

Choledocholithiasis Management: Comparing Efficacy and Safety of Endoscopic Retrograde Cholangiopancreatography and Open Surgical Exploration

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Abstract

Background: Choledocholithiasis is a significant issue in gallstone disease, and common bile duct (CBD) stones can cause serious complications. **Objective:** This retrospective study compared the outcomes of endoscopic retrograde cholangiopancreatography (ERCP) and laparoscopic surgery for choledocholithiasis at a tertiary care facility. **Methods:** Thirty-eight patients were divided into two groups: Group 1 ($n = 21$) underwent ERCP, whereas Group 2 ($n = 17$) underwent open laparotomy with biliary drainage. Liver function tests, including bilirubin, thymol turbidity, alanine aminotransferase (ALT), and aspartate aminotransferase (AST) levels, were performed before and after the intervention. **Results:** In Group 1, serum bilirubin levels decreased significantly from $172.3 \pm 2.21 \mu\text{mol/L}$ to $24.2 \pm 0.97 \mu\text{mol/L}$ postoperatively ($P < 0.001$), with significant improvements in the thymol test, ALT, and AST ($P < 0.05$). Group 2 showed moderate, non-significant biochemical improvements. Group 1 experienced no complications, whereas one patient in Group 2 had partial failure of the biliary-enteric anastomosis. Patients in Group 1 had shorter hospital stays than those in Group 2. **Conclusion:** The results support that ERCP is the preferred initial treatment for CBD stones when technically feasible, leading to quicker liver recovery, fewer complications, and reduced hospital stays. Laparoscopic surgery remains crucial when ERCP fails or in cases that are complex.

Key words: Cholecystectomy, choledocholithiasis, common bile duct stones, endoscopic retrograde cholangiopancreatography, laparoscopic common bile duct exploration

INTRODUCTION

Choledocholithiasis, with stones in the common bile duct (CBD), is a significant issue in gallstone disease. When gallstones move into the CBD, they can cause serious conditions such as biliary obstruction, obstructive jaundice, ascending cholangitis, and acute biliary pancreatitis.^[1,2] These complications are particularly concerning in older individuals and those with metabolic disorders, emphasizing the need for timely diagnosis and treatment.

The worldwide occurrence of choledocholithiasis is linked to gallstone disease, affecting 5–22% of adults in Western

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nations and up to 15% globally.^[1-3] Among those with gallbladder stones, 8–20% have CBD stones,^[1,2] with rates increasing due to aging populations, obesity, type 2 diabetes, and metabolic syndrome.^[1,3] Infections in the biliary tract and changes in bile composition influence stone formation and recurrence.^[1,3] While CBD stones in Western populations are mainly secondary to gallbladder stones (cholesterol or black-pigment stones), primary CBD (brown-pigment) stones forming directly in the duct are more common in East Asia.^[2] Recent advances in imaging techniques, including abdominal ultrasonography, endoscopic ultrasound, and magnetic resonance cholangiopancreatography, have improved choledocholithiasis detection. Magnetic resonance cholangiopancreatography shows 93% sensitivity and 100% specificity for identifying CBD stones compared to endoscopic retrograde cholangiopancreatography (ERCP) and intraoperative cholangiography,^[4] though it has limitations in detecting microlithiasis (<3 mm).

Failing to identify choledocholithiasis can result in serious consequences such as sepsis, liver dysfunction, and death.^[1] Diagnosis is indicated by biochemical irregularities, patient history (jaundice and pancreatitis), and imaging results (dilated CBD and visible stones).^[5,6] Selective intraoperative cholangiography identifies patients needing duct exploration.^[5] Asymptomatic CBD stones, occurring in 10% of cases, pose a significant risk if untreated.^[6]

The management of choledocholithiasis requires consideration of efficacy, safety, and resource allocation. Principal treatments include:

ERCP

When combined with endoscopic sphincterotomy, ERCP achieves duct clearance in up to 95% of cases.^[1,3] Recurrence rates range from 4% to 25%, depending on biliary anatomy, infection, and technique.^[3] ERCP is preferred for patients with small bile ducts.^[7]

Laparoscopic CBD exploration

Advances in minimally invasive surgery enable laparoscopic cholecystectomy with CBD exploration in a single-stage procedure, proven safe and effective regardless of duct size.^[7,8] No consensus exists on optimal ERCP and surgery sequence; approach depends on center experience and patient factors.^[7,8]

Alternative modalities

For difficult stones, mechanical, electrohydraulic, or laser lithotripsy, or peroral cholangioscopy may be needed.^[1,9] Biliary stenting suits frail patients.^[9] ESWL and dissolution therapies are for specific cases.^[11]

Role of cholecystectomy

While endoscopic CBD stone clearance may suffice for high-risk patients, routine cholecystectomy prevents future biliary complications.^[10] Patients without cholecystectomy are at risk of recurrent stones or cholecystitis.^[10]

ERCP and laparotomy for treating CBD stones are distinct yet complementary methods. ERCP, which integrates diagnostic and therapeutic functions, has become the leading procedure for CBD stones. This enables minimally invasive stone removal with endoscopic sphincterotomy to ease passage through the duct. This approach has a high success rate in clearing stones without open surgery.^[11] Although complications such as pancreatitis, bleeding, and perforation can occur, they are uncommon.^[12] This procedure has lower morbidity and mortality rates than traditional surgeries.^[11]

Surgical exploration of the CBD through open laparotomy remains viable when ERCP is impossible or unsuccessful, particularly for large stones or in patients with gastrointestinal reconstructions that limit endoscopic access.^[13] Laparoscopic CBD exploration offers a minimally invasive alternative with shorter recovery times than open surgery,^[14] although these procedures require advanced surgical expertise.^[12] The choice between ERCP and surgery depends on the patient's anatomy, disease severity, and complications, such as biliary infections.^[11,15] Stone recurrence may necessitate repeated procedures. ERCP remains fundamental in managing CBD stones; however, surgical methods, especially laparoscopic techniques, are crucial when ERCP fails. Treatment selection should be personalized based on patient needs and facility expertise.^[16]

Endoscopic methods such as ERCP with sphincterotomy provide a minimally invasive treatment for choledocholithiasis. However, these techniques are not always suitable because of factors such as anatomical changes from previous surgeries, large bile duct stones, biliary strictures, and limited access to specialized equipment. In such cases, laparotomic exploration remains crucial, especially when endoscopic procedures fail or anatomical challenges prevent cannulation of the CBD. Although more invasive, open surgical intervention remains essential for treating choledocholithiasis.

Although endoscopic procedures are widely used, questions remain regarding their effectiveness compared to traditional surgery, particularly in developing regions with limited resources. Although research from high-income countries generally favors endoscopic techniques, these findings may not be universally applicable. The lack of outcome data from Central Asia and similar regions, where health-care infrastructure and expertise differ significantly, makes comparative research crucial for context-specific clinical decision-making and policy development.

This study aimed to contrast the clinical outcomes of endoscopic and laparotomic procedures for choledocholithiasis at a

tertiary care facility. This study examined the success rates, liver function recovery, and complications of both treatments. Through a comparative analysis of these outcomes, this study aims to provide evidence for optimizing treatment strategies in resource-limited settings with diverse surgical practices.

METHODS

This retrospective comparative study assessed endoscopic and laparotomic procedures for choledocholithiasis at a tertiary care facility. The analysis included patients who were diagnosed and treated between June 2014 and December 2024. This study adhered to the Declaration of Helsinki (2013) and was approved by the Bioethics Committee of the I.K. Akhunbaev Kyrgyz State Medical Academy (Protocol No. 132 dated February 23, 2014).

We studied 38 patients with choledocholithiasis confirmed through imaging or surgery. The inclusion criteria were adults aged 18 years or older with CBD stones on ultrasound, magnetic resonance cholangiopancreatography, or surgical findings. Patients with incomplete records, biliary cancer, or recurrent CBD stones who had undergone treatment within the previous 6 months were excluded.

The participants were split into two treatment groups: Group 1 (endoscopic group) received ERCP, with or without endoscopic sphincterotomy. Group 2 (laparotomy group) underwent open surgical exploration of the CBD through laparotomy.

Patient information, including demographics, surgical background, biochemical data, procedure type, and perioperative outcomes, was gathered from medical records. Liver function tests, including total bilirubin, thymol turbidity test, alanine aminotransferase (ALT), and aspartate aminotransferase (AST), were performed before surgery and 5–6 days after surgery.

The main outcomes assessed were changes in liver function tests and procedural complications. Secondary outcomes included the length of hospital stay and the need for additional interventions. Clinical improvement was characterized by a significant decrease in the bilirubin and aminotransferase levels after treatment.

Statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables, including liver function parameters such as bilirubin, thymol turbidity test, ALT, and AST, are presented as mean \pm standard deviation. To evaluate differences before and after surgery within groups, a paired sample *t*-test was used, whereas an independent sample *t*-test compared results between Group 1 (ERCP) and Group 2 (laparotomy). Categorical variables, including clinical subtypes and

complications, were described using frequencies and percentages and analyzed using the Chi-square test. Statistical significance was set at $P < 0.05$. Missing data were addressed through listwise deletion without imputation due to the small sample size.

RESULTS

This study included 38 patients with choledocholithiasis. Among them, there were 22 women (57.9%) and 16 men (42.1%), with a mean age of 64.8 ± 13.2 years (range: 32–95 years). The patients were divided into two groups: 21 underwent ERCP (Group 1), whereas 17 underwent open laparotomy with biliary drainage (Group 2).

In Group 1, patients undergoing ERCP received standard pre-medication. Midazolam was administered intravenously at a dose of 0.05–0.1 mg/kg to provide anxiolysis and mild sedation. Atropine, at a dose of 0.5 mg IV, was used to reduce duodenal peristalsis and facilitate papilla cannulation. To prevent cholangitis and infections, ciprofloxacin (400 mg IV) was administered 30 min before ERCP. Throughout the procedure, continuous cardiorespiratory monitoring was performed, and supplemental oxygen was provided through a nasal cannula.

In Group 2, patients undergoing laparotomy received prophylactic ceftriaxone (1–2 g IV). General anesthesia was achieved using fentanyl (2 μ g/kg), propofol (2 mg/kg), and rocuronium (0.6 mg/kg) for intubation and neuromuscular blockade purposes. Post-operative pain management included ketorolac (30 mg IV every 8 h) and paracetamol (1 g IV every 6 h). Intravenous antibiotics were administered for 5–7 days postoperatively, with adjustments made based on liver function and clinical progress.

Table 1 presents the clinical classification of patients with choledocholithiasis and their surgical history. Of the 38 patients, the largest group (39.5%, $n = 15$) had undergone previous cholecystectomy without biliary drainage. The second largest group (31.6%, $n = 12$) had calculous

Table 1: Distribution of patients based on their clinical context and prior surgical history

Clinical subtype	Group 1	Group 2	Total (%)
Calculous cholecystitis+choledocholithiasis	8	4	12 (31.6)
Post-cholecystectomy	9	6	15 (39.5)
Post-cholecystectomy+prior bile duct drainage	8	3	11 (28.9)
Total	25	13	38 (100)

Data presented as n (%)

cholecystitis with choledocholithiasis. The remaining 28.9% ($n = 11$) underwent cholecystectomy with prior external biliary drainage. Overall, 25 patients underwent endoscopic procedures (Group 1), whereas 13 required laparotomic surgery (Group 2). Endoscopic treatment was used for patients with previous interventions or isolated bile duct stones, whereas open surgery was performed when endoscopic cannulation failed or anatomical variations prevented access. These patterns show varied presentations of choledocholithiasis and the need for individualized treatment.

Table 2 provides an overview of the liver function test parameters, including bilirubin, thymol test, ALT, and AST, measured before and 5–6 days after the intervention in both groups. In Group 1, serum bilirubin levels decreased significantly from $172.3 \pm 2.21 \mu\text{mol/L}$ to $24.2 \pm 0.97 \mu\text{mol/L}$ postoperatively ($P < 0.001$). Significant improvements were also observed in thymol test values ($P < 0.05$), ALT ($P < 0.05$), and AST ($P < 0.05$), indicating positive hepatic recovery after minimally invasive stone extraction. Group 2 showed moderate biochemical improvements that were not statistically significant for most of the parameters. Bilirubin levels decreased from $168.5 \pm 2.12 \mu\text{mol/L}$ to $74.8 \pm 2.41 \mu\text{mol/L}$ post-surgery, but the change was not significant ($P > 0.05$). The ALT, AST, and thymol test values showed only slight post-operative changes. These results suggest a quicker restoration of liver function following endoscopic intervention, supporting its role as the preferred first-line treatment.

Group 1 did not experience any complications during or after surgery. In Group 2, one patient (5.9%) experienced partial failure of biliary-enteric anastomosis. This issue was managed conservatively without additional surgery because the external drainage continued to function adequately. Although the exact hospital stay durations were not consistently documented, patients in Group 1 had shorter hospitalizations than those in Group 2, aligning with faster clinical and biochemical recovery.

DISCUSSION

This study evaluated the outcomes of endoscopic (ERCP) versus open surgical (laparotomic) procedures for choledocholithiasis, showing that ERCP led to quicker liver recovery, fewer complications, and reduced hospital stays. These results support the notion that ERCP should be the preferred initial treatment for CBD stones when technically feasible.

The reduction in serum bilirubin and transaminase levels in the ERCP group corroborates previous studies showing rapid normalization of liver enzymes after endoscopic stone removal.^[17,18] Patients who underwent laparotomy showed less improvement in liver function due to surgical trauma, extended recovery, and potential complications. This aligns with reviews showing that ERCP has lower morbidity and mortality than open surgical exploration.^[19,20]

The lack of procedural complications in the ERCP group was significant. Although concerns such as post-ERCP pancreatitis, perforation, and cholangitis persist, their occurrence is minimal in centers with experienced practitioners.^[21] This may be attributed to the use of prophylactic antibiotics and careful patient selection following international guidelines. Biliary-enteric anastomotic complications in the laparotomy group, even when managed conservatively, highlight the technical difficulties and increased complications associated with open surgery.

The shorter hospital stay in the ERCP group corroborates existing research. A meta-analysis by Dasari *et al.* found that ERCP significantly decreased hospital stay compared to surgical exploration.^[19] Quicker biochemical recovery and reduced post-operative pain facilitate earlier discharge, which is advantageous in resource-limited settings.

Laparotomic surgery remains crucial in situations such as altered anatomy, unsuccessful ERCP, or large, lodged stones. Research indicates that surgery may be necessary for 10–15% of patients with CBD stones when endoscopic access is not feasible.^[22]

Table 2: Pre-operative and post-operative liver function parameters in both groups

Parameter	Groups	Pre-operative	Post-operative (Days 5–6)	P-value
Bilirubin ($\mu\text{mol/L}$)	Group 1	172.3 ± 2.21	24.2 ± 0.97	<0.001
	Group 2	168.5 ± 2.12	74.8 ± 2.41	>0.05
Thymoltest (units)	Group 1	9.4 ± 0.19	6.1 ± 0.09	$<0.05^*$
	Group 2	8.2 ± 0.27	7.1 ± 0.18	<0.05
Alanine aminotransferase (U/L)	Group 1	0.22 ± 0.06	0.17 ± 0.03	$<0.05^*$
	Group 2	0.24 ± 0.07	0.21 ± 0.005	<0.05
Aspartate aminotransferase (U/L)	Group 1	0.21 ± 0.004	0.16 ± 0.001	$<0.05^*$
	Group 2	0.19 ± 0.003	0.19 ± 0.03	<0.05

Values are expressed as mean \pm standard deviation, $^*P < 0.05$

These findings align with recent evidence supporting selective laparotomy in complex situations. ElGeidie highlighted that laparotomy remains relevant for managing challenging stones, especially when intraoperative cholangiography identifies multiple or intrahepatic stones.^[23] A comprehensive national audit in the United Kingdom revealed that laparotomy was more frequently necessary for patients with unsuccessful pre-operative imaging or complications, such as Mirizzi syndrome.^[24] The decision between ERCP and surgical exploration should consider anatomical, technical, and institutional factors of the patient. In patients with Roux-en-Y anatomy or duodenal diverticula, ERCP success rates decrease significantly, making surgical methods more favorable. In addition, delays in accessing ERCP during emergencies may heighten the risk of sepsis and complications, necessitating urgent laparotomy.^[25]

The absence of significant liver function enhancement in the laparotomy group prompted an examination of the timing and criteria for surgical intervention. Future research should investigate whether earlier surgical drainage or hybrid methods, such as laparoscopic-assisted ERCP, can improve biochemical outcomes and reduce complications. This study has some limitations, including its retrospective nature, small sample size, and single-center focus. Nevertheless, it offers insights into real-world outcomes in tertiary care settings in low-to-middle-income regions where both ERCP and surgery are common. Multicenter randomized controlled trials are needed to define patient selection criteria and create algorithms for choosing optimal treatment modalities in various health-care settings.

CONCLUSION

ERCP shows benefits over laparotomic exploration for treating choledocholithiasis, with improved post-operative liver function, fewer complications, and reduced hospitalization. These results support ERCP as the initial treatment for suitable patients in facilities with endoscopic expertise. While laparotomy remains crucial when ERCP fails, anatomical limitations exist, or stone burdens are complex, it should be reserved for cases where endoscopic methods are unfeasible. Limited biochemical recovery and higher complications in the laparotomy group emphasize the importance of patient selection and timely referral for endoscopic treatment.

In resource-constrained settings, enhancing ERCP services and building local surgical and endoscopic capabilities are essential for better outcomes in patients with CBD stones. Future multicenter studies should focus on creating treatment algorithms integrating clinical, anatomical, and logistical factors to guide optimal management strategies for choledocholithiasis.

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