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Original Research Article

Laparoscopic common bile duct exploration versus endoscopic retrograde cholangiopancreatography as the first line treatment for choledocholithiasis

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ABSTRACT

Background: Choledocholithiasis, or common bile duct (CBD) stones, often occurs in patients undergoing cholecystectomy. Management typically involves either laparoscopic CBD exploration (LCBDE) with cholecystectomy or a two-stage approach using endoscopic retrograde cholangiopancreatography (ERCP) followed by surgery. Although ERCP is widely used, its complication risks have led to increased interest in LCBDE. The objective is to compare the efficacy and outcomes of LCBDE versus ERCP in the treatment of choledocholithiasis.
Methods: A prospective study of 40 patients with confirmed choledocholithiasis at KR Hospital, Mysuru, was conducted over 24 months. Patients were evenly divided between LCBDE and ERCP groups.
Results: Both methods were effective in CBD stone clearance. ERCP was associated with faster recovery, earlier oral intake, and return to work. LCBDE was preferred for larger stones and wider ducts. Although a bile leak occurred only in the LCBDE group and ERCP had a 15% re-exploration rate, these differences were not statistically significant. ERCP had a 7.5% failure rate requiring surgical intervention. Notably, despite longer operative time, LCBDE resulted in significantly shorter total hospital stays due to its single-stage nature.
Conclusions: Both LCBDE and ERCP are safe and effective for choledocholithiasis. ERCP offers faster recovery and is better suited for smaller, uncomplicated stones. LCBDE provides a more definitive solution for complex cases with larger stones, leading to shorter hospital stays. Treatment choice should be tailored based on stone characteristics, patient condition, and available expertise.

Keywords: Choledocholithiasis, Laparoscopic CBD exploration, ERCP, Laparoscopic cholecystectomy

INTRODUCTION

The management of choledocholithiasis remains a subject of ongoing clinical debate, particularly with the evolution of minimally invasive techniques over the past few decades. Traditionally, surgical exploration of the common bile duct (CBD) was the mainstay of treatment; however, with the advent of endoscopic techniques such as endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic sphincterotomy (ES), treatment paradigms have shifted considerably.

CBD exploration was traditionally performed as an open procedure but can be performed laparoscopically either via a trans cystic approach or transductal approach. Nevertheless, laparoscopic CBD exploration (LCBDE) has not been adopted widely as it is technically challenging and strongly dependent on surgeon experience and equipment availability. LCBDE combined with cholecystectomy is a feasible and effective option as a single-stage procedure for the management of choledocholithiasis.

A seminal Cochrane review by Martin et al conducted a meta-analysis comparing surgical and endoscopic management of CBD stones. The study concluded that while both approaches are highly effective in stone clearance, endoscopic techniques were associated with a lower morbidity rate, shorter hospital stays, and less postoperative discomfort. However, they also found that surgical interventions might be more definitive, especially in patients undergoing concurrent cholecystectomy, as they reduce the likelihood of stone recurrence and the need for subsequent procedures.[1]

The debate between LCBDE and endoscopic treatment is further elaborated in a study by Tranter and Thompson who compared ES with LCBDE. Their findings suggested that LCBDE can achieve comparable, if not superior, outcomes in terms of stone clearance, with the added advantage of addressing both the gallbladder and bile duct pathology in a single-stage procedure. Moreover, they noted a reduced incidence of stone recurrence with LCBDE, likely due to the preservation of the sphincter of Oddi.[2]

Support for the single-stage surgical approach is robustly presented by Bansal et al who evaluated the outcomes of single-session laparoscopic cholecystectomy and CBD exploration. The study highlighted that in skilled hands, this approach is not only safe and effective but also leads to significantly reduced hospital stays and healthcare costs. This technique becomes particularly valuable in settings with limited access to endoscopic services or where cost containment is a priority.[3]

The technical feasibility of LCBDE was first comprehensively documented by Cuschieri, a pioneer in laparoscopic surgery. His work laid the foundation for modern minimally invasive biliary surgery and demonstrated that laparoscopic techniques could be safely extended to CBD exploration with acceptable complication rates, provided that proper equipment and expertise were available.[4]

Further refinements in surgical technique have focused on the method of CBD closure following exploration. Zhang et al compared primary duct closure with traditional T-tube drainage. Their results indicated that primary closure was associated with fewer complications, shorter operative time, and quicker postoperative recovery, advocating for its routine use in select patients with a non-dilated CBD and complete stone clearance.[5]

Additionally, Júnior et al investigated the differences between the transcystic and choledochotomy approaches in LCBDE. The transcystic route, being less invasive, was favored for patients with smaller or fewer stones and a favourable cystic duct anatomy. In contrast, choledochotomy was reserved for complex cases, such as large or multiple stones, or when the transcystic approach failed.[6]

On the other hand, Rhodes et al conducted a randomized trial comparing laparoscopic exploration of the CBD with postoperative ERCP. They demonstrated that LCBDE could effectively eliminate the need for postoperative ERCP, thus minimizing the number of procedures and overall patient burden. Their findings underscore the efficiency and potential cost-effectiveness of the laparoscopic approach, particularly in centres with surgical expertise in minimally invasive techniques.[7]

Objectives

This study aims to compare the duct clearance rates, the operating time, the cost, morbidity and length of hospital stay of LCBDE to those of ERCP stone extraction followed by laparoscopic cholecystectomy in patients with choledocholithiasis

METHODS

Patient selection

This is an observational study, conducted over an 24-month period (July 2023 to July 2025) at the department of general surgery, Mysore medical college and research institute, Mysore, included a total sample size of 40 patients presenting with obstructive jaundice secondary to choledocholithiasis who were treated at K. R. hospital, Mysore.

The methodology involved recording 1clinical history, patient variables, investigations, and treatment details in a specific proforma, followed by clinical and biochemical evaluation upon admission, documentation of intraoperative data from the ERCP or LCBDE procedure, and a 30-day post-operative follow-up to document complications, ultimately allowing for a comparison between the two treatment modalities.

Inclusion criteria

The study employed consecutive non-probability sampling to enrol eligible patients aged 18 years and above, of either sex, who had radiological evidence of CBD stone and underwent either ERCP or LCBDE were included in the study.

Exclusion criteria

Patients below 18 years of age and patients unwilling for surgery were excluded.

Data collection

The study data were collected and structured into three main categories: Preoperative parameters, which included the CBD diameter, choledocholithiasis stone size, serum levels of total bilirubin, direct bilirubin, and liver enzymes, as well as patient comorbidities; Intraoperative parameters, which covered the specific modality of

treatment utilized and any intraoperative complications that occurred; and finally; Postoperative parameters, which were assessed through the duration of hospital stay, time spent in the intensive care unit stay, overall expenditure, occurrence of a bile leak, and other post operative complications.

Statistical method

The required sample size was calculated considering an anticipated prevalence of 4%, derived from existing literature relevant to the study population. A 95% confidence level and an absolute margin of error of 6.1% were assumed to ensure adequate precision in estimating this proportion. Based on these parameters, the minimum sample size required was estimated to be 40 participants, which would provide sufficient power to yield statistically reliable and generalizable results.

Statistical plan

Microsoft excel and SPSS (version 27) were used for data entry, cleaning and analysis. Continuous variables are presented as mean±standard deviation (SD), and categorical variables are summarised as frequencies and percentages. The association between two categorical variables was evaluated using the Chi-square test. In cases where the expected frequency in any cell was less than 5, Fisher's Exact Test was employed. Mann Whitney U test was used to assess the change in mean across the independent group. Statistical significance was determined at a 5% level of significance.

RESULTS

Age distribution

The study population had a mean age of 46.55±9.09 years. The majority of participants were between 41-50 years (13 participants, 32.5%) and 51-60 years (13 participants, 32.5%), followed by 30-40 years (12 participants, 30%). Only a small proportion of participants were aged between 61-70 years (2 participants, 5%) (Table 1).

Table 1: Age distribution.

Age distribution (in years)	N (%)
30-40	12 (30)
41-50	13 (32.5)
51-60	13 (32.5)
61-70	2 (5)
Mean age	46.55±9.09

Gender distribution

In terms of gender, there was female predominance with 28 females (70%) and 12 males (30%) among the study participants (Figure 1).

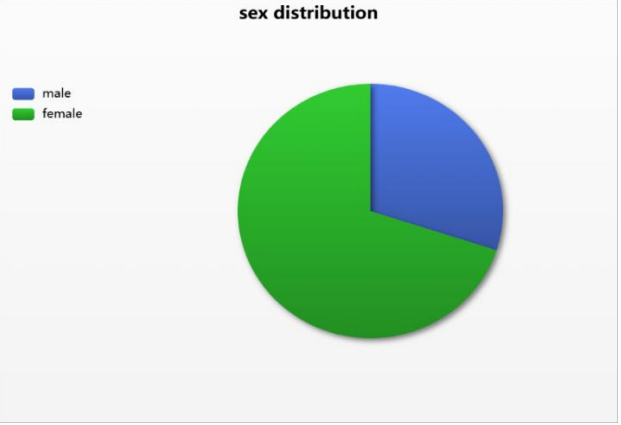

Figure 1: Sex distribution of study group.

Co-morbidity

Regarding co-morbid conditions, hypertension was the most frequently observed, affecting 6 participants (15%), followed by diabetes mellitus in 4 participants (10%) and anaemia in 3 participants (7.5%). Hypothyroidism and ischemic heart disease were noted in 2 (5%) and 1 (2.5%) participant, respectively.

Laboratory data

The mean total bilirubin level among the study participants was 3.49±1.30 mg/dl, while the mean direct bilirubin level was 3.18±1.27 mg/dl. The liver enzyme levels were elevated, with mean AST at 123.93±73.77 U/l, mean ALT at 129.78±83 U/l, and mean ALP at 386.5±164.09 U/l, indicating underlying hepatobiliary pathology (Table 2).

Table 2: Laboratory data.

Laboratory data	Mean±SD
Total bilirubin	3.49±1.30
Direct bilirubin	3.18±1.27
AST	123.93±73.77
ALT	129.78±83
ALP	386.5±164.09

CBD stone details across the study group

Significant differences were observed in CBD stone characteristics between the two groups. The mean CBD stone size was larger in the LCBDE group (11.25±2.07 mm) compared to the ERCP group (8.70±2.47 mm). Similarly, the mean CBD diameter was greater in the LCBDE group (14.15±3.80 mm) compared to the ERCP group (10.90±2.63 mm), with a statistically significant difference (p=0.003) (Table 3).

Oral intake post surgery across the study group

There was a statistically significant difference in the timing of resumption of oral intake between the two

groups (p<0.001). All patients in the ERCP group (100%) resumed oral intake on the first day itself, whereas in the LCBDE group, the majority resumed on the second day (17 patients, 85%), with a few resuming later on day 7 (2 patients, 10%) and day 8 (1 patient, 5%) (Figure 2).

Table 3: CBD stone details across the study group.

CBD stone details	Study group		P value
	LCBDE, (n=20)	ERCP, (n=20)	
CBD stone size (mm)	11.25±2.07	8.70±2.47	0.004
CBD diameter (mm)	14.15±3.80	10.90±2.63	0.003

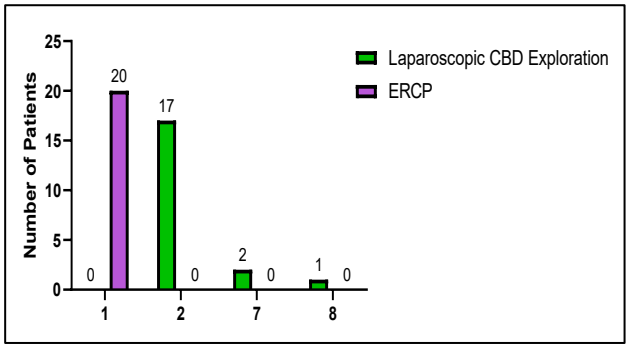

Figure 2: Oral intake post-surgery across the study group.

VAS score across the study group

Postoperative pain, assessed using the visual analogue scale (VAS), was similar between the two groups (p=0.723). In the LCBDE group, 15 participants (75%) reported a VAS score of 2, and 5 participants (25%) reported a score of 3. In the ERCP group, 14 participants (70%) had a VAS score of 2, and 6 participants (30%) reported a score of 3, indicating mild to moderate pain levels in both groups.

Bile leak across the study group

Bile leak was observed in 3 patients (15%) in the LCBDE group and were managed conservatively, whereas no cases of bile leak were reported in the ERCP group. However, this difference was not statistically significant (p=0.231).

Re exploration across study group

Re-exploration was required in 3 patients (15%) following ERCP, due to persistent stones, while none of the patients who underwent LCBDE required re-exploration. The difference between the groups was not statistically significant (p=0.231).

Work resume across the study group

A higher proportion of patients in the ERCP group (100%) resumed work within 1 week compared to 80% in the LCBDE group. In the LCBDE group, 20% of patients required 2 weeks to resume work. However, this difference was not statistically significant (p=0.106).

Hospital duration across the study group

The mean total hospital duration was significantly longer in the ERCP group (36.30±11.30 days) compared to the LCBDE group (19.95±3.36 days), with the difference being highly significant (p<0.001). Similarly, the time spent specifically for surgery was longer in the LCBDE group (19.95±3.36 days) compared to the ERCP group (12.60±9.55 days), which also showed a statistically significant difference (p<0.001) (Figure 3).

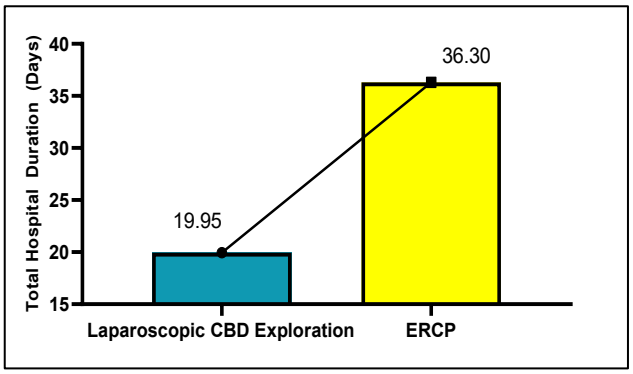

Figure 3: Total hospital duration across the study group.

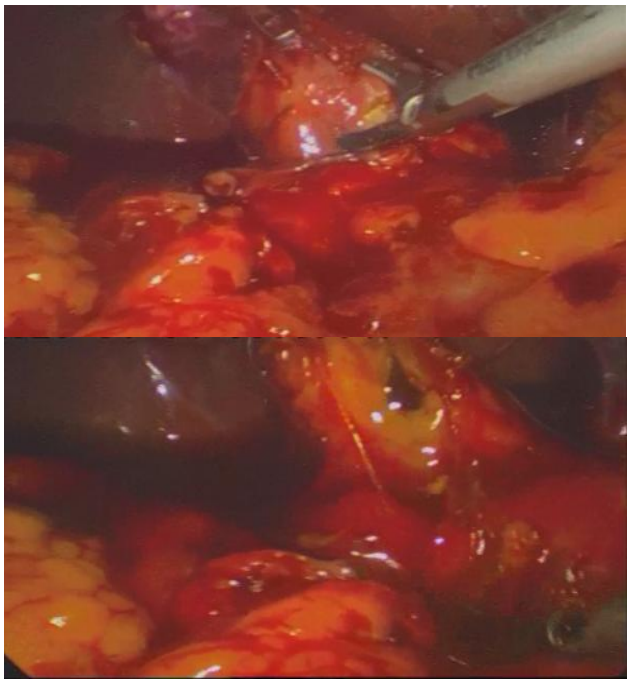

Figure 4: Choledochotomy done using harmonic energy source.

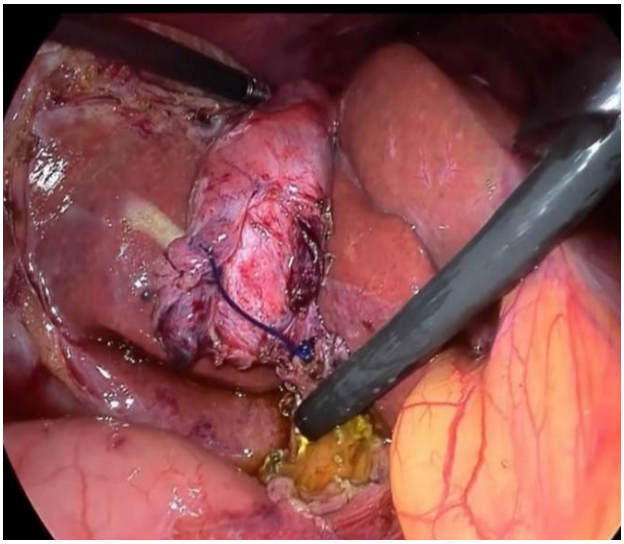

Figure 5: Choledochoscope being introduced into the CBD through choledochotomy incision.

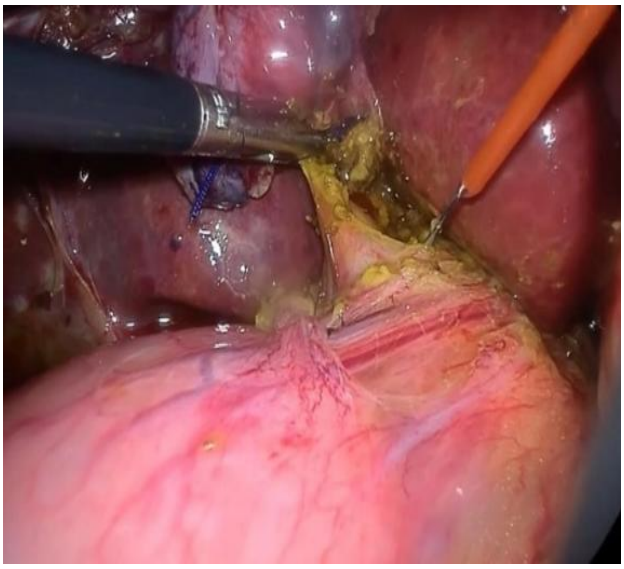

Figure 6: Saline irrigation being given to CBD through choledochotomy incision.

DISCUSSION

The present study employed a prospective comparative design involving 40 patients, with 20 in each group (LCBDE vs ERCP), and both groups were demographically similar in terms of age and gender, minimizing selection bias, although stone size and CBD diameter were significantly larger in the laparoscopic group, suggesting more complex disease.

In this study the two groups were demographically comparable. There was no statistically significant difference in age (mean age ~46.5 years, p=0.881) or gender distribution (p=0.525), ensuring balanced cohorts for valid comparison. Most patients were between 41-60 years old and predominantly female (70%).

One key distinction lies in the size and diameter of CBD stones. Patients in the LCBDE group had significantly larger stones (11.25±2.07 mm vs. 8.70±2.47 mm; p=0.004) and wider ducts (14.15±3.80 mm vs. 10.90±2.63 mm; p=0.003), indicating that LCBDE was more frequently utilized in complex or larger stone burdens, consistent with current surgical indications.

No statistically significant differences were found between the two groups in liver function tests (bilirubin, AST, ALT, ALP), suggesting similar levels of preoperative hepatobiliary obstruction and systemic impact.

Postoperative recovery

Oral intake

A significant difference emerged in the resumption of oral intake. All ERCP patients resumed oral intake on the first day, while the majority of laparoscopic cases began on day 2 or later (p<0.001), indicating faster GI recovery post-ERCP.

Pain (VAS score)

Postoperative pain was generally mild in both groups, with no significant difference (p=0.723). The minimally invasive nature of both procedures likely contributed to low pain scores.

Return to work

While 100% of ERCP patients resumed work within 1 week, this was true for only 80% of the laparoscopic group (p=0.106). Though not statistically significant, the trend favours ERCP for quicker return to daily activities.

Complications

Bile leak

Bile leakage occurred in 15% of laparoscopic patients vs. none in the ERCP group, though this was not statistically significant (p=0.231). Surgical manipulation of the bile duct may explain this higher risk.

Re-exploration

Notably, only the ERCP group required re-exploration (15%) for persistent stones (p=0.231), underscoring the potential for incomplete ductal clearance with ERCP, especially in cases involving multiple or large stones.

This study reveals a counterintuitive but statistically significant finding: the total hospital stay was longer in the ERCP group (36.30±11.30 days vs. 19.95±3.36 days; p<0.001). This could be attributed to: Preoperative admission for ERCP planning or failed ERCP leading to further intervention. Staged procedures often associated

with ERCP (e.g., ERCP followed by laparoscopic cholecystectomy).

On the other hand, although LCBDE involved a longer surgical hospital stay (19.95±3.36 days vs. 12.60±9.55 days; p<0.001), the overall length of hospitalization was significantly shorter, possibly due to the one-stage nature of surgical stone clearance and cholecystectomy.

ERCP failed in 3 patients (7.5%), aligning with known literature that reports ERCP failure in cases of large, impacted, or multiple stones. These patients required surgical intervention, emphasizing importance of patient selection and limitations of ERCP in complex cases.

Literature review

This study results aligns with previous research, including a randomized study by Koc et al with 120 patients comparing LCBDE plus cholecystectomy (LCBDE+LC) versus ERCP+LC, which reported higher success for LCBDE with comparable morbidity.[8] Similarly, Elbegawy et al analysed 120 patients undergoing LCBDE versus intraoperative ERCP and noted differences in operative time but no mortality, reinforcing feasibility.[12] A large database study by Al-Temimi et al compared 105 LCBDE and 195 ERCP patients, showing higher stone clearance with laparoscopic approaches while morbidity and hospital stay were similar.[11] In the present study, ERCP failures occurred in 3 patients (7.5%) due to large or impacted stones, necessitating surgical intervention, consistent with literature reporting reduced ERCP effectiveness in patients with large or multiple stones.[9] Postoperative recovery showed that ERCP patients resumed oral intake earlier and returned to work faster, though total hospital stay was longer in the ERCP group (36.3 vs 19.95 days; p<0.001), likely reflecting preoperative admissions and staged procedures rather than procedural limitations. Meta-analyses and cohort studies indicate that single-stage LCBDE+LC is generally associated with shorter hospital stay compared to two-stage ERCP+LC.[10,14] Regarding complications, bile leaks occurred only in laparoscopic cases (15%) and re-exploration for stone clearance occurred only in ERCP patients (15%), reflecting procedure-specific risks: ERCP carries higher pancreatitis risk, while LCBDE is more associated with wound-related issues.[13] Overall, both approaches are viable; choice should consider stone burden, duct anatomy, and institutional protocols. While ERCP may facilitate earlier postoperative recovery, single-stage laparoscopic management is often preferred for shorter hospitalization and cost-effectiveness, although ERCP remains essential for patients unsuitable for surgery or requiring definitive stone clearance.[11,13]

Limitations

The study is based on a single centre KR hospital and the sample size is small.

CONCLUSION

In conclusion, both surgical and endoscopic approaches have distinct advantages. While ERCP remains a valuable and less invasive option, especially for elderly or high-risk surgical candidates, LCBDE offers a comprehensive, single-session treatment that is particularly advantageous in younger, lower-risk patients or in healthcare systems prioritizing cost and procedural efficiency. The choice of treatment must therefore be individualized, taking into account patient factors, stone characteristics, anatomical considerations, and institutional expertise.

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