed by a single surgeon in the General Surgery Department of E Hospital.

Research Method: Prospective study.

Research Location: General Surgery Department of E Hospital.

Inclusion Criteria: Patients diagnosed with CL-CBDS who were deemed suitable for laparoscopic surgery and underwent the following procedures: LC, CBD exploration with endoscopic lithotripsy of bile duct stones, and antegrade biliary stenting.

Exclusion Criteria:

Individuals diagnosed with acute severe cholangitis or acute pancreatitis.

Those who have coagulation disorders.

Patients presenting with contraindications to anesthesia or laparoscopic surgery.

Cases involving multiple bile duct stones, whether intrahepatic or extrahepatic.

Surgical Technique

Anesthesia and Position: The operation was performed under general anesthesia, with the patients placed in the supine position with head elevated and the table tilted to the left. The surgeon stood to the left of the patient, with the camera holder beside them and the first assistant on the right side of the patient. A 30^0 laparoscope was employed, and surgery was carried out using a standard four-port approach for cholecystectomy: a 10-mm port at the umbilicus for the laparoscope, a 10-mm port at the epigastrium for the choledochoscope, and two 5-mm ports at the mid-clavicular line close to the right costal margin and the right anterior axillary line for operating (Fig. 1).

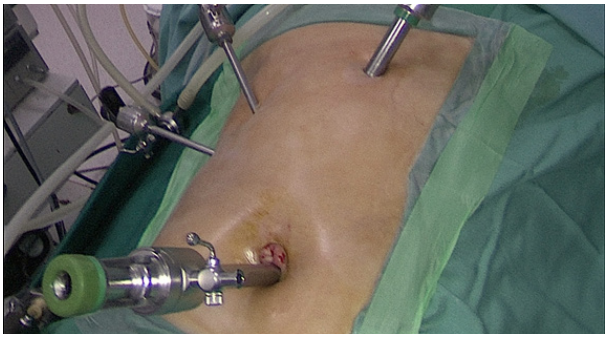


Fig. 1 Positions of the trocars

Step 1: The gallbladder was dissected free from the liver bed using hook cautery and was left in place to facilitate retraction and exposure of the bile duct during exploration (Fig. 2).

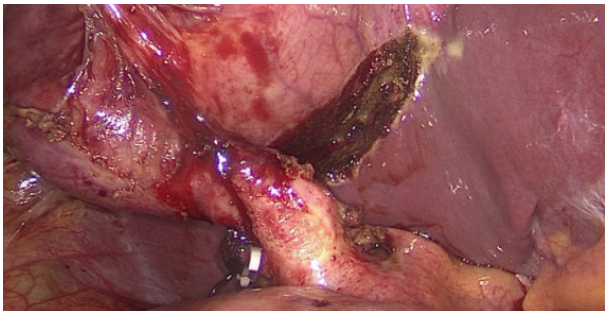


Fig. 2 Dissection to free the gallblader from the liver bed

Step2: A vertical supra-duodenal choledochotomy was performed using laparoscopic hook scissors to match the width of the choledochoscope (Fig. 3). Exploration and visualization of the CBD were achieved using a 5-mm choledochoscope with normal saline irrigation (Fig. 4).

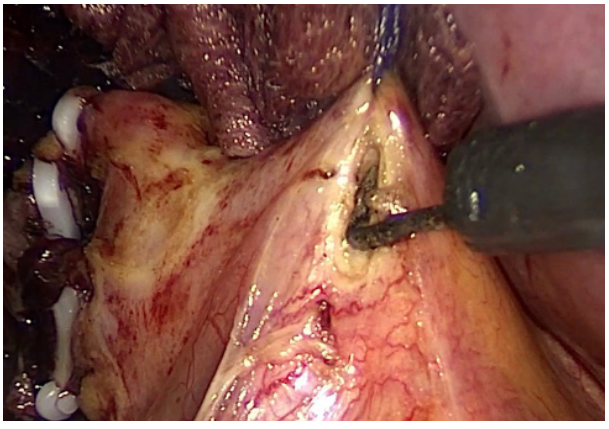


Fig. 3 A vertical supra-duodenal choledochotomy

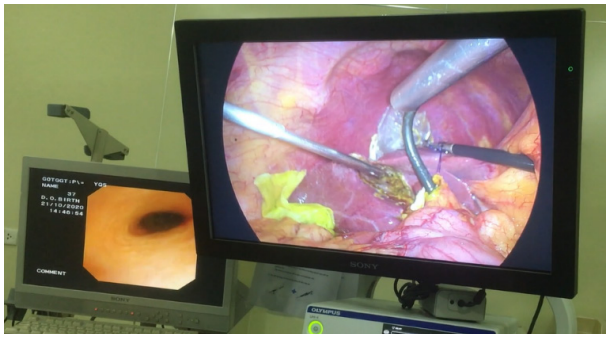


Fig. 4 Exploration and visualization of the CBD using a 5-mm choledochoscope

Step 3: Stones were extracted from the bile duct through direct access using a 5-mm choledochoscope and a Dormia basket. Holmium laser lithotripsy was utilized as necessary to clear large solitary or impacted stones (Fig. 5).

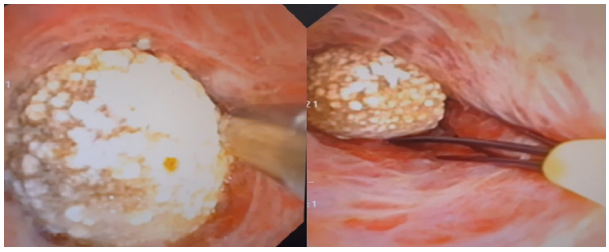


Fig. 5 Laser lipthotripsy and dormia basket for bile duct stones

Step 4: After stone removal, the choledochoscope was used to visualize the CBD from the ampulla of Vater to the hepatic ducts. An ante-grade biliary stent, a plastic size 7Fr and length (9–11 cm), was then inserted through the choledochotomy into the CBD, directed blindly across the ampulla of Vater. A choledochoscope was utilized to confirm proper positioning (Fig. 6).

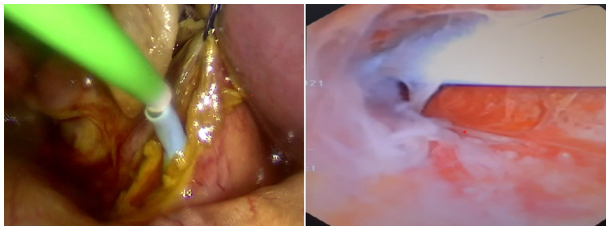


Fig. 6 Placement of antegrade biliary stenting

Step 5: The longitudinal choledochotomy was then closed using 4-0 Vicryl sutures (Fig. 7). Finally, cholecystectomy was completed, and both the

gallbladder and the CBDS were retrieved using a plastic bag through the umbilical port site. A silicone drain was then placed in the subhepatic space and was removed on the second or third postoperative day if no evidence of bile leakage was present. Antegrade biliary stents were removed endoscopically 4–8 weeks post-operation.

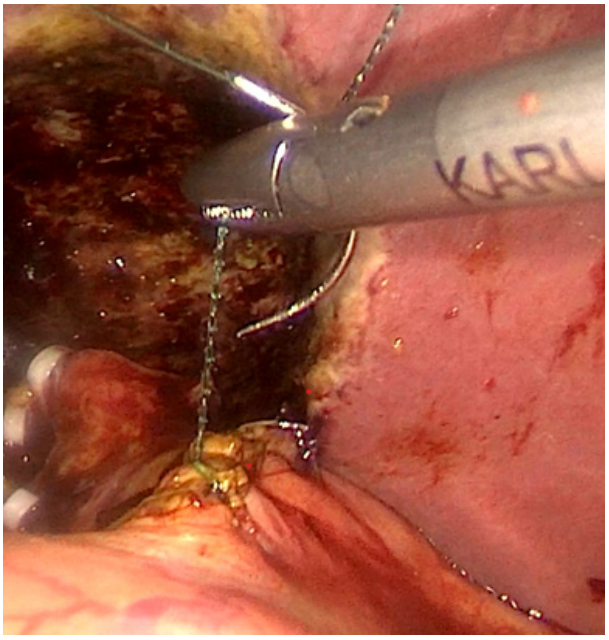


Fig. 7 Primary closure of choledochotomy



Fig. 8 Post-operative abdominal X-ray

Outcome Definitions and Follow-Up

Complications were graded according to the Clavien-Dindo classification of surgical complications.

Follow-Up

Follow-up assessments, including biochemical tests, imaging studies, and gastro-endoscopy, were conducted one month after surgery.

Statistical Analysis: Data were analyzed using the SPSS software package version 22.0 (SPSS, Inc., Chicago, IL, USA).

Compliance with ethical standards:

All patients in our study provided written informed consent, and the study was approved by the Ethics Committee of E Hospital, Vietnam (Decision No. 2131/QD-BVE, dated July 6, 2023).

Results

From January 2020 to December 2022, a total of 15 patients underwent LC, CBD exploration with endoscopic lithotripsy of bile duct stones, and antegrade biliary stenting. The average age of the patients was 64.9 ± 12.1 years, with a body mass index (BMI) of 21.2 kg/m². The male-to-female ratio was 8:7. Previous upper abdominal surgery was reported in 13.3% of cases. Most patients were in either normal health or had mild systemic disease, with an average American Society of Anesthesiologists (ASA) score of 2. All patients presented with abdominal pain, while 26.7% also exhibited fever or jaundice.

In terms of laboratory findings, eight patients (53.3%) had elevated direct bilirubin levels, and seven (46.7%) had abnormal liver enzyme levels. All patients underwent hepatobiliary magnetic resonance cholangiopancreatography (MRCP) prior to surgery, confirming a diagnosis of CL-CBDS. One patient additionally had intrahepatic stones. The mean diameter of the CBD was 9.9 ± 1.9 mm, with a mean stone diameter of 10.7 ± 2.6 mm. Among the cohort, two patients had more than two stones, while the remaining patients had one or two stones each.

Intraoperative Outcomes

The average surgical time was 195.9 ± 63.4 minutes, with the shortest time recorded at 100 minutes and the longest at 300 minutes. No complications occurred during surgery.

Postoperative Outcomes and Follow-Up

The mean postoperative hospital stay was 7 days, and there were no complications reported during the postoperative period. The stone clearance rate was 100%, as confirmed by postoperative plain X-ray and abdominal ultrasound.

The median follow-up duration was one month, during which no patients exhibited further bile duct stones, bile duct strictures, or any complications. In five cases (33.3%), upper endoscopy was not required for stent removal since spontaneous expulsion was confirmed via plain X-ray prior to the procedure. The remaining ten patients (66.7%) underwent endoscopic stent removal without complications.

Discussion

Currently, the optimal treatment for CL-CBDS remains controversial and unclear. The conventional management approach involves open surgery for cholecystectomy, CBD exploration, and T-tube drainage. This method has several advantages, including postoperative CBD decompression, trans-tubal cholangiography, prevention of stricture formation, and facilitation of retained CBDS extraction. However, it also carries potential complications that can occur in 6-30% of patients.[2,4] The most frequent complications include bile leaks, tract infections, T-tube dislodgement, electrolyte and nutritional disturbances, cholangitis, and acute renal failure. Furthermore, it can lead to patient discomfort and long-term pain, as well as increased hospital admissions, imposing an economic burden on healthcare systems.[2]

With the advent of laparoscopic surgery and improvements in surgical techniques—especially the direct visualization of the CBD using a choledochoscope—the rates of retained CBDS have decreased. Recent studies suggest that the rates of retained stones following single-stage surgical management of CL-CBDS range from 3.3% to 11%. Thus, primary closure of the CBD after exploration has gained increasing acceptance.[6] A recent Cochrane review advised against T-tube insertion due to significantly longer operating times, prolonged hospital stays, and an observed trend towards increased complications compared to primary closure.[7]

Unfortunately, primary closure does not provide biliary decompression, which can be crucial in such clinical situations. Additionally, primary closure has potential complications, such as bile leaks and CBD strictures, which may result from papillary edema and insufficient bile duct expansion. Consequently, ante-grade biliary stenting was utilized to minimize the complications associated with T-tube drainage and primary closure. The insertion of an ante-grade biliary stent prior to CBD closure theoretically combines the benefits of T-tube decompression with the reduced morbidity associated with primary closure. Biliary stent placement is a relatively simple technique that allows for effective decompression of the biliary tree immediately, eliminating the need for T-tube drainage, which is critical in reducing postoperative pain and enhancing the quality of life.

Lyon et al. demonstrated that this technique, similar to primary closure, reduces surgical time, decreases morbidity, shortens hospital stays, and increases patient comfort. Another major benefit is related to retained stones; placement of a stent not only maintains the patency of the CBD but also simplifies CBD cannulation via ERCP, improving the success rate of postoperative ERCP stone extraction from 82% to nearly 100%.[2]

Omar et al. compared three techniques for CBD closure after choledocholithotomy: T-tube drainage, primary closure, and biliary stenting. Their findings indicated that overall biliary complications were statistically significantly lower in the ante-grade biliary stenting group compared to the T-tube drainage and primary closure groups.[4]

Indications for the procedures in patients with known CL-CBDS—who do not have multiple intrahepatic or extrahepatic bile duct stones or cholangitis—involve ensuring the removal of all retained stones before primary closure, as this is necessary to avoid complications.

In our study, the average surgical time was 195.9 minutes, with a mean postoperative hospital stay of 7 days. The surgical time can vary based on factors such as the patient's condition, the presence of cholecystitis, and the number and location of bile stones. Our results indicated no complications and no residual stones postoperatively. Similar outcomes have been reported in several recent studies: Hien Trong Duong et al. found an average surgical time of 145 ± 45 minutes with no postoperative complications and no bile leaks, and a mean hospital stay of 8 ± 1.5 days; Lyon et al. reported no complications, with a mean postoperative hospital stay of only one day for patients; Jalal et al. noted postoperative complications including bile leakage (18%), cholangitis (5%), and pancreatitis (5%); and Martinez-Beana et al. reported a bile leakage rate of 17.85% and a residual stone rate of 3.6%.[2,3,8,9]

Documented stent-specific complications in the literature include stent occlusion, early migration, and duodenal erosion. Prolonged stent placement, exceeding 30 days, has been associated with ampullary stenosis and stent migration leading to intestinal perforation. However, our study revealed no stent complications during the one-month follow-up. No complications occurred during the endoscopic removal of the stents in 10 out of 15 patients, with 5 patients passing their stents spontaneously.

Conclusion

In conclusion, LC and CBD exploration with endoscopic lithotripsy of bile duct stones, along with ante-grade biliary stenting, represent an effective and safe technique for the single-stage treatment of patients with CL-CBDS. This approach avoids the complications associated with T-tube drainage management and removal, while also providing CBD decompression and reducing the length of hospital stay.

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