Laparoscopic Common Bile Duct Exploration Using Flexible Ureteroscope: Ain Shams University Experience

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Introduction: Choledocholithiasis remains a common complication of gallstone disease, with endoscopic retrograde cholangiopancreatography (ERCP) being the current gold standard for management. However, ERCP has limitations, particularly in cases involving large or impacted stones. Laparoscopic common bile duct exploration (LCBDE) using flexible choledochoscopes offers an alternative but is underutilized due to high costs. This study evaluates the feasibility, safety, and short-term outcomes of LCBDE using flexible ureteroscopes as a cost-effective alternative.

Patients and methods: This prospective observational study included 15 patients with choledocholithiasis who had previously failed ERCP and underwent LCBDE assisted by a flexible ureteroscope at Ain Shams University Hospital between October 2023 and September 2024. Procedures were performed using standardized laparoscopic techniques, with stone retrieval achieved by using flexible ureteroscope. Technical success was defined as complete stone clearance with primary closure of the CBD.

Results: The mean age of the cohort was 52.1±9.7 years, with males representing 60% of the patients. The mean operative time was 163.3±29.2 minutes, and the mean hospital stay was 5.1±1.0 days. Blood loss averaged 168.7±85.4 mL. Technical success was achieved in 14 out of 15 patients (93.3%), with one case requiring conversion to open surgery due to stone impaction. Complications occurred in 13.3% of patients, including one instance of biliary leakage managed conservatively and one missed stone detected during follow-up, which was resolved via ERCP.

Conclusion: Flexible ureteroscopy-assisted LCBDE is a feasible, safe, and effective option for managing choledocholithiasis, particularly in resource-constrained settings. While further studies with larger cohorts and longer follow-up periods are needed to evaluate long-term outcomes, this technique holds promise for addressing gaps in hepatobiliary care access.

Key words: Laparoscopic common bile duct exploration, flexible ureteroscopy, choledocholithiasis, resource-constrained settings, cost-effectiveness.

Introduction

Stones in the common bile duct (CBD) are a frequent complication of gallstone disease, occurring in 3–14.7% of patients,[1] with an increased prevalence in older adults (20–25% in those over 60 years).[2] These stones can lead to life-threatening complications, including cholangitis, gallstone pancreatitis, and biliary cirrhosis.[2] Historically, open cholecystectomy with CBD exploration was the standard treatment, often requiring prolonged hospitalization, T-tube insertion, or biliary-enteric anastomosis, which carried significant morbidity.[3]

Management has shifted toward minimally invasive approaches. Endoscopic retrograde cholangiopancreatography (ERCP) combined with laparoscopic cholecystectomy (LC) is currently the gold standard for choledocholithiasis.[4] However, ERCP is associated with procedural limitations, including: Up to 10–15% failure rates in large or impacted stones,[5] a two-staged approach increasing costs and patient burden6, and procedural risks such as post-ERCP pancreatitis (3–8% incidence),[7] bleeding, and perforation. These drawbacks highlight the need for alternative strategies.

Laparoscopic common bile duct exploration (LCBDE) offers a single-stage solution with comparable efficacy to ERCP.[6] Despite its advantages, LCBDE remains underutilized in low- and middle-income countries (LMICs) due to high costs and reliance on specialized equipment, such as flexible choledochoscopes, which are often inaccessible.[8] Flexible ureteroscopes, commonly used in urology, provide a cost-effective alternative with comparable visualization capabilities make them an attractive option in resource-limited settings.[9]

This study evaluates the feasibility, safety, and short-term outcomes of LCBDE using flexible ureteroscopy in a prospective cohort of patients.

Patients and methods

This is a prospective observational study conducted at the Hepatobiliary-Pancreatic Unit, Department of General Surgery, Ain Shams University Hospital. The study included 15 patients diagnosed with choledocholithiasis who underwent laparoscopic common bile duct exploration (LCBDE) assisted by a flexible ureteroscope between October 2023 and September 2024. All patients had previously failed ERCP due to large or impacted stones and required placement of a plastic stent preoperatively to relieve jaundice. The study was approved by the Research

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Ethical Committee (REC) of the Department of Surgery, Ain Shams University Faculty of Medicine (IRB 00006379), and all procedures were performed in accordance with the ethical standards laid down in the Declaration of Helsinki and its later amendments. Written informed consent was obtained from all participants prior to enrollment.

Patients were included if they met the following criteria: confirmed diagnosis of choledocholithiasis via imaging studies such as ultrasonography and magnetic resonance cholangiopancreatography (MRCP), failed ERCP attempts due to large or impacted stones, age of 18 years or older, and approval of the procedure. Exclusion criteria included malignant biliary obstruction, severe liver dysfunction (Child-Pugh class C), contraindications to laparoscopic surgery (e.g., coagulopathy, severe cardiopulmonary disease, or prior upper abdominal surgery), and contraindications to general anesthesia.

Patient positioning and port placement were carefully planned to optimize access and visualization. Patients were positioned in the French position, supine with their legs open in the reverse Trendelenburg position, with a slight left lateral tilt to improve exposure of the hepatoduodenal ligament. The standard laparoscopic port placement was used: two 10 mm ports—one just above the umbilicus for the scope and another in the epigastric region for the flexible ureteroscope—and two 5 mm ports placed in the right mid-clavicular and right mid-axillary lines for assistance and traction. Additionally, a fifth 5 mm port was added in the left mid-clavicular line in five cases to assist with CBD closure. The procedure began with the dissection of Calot's triangle to isolate the cystic artery and duct, which were clipped and cut using standard laparoscopic techniques. The gallbladder was left attached to the liver bed to serve as a retraction tool during CBD exposure. CBD identification was achieved using the aspiration technique. A 1.5 cm vertical incision was made along the anterolateral aspect of the CBD, typically opposite the cystic duct insertion, and two stay sutures (PDS 3-0) were placed at the edges to facilitate stone extraction. A 9.5 F (3.23 mm) diameter flexible ureteroscope of 68 cm length LithoVueTM (Boston Scientific, USA) was introduced through the 5/10 mm epigastric port to visualize the proximal CBD, **Fig. 1**, up to the common hepatic duct and bifurcation, Figure 2, and the distal CBD down to the ampulla of Vater, Figure 3, and second part of the duodenum, when possible, with the assistance of forceps grasper. Stones were retrieved using a Dormia basket passed through the ureteroscope, flushing and milking techniques were used to force out fragmented stones. After ensuring the complete removal of all stone fragments and debris via meticulous inspection, the biliary stent previously inserted during ERCP was kept in place. An intraoperative cholangiogram was performed in all cases to confirm stone clearance before final closure, the choledochotomy was closed primarily using interrupted 3-0 polydioxanone (PDS) sutures.

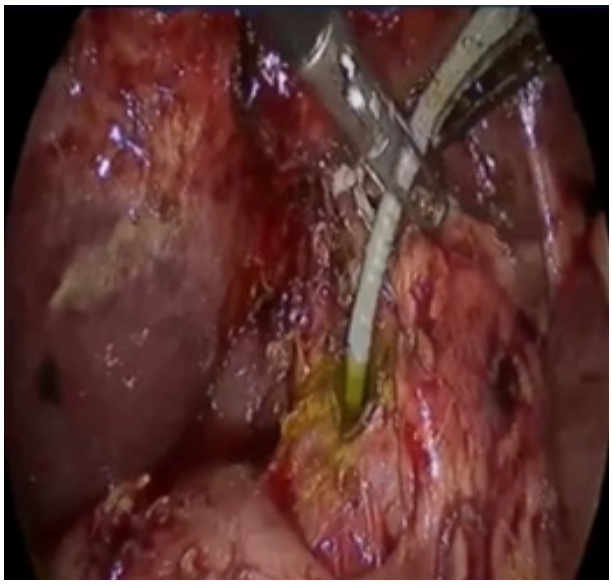

Fig 1: Insertion of the ureteroscope in the common bile duct.

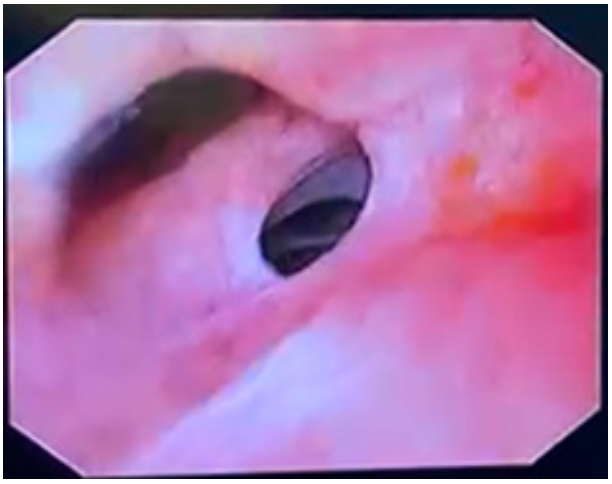

Fig 2: Right and left hepatic ducts.

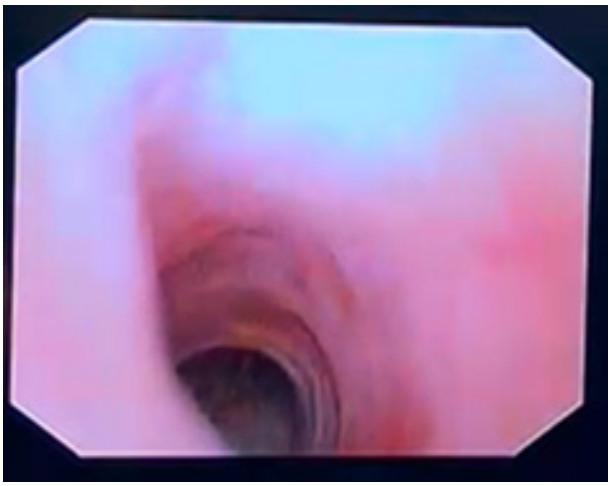

Fig 3: Common bile ducts.

Postoperatively, surgical drains were placed in Morrison's pouch and removed on the day of discharge. Patients were started on a liquid diet on postoperative day 1 and transitioned to a solid diet by postoperative day 3. Biliary stents were removed endoscopically after one month.

All patients attended follow-up evaluations on postoperative day 10, as well as at 1, 3, and 6 months postoperatively.

Data were analyzed using SOFA statistics Version 1.5.4, Paton-Simpson & Associates Ltd, Auckland, New Zealand. Continuous variables are presented as mean ± standard deviation (SD) or median (interquartile range [IQR]) depending on normality. Categorical variables are expressed as frequencies and percentages.

Results

This study evaluated the feasibility, safety, and outcomes of flexible ureteroscopy during laparoscopic common bile duct (CBD) exploration in a cohort of 15 patients managed at Ain Shams University Hospitals.

The mean age of the cohort was 52.1±9.7 years (interquartile range IQR: 14.0 years). The cohort consisted of 9 males (60%) and 6 females (40%). The mean body mass index (BMI) was 29.9±3.4 kg/m² (IQR: 6.0), reflecting a predominantly overweight or obese population. Comorbidities were present in 40% of patients (n=6), with hypertension being the most common (26.7%, n=4), followed by diabetes mellitus (20.0%, n=3). The mean CBD diameter was 12.8±3.0 mm (IQR: 5.0 mm). The demographic and clinical characteristics of the study population are summarized in **Table 1.**

Table 1: Demographics and baseline characteristics

Parameter		Results (N=15)
Age	Mean (SD)	52.1 (9.7)
	IQR	14.0
Gender	Male (%)	9 (60 %)
	Female (%)	6 (40 %)
BMI	Mean (SD)	29.9 (3.4)
	IQR	6.0
Comorbidities	Non (%)	9 (60.0 %)
	Yes (%)	6 (4.0%)
	DM	3 (20.0 %)
	Hypertension	4 (26.7 %)
CBD diameter	Mean (SD)	12.8 (3.0)
	IQR	5.0

SD: Standard deviation.
IQR: Interquartile range.
BMI: Body mass index.
DM: Diabetes mellitus.

The mean operative time was 163.3±29.2 minutes (IQR: 40.0 minutes). The mean hospital stay was 5.1±1.0 days (IQR: 2.0 days). The average intraoperative blood loss was 168.7±85.4 mL (IQR: 100.0 mL). Procedural parameters are detailed in **Table 2.**

Table 2: Procedure parameters

Parameter		Results (N=15)
Operative time	Mean (SD)	163.3 (29.2)
	IQR	40.0
Hospital stay	Mean (SD)	5.1 (1.0)
	IQR	2.0
Blood loss	Mean (SD)	168.7 (85.4)
	IQR	100.0

SD: Standard deviation.
IQR: Interquartile range.

Procedural outcomes are presented in **Table 3**. Technical success, defined as complete stone clearance with primary closure of the CBD, was achieved in 93.3% of cases (n=14). One case (6.7%) was deemed unsuccessful due to the presence of impacted stones, requiring conversion to open surgery with choledochoduodenostomy after stone extraction. Complications occurred in 13.3% of patients (n=2). Specifically, one patient (6.7%) developed a biliary leak, which resolved with conservative management, and another (6.7%) experienced a missed stone, presented after one month with jaundice, requiring subsequent endoscopic retrograde cholangiopancreatography (ERCP). Notably, there were no instances of cholangitis or early strictures. The majority of patients (86.7%, n=13) had an uneventful postoperative course without adverse events.

Table 3: Procedure outcomes

Parameter		Results (N=15)
Technical success	Yes (%)	14 (93.3%)
	No (%)	1 (6.7%)
Complications	Non	13 (86.7%)
	Biliary leak	1 (6.7%)
	Cholangitis	0 (0.0%)
	Missed stone	1 (6.7%)
	Early stricture	0 (0.0%)

Discussion

The introduction of laparoscopic cholecystectomy (LC) revolutionized the management of gallstone disease10–12; however, patients presenting with concomitant choledocholithiasis posed a significant challenge, as the only viable option was open cholecystectomy combined with open common bile duct (CBD) exploration.[13,14] This issue was largely addressed with the introduction of endoscopic

retrograde cholangiopancreatography (ERCP),[4,13] which became the gold standard for managing CBD stones.[4] Despite its widespread adoption, ERCP has notable limitations, particularly in cases involving large or impacted stones, where failure rates can reach up to 10–15%5. Such failures necessitate a return to more invasive approaches, including open CBD exploration, thereby negating the benefits of minimally invasive techniques. Early attempts to address CBD stones during LC-such as blind catheter insertion and irrigation or the use of rigid scopes[15] provided unsatisfactory results due to inadequate visualization of the biliary tree and the inherent risk of biliary injury caused by the limited maneuverability of rigid instruments.[16] These challenges highlight the need for advanced, yet accessible, tools that combine the precision of flexible visualization with the safety and efficacy of minimally invasive surgery.

Flexible scopes, such as choledochoscopes, represent an optimal solution for direct visualization and stone retrieval during laparoscopic common bile duct exploration (LCBDE). However, their adoption is challenging due to the high cost of the system and the specialized setup required, which limits accessibility in many low- and middle-income countries (LMICs).[9] In contrast, flexible ureteroscopes, which have revolutionized urological surgery, are far more popular and widely used in hospitals worldwide due to their lower acquisition and maintenance costs. This increased availability makes flexible ureteroscopes a practical alternative for LCBDE. Theoretically, the use of a flexible ureteroscope could provide visualization capabilities equivalent to those of a choledochoscope, given their similar design and functionality. Our study explores the role of flexible ureteroscopes in meeting the demand, offering a cost-effective and technically feasible alternative for LCBDE in resource-constrained settings.

A total of 15 patients were recruited for this study, with males representing 60% of the cohort and a mean age of 52.1±9.7 years. The mean operative time was 163.3±29.2 minutes, which is relatively prolonged compared to other studies,[17] but acceptable given the lack of extensive experience with this technique. As experience with ureteroscope-assisted LCBDE grows, we anticipate that operative times will decrease, further enhancing the efficiency of this approach. The mean hospital stay was 5.1±1.0 days, comparable to previously reported durations for LCBDE using choledochoscopes.[16,17] Blood loss during the procedure averaged 168.7±85.4 mL, which, despite being higher than ideal, is still minimal and acceptable, especially when compared to open CBD exploration, where blood loss can be significantly greater.

We defined technical success as the achievement of complete stone clearance with primary closure of the CBD, confirmed intraoperatively with cholangiography. Technical success was achieved in 14 out of 15 patients (93.3%), aligning closely with success rates reported in studies utilizing choledochoscopes17,18. One case required conversion to an open approach due to the impaction of a stone at the retropancreatic portion of the CBD, highlighting potential limitations in some scenarios. Notably, complications were minimal, with one instance of biliary leakage managed conservatively and one missed stone detected during the follow-up and managed by ERCP, this was similar to the results reported with the use of choledocoscope.[17]

Strengths and Limitations

Our study's key strength is its focus on a resource-constrained alternative, addressing a critical gap in hepatobiliary care.

However, limitations must be noted. The small sample size (n=15) restricts generalizability, necessitating larger multicenter studies for validation. The short follow-up (up to six months) limits assessment of long-term complications, such as stricture formation. While the technique is technically feasible, the learning curve for surgeons is unaccounted for. Additionally, the absence of direct comparison with conventional choledochoscopes hinders definitive conclusions on relative efficacy.

Conclusion

Flexible ureteroscopy-assisted LCBDE is a feasible, safe, effective, and cost-efficient option for managing choledocholithiasis, particularly in cases of failed ERCP. This technique holds promise for addressing gaps in hepatobiliary care access. Further research, including large-scale randomized trials comparing ureteroscopes with choledochoscopes, as well as long-term studies assessing outcomes such as strictures or recurrence, is essential to evaluate the technique's durability.

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