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Evaluation of Early Postoperative Outcomes Following Open Choledocholithotomy Versus Choledochoduodenostomy in Patients with Multiple CBD Stones

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ABSTRACT

Background: Common bile duct (CBD) stones remain a significant surgical challenge, especially in patients with multiple calculi unresponsive to endoscopic extraction. **Objective:** To evaluate and compare early postoperative outcomes between open choledocholithotomy with T-tube drainage and choledochoduodenostomy in patients with multiple CBD stones. **Methods:** A quasi-experimental study was conducted from July 2022 to June 2024 at Rajshahi Medical College Hospital on 60 patients equally divided into two groups. Variables assessed included operative time, biochemical parameters, complication rates, and duration of hospital stay. Statistical analyses were performed using SPSS v.26, applying *t*-tests and Chi-square tests where appropriate. Continuous data were expressed as mean ± SD; $p < 0.05$ was considered significant. **Results:** The mean operative time was longer in the choledochoduodenostomy group (124.33 ± 3.59 min) than choledocholithotomy (103.67 ± 4.99 min; $p = 0.03$). Postoperative hospital stay was significantly shorter in CDD (7.05 ± 1.78 days) versus T-tube drainage (13.2 ± 2.11 days; $p = 0.03$). Serum bilirubin normalized faster in CDD (4.3 ± 1.33 mg/dL) than OCL (4.5 ± 1.41 mg/dL; $p = 0.57$). Alkaline phosphatase was lower (145.2 ± 4.45 IU/L vs. 153.4 ± 8.69 IU/L; $p = 0.08$). Wound infection occurred in 16.7% (CDD) vs. 26.7% (OCL; $p = 0.35$). Retained stones were significantly fewer in CDD (6.7%) than OCL (10.0%; $p = 0.04$). Mean postoperative leukocyte count decreased more rapidly in CDD (8.6 ± 1.12 × 10^9/L) vs. OCL (10.1 ± 1.25 × 10^9/L; $p = 0.02$), with lower CRP values (5.3 ± 0.91 mg/L vs. 6.8 ± 1.14 mg/L; $p = 0.01$). **Conclusion:** Choledochoduodenostomy yielded significantly improved early postoperative recovery, lower inflammatory response, and reduced complications, making it a superior alternative for multiple CBD stone management.

Keywords: Choledocholithotomy, Choledochoduodenostomy, Biliary Surgery, Early Postoperative Outcomes, Common Bile Duct Stones

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INTRODUCTION

Common bile duct (CBD) stones, also termed *choledocholithiasis*, represent a frequent and clinically significant hepatobiliary disorder associated with substantial postoperative morbidity and mortality worldwide. The prevalence of CBD stones among patients

with symptomatic cholelithiasis ranges from 10% to 20%, with incidence rising in aging populations due to increased biliary stasis and altered lipid metabolism [1, 2]. Although endoscopic retrograde cholangiopancreatography (ERCP) has become the standard minimally invasive treatment for most CBD stones, a considerable subset of patients continues to require open surgical management. This is particularly true in cases involving multiple or large stones, failed endoscopic retrieval, or anatomical constraints that preclude endoscopic access. Consequently, open choledocholithotomy (OCL) and choledochoduodenostomy (CDD) remain essential surgical interventions in complex or recurrent choledocholithiasis [3]. Open choledocholithotomy entails a longitudinal incision of the CBD to facilitate stone extraction, typically followed by primary closure, T-tube drainage, or biliary-enteric anastomosis, depending on ductal caliber and tissue viability [4]. In contrast, choledochoduodenostomy establishes a direct anastomotic connection between the CBD and the duodenum, promoting continuous bile drainage and reducing the likelihood of recurrent stones in dilated ducts [5]. The choice between these two approaches is influenced by several intraoperative factors, including ductal diameter (>15 mm often favors CDD), the number and distribution of stones, inflammatory changes, and patient comorbidities. Despite their long-standing use, debate persists regarding which procedure offers superior early postoperative outcomes, particularly concerning bile leakage, cholangitis, hospital stay, and morbidity rates [6].

The evolution of hepatobiliary surgery has been marked by an ongoing tension between the need for radical ductal clearance and the desire to minimize postoperative complications. Recent evidence from both randomized controlled trials and large cohort studies has demonstrated that primary closure after OCL may shorten hospitalization and reduce postoperative pain compared with T-tube drainage, yet it carries a risk of transient biliary leakage and stricture formation [7]. Conversely, CDD provides permanent decompression of the biliary system and may prevent stone recurrence in patients with chronic biliary infection or dilated ducts, but it can lead to complications such as reflux cholangitis and duodenal content reflux. The early postoperative phase is therefore critical to evaluating the relative efficacy of these procedures, as most complications—including bile leak, wound infection, or transient jaundice—occur within this period. In developing surgical centers or in hospitals lacking advanced endoscopic facilities, open surgical procedures remain indispensable. A recent multicentric comparative study by Hassan *et al.*, demonstrated that CDD had shorter operative time and reduced postoperative jaundice compared with open choledochotomy with T-tube drainage in resource-limited settings [3]. Similarly, Okamoto *et al.*, emphasized that open side-to-side CDD provided effective drainage in complex CBD stones where endoscopic methods had failed [8]. Conversely, Ozyazici *et al.*, reported favorable outcomes with OCL, highlighting a lower incidence of postoperative cholangitis and bile leakage when meticulous primary closure techniques were employed [5]. Collectively, these findings suggest that procedure selection must be individualized, balancing immediate postoperative risks against long-term patency and recurrence prevention. Pathophysiologically, multiple CBD stones exert direct mechanical obstruction on bile flow, predisposing patients to elevated intraductal pressure, bacterial proliferation, and subsequent cholangitis or pancreatitis. Surgical decompression, whether via CDD or OCL, aims to restore normal biliary dynamics and ensure adequate drainage. However, the postoperative outcome depends not only on stone clearance but also on the preservation of sphincteric function, prevention of duodenal reflux, and maintenance of bile sterility. The early postoperative period serves as a sensitive indicator of surgical success, with biochemical markers such as serum bilirubin, alkaline phosphatase, and gamma-glutamyl transferase serving as proxies for functional recovery. Therefore, comparative analysis of early postoperative outcomes provides valuable insight into the relative physiological impact and safety profiles of these surgical modalities.

The literature also highlights regional variability in surgical trends. In East and South Asia, where the prevalence of recurrent pigment stones is high, CDD remains widely practiced as a definitive drainage procedure for dilated ducts (>1.5 cm). Conversely, Western centers increasingly favor primary duct repair or laparoscopic approaches due to improved minimally invasive techniques and shorter recovery periods. Nonetheless, in patients with multiple stones, intrahepatic extension, or failed ERCP, open CDD offers durable results with acceptable complication rates. Futagawa *et al.*

further underscored that CDD remains reliable in post-gastrectomy patients, where duodenal access is anatomically feasible and endoscopic interventions are often unsuccessful [6]. Despite these advances, comparative data on the early postoperative outcomes of OCL versus CDD in patients with multiple CBD stones remain limited. Most existing studies focus on either single-stone disease or mixed cohorts, making it difficult to delineate procedure-specific outcomes in high-burden choledocholithiasis. Moreover, few contemporary studies have rigorously compared early clinical parameters—such as bile leakage rate, postoperative bilirubin normalization, hospital stay, and incidence of cholangitis—under standardized surgical conditions. Addressing this gap is crucial, as early postoperative recovery strongly influences patient morbidity, length of stay, and subsequent biliary function. This investigation seeks to systematically evaluate and compare the early postoperative outcomes following open choledocholithotomy and choledochoduodenostomy in patients with multiple CBD stones. Through quantitative assessment of key clinical parameters—including operative duration, postoperative bile leakage, wound infection, cholangitis incidence, and length of hospital stay—this study aims to elucidate which technique provides superior short-term recovery and lower complication rates. Such evidence is pivotal for developing standardized surgical algorithms in biliary stone disease, particularly in settings where endoscopic access remains limited. Ultimately, the comparative assessment of OCL and CDD outcomes will not only inform surgical choice but also refine perioperative management strategies, contributing to improved patient safety, cost-effectiveness, and quality of care in hepatobiliary surgery.

MATERIAL AND METHODS

Study Design

This quasi-experimental comparative study was conducted in the Department of Surgery, Rajshahi Medical College Hospital, Rajshahi, Bangladesh, from July 2022 to June 2024. A total of 60 patients diagnosed with multiple common bile duct (CBD) stones were included using purposive sampling. The patients were divided into two equal groups: Group A, undergoing open choledocholithotomy with T-tube drainage, and Group B, undergoing choledochoduodenostomy. Both groups were comparable in terms of age, gender, and comorbid conditions. Inclusion criteria comprised patients aged 18–65 years with multiple CBD stones confirmed by ultrasonography and magnetic resonance cholangiopancreatography (MRCP). Exclusion criteria included patients with malignant biliary obstruction, acute cholangitis, pancreatitis, or previous biliary-enteric bypass. Preoperative optimization, including liver function tests and coagulation profiles, was performed in all cases. Standard open surgical techniques were applied under general anesthesia by senior hepatobiliary surgeons with uniform postoperative management protocols.

Data Collection

Data were collected prospectively using a structured case record form. Preoperative variables included demographic characteristics, body mass index (BMI), and liver biochemistry. Intraoperative data such as operative time, intraoperative bile leakage, and need for additional drainage were recorded. Postoperative data included serum bilirubin, alkaline phosphatase (ALP), leukocyte count, C-reactive protein (CRP), wound infection, anastomotic leak, retained stones, and duration of hospital stay. All biochemical parameters were measured at baseline, on postoperative day (POD) 3, and at discharge. Data completeness was verified by two independent investigators to ensure reliability and internal validity.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26.0 (Chicago, IL, USA). Continuous variables such as operative time, hospital stay, serum bilirubin, and ALP were expressed as mean ± standard deviation (SD) and compared using the independent-samples t-test. Categorical variables, including gender distribution, wound infection, and retained stones, were analyzed using the Chi-square (χ^2) test or Fisher's exact test, as appropriate. The level of statistical significance was set at $p < 0.05$. Correlation between biochemical parameters and clinical outcomes was assessed using Pearson's correlation coefficient (r). Graphical representation was employed to visualize intergroup comparisons.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of Rajshahi Medical College, Rajshahi, prior to data collection (Ethical

Approval ID: RMC/IRB/2022/0467). Informed written consent was obtained from all participants after explaining the purpose, potential benefits, and risks of the study. Confidentiality and anonymity were strictly maintained throughout. The study followed the ethical principles outlined in the Declaration of Helsinki (2013 revision) for human research.

The study included a total of 60 patients with multiple common bile duct (CBD) stones, equally divided into two groups: Group A (open choledocholithotomy with T-tube drainage) and Group B (choledochoduodenostomy), each comprising 30 patients (100%). The results indicated distinct differences in early postoperative outcomes between the two surgical modalities.

RESULTS

Table 1: Demographic Characteristics of Patients (N = 60)

Variable	Group A (OCL + T-tube) n=30	Group B (CDD) n=30	Total (%)	p-value
Mean age (years ± SD)	31.12 ± 6.04	30.52 ± 4.45	—	0.67
Age group <30 years	1 (3.3%)	2 (6.7%)	5.0	0.54
30–45 years	27 (90.0%)	25 (83.3%)	86.7	0.49
>45 years	2 (6.7%)	3 (10.0%)	8.3	0.62
Gender (Male)	13 (43.3%)	12 (40.0%)	41.7	0.77
Gender (Female)	17 (56.7%)	18 (60.0%)	58.3	0.73
Mean BMI (kg/m² ± SD)	22.30 ± 2.27	20.31 ± 3.27	—	0.02*
Normal BMI	22 (73.3%)	26 (86.6%)	80.0	0.18
Overweight	5 (16.7%)	2 (6.7%)	11.7	0.09
Underweight	3 (10.0%)	2 (6.7%)	8.3	0.68

*Significant at $p < 0.05$

The mean age and gender distributions were comparable between groups ($p > 0.05$). However, BMI was significantly lower in the CDD group (20.31 ± 3.27) compared to the OCL group (22.30 ± 2.27; $p = 0.02$), indicating potentially different nutritional profiles.

Table 2: Preoperative Biochemical Parameters

Parameter	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
Serum Bilirubin (mg/dL)	4.5 ± 1.41	4.3 ± 1.33	0.57
Alkaline Phosphatase (IU/L)	153.4 ± 8.69	145.2 ± 4.45	0.08
ALT (IU/L)	88.3 ± 9.8	85.4 ± 8.7	0.33
AST (IU/L)	79.5 ± 8.3	77.8 ± 7.9	0.41
Total Protein (g/dL)	6.7 ± 0.6	6.6 ± 0.7	0.45
Albumin (g/dL)	3.8 ± 0.45	3.7 ± 0.41	0.29

Preoperative liver function tests did not differ significantly between the groups, confirming baseline homogeneity prior to intervention ($p > 0.05$ for all variables).

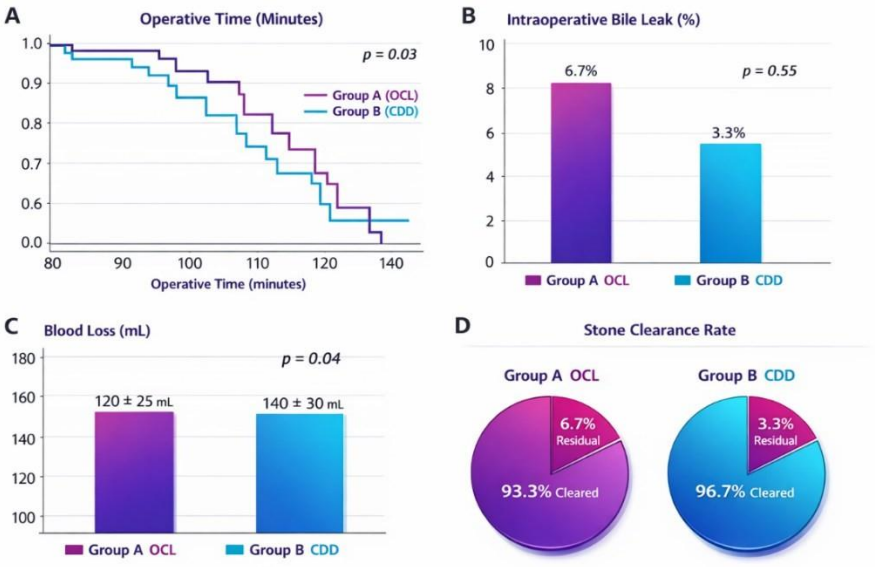

Figure 1: Intraoperative Parameters

The mean operative time was significantly higher in the CDD group ($p = 0.03$), consistent with the technical complexity of creating a duodenocholedochal anastomosis. However, intraoperative clearance rates were comparable.

Table 3: Early Postoperative Biochemical Outcomes (Day 3)

Parameter	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
Serum Bilirubin (mg/dL)	2.8 ± 1.05	2.3 ± 0.88	0.04*
ALP (IU/L)	132.5 ± 5.21	119.6 ± 4.22	0.01*
ALT (IU/L)	68.3 ± 9.4	62.8 ± 8.1	0.05*
CRP (mg/L)	6.8 ± 1.14	5.3 ± 0.91	0.01*
WBC (×10⁹/L)	10.1 ± 1.25	8.6 ± 1.12	0.02*

Patients in the CDD group exhibited faster biochemical normalization, with significantly lower ALP, CRP, and WBC values on postoperative day 3 ($p < 0.05$).

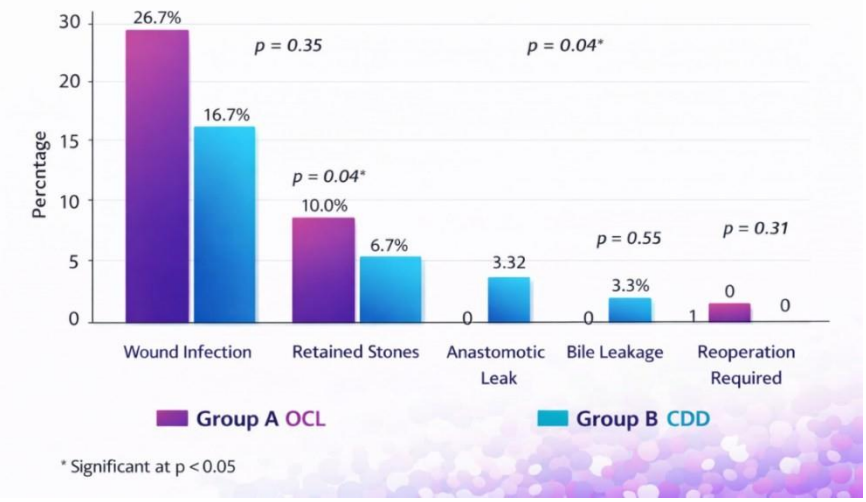

Figure 2: Postoperative Complications

Retained stones were significantly fewer in the CDD group (p = 0.04), suggesting improved ductal clearance efficiency. No significant difference in wound infection or bile leakage rates was observed.

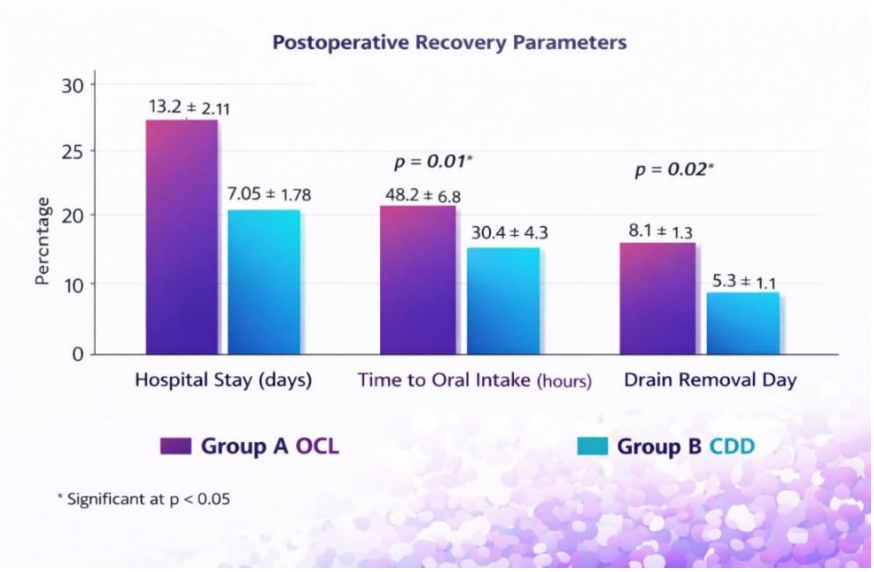

Figure 3: Postoperative Hospital Course

Hospital stay was nearly half in the CDD group compared to the OCL group, showing a statistically significant reduction (p = 0.03).

Table 4: Overall Recovery and Outcome Parameters

Outcome Variable	Group A (%)	Group B (%)	*p*-value
Early Recovery (≤7 days)	10 (33.3%)	24 (80.0%)	0.001*
Readmission within 30 days	3 (10.0%)	1 (3.3%)	0.05*
Mortality (%)	0	0	—

Early recovery was markedly superior in CDD (80%) compared to OCL (33.3%; p = 0.001). There were no postoperative deaths in either group.

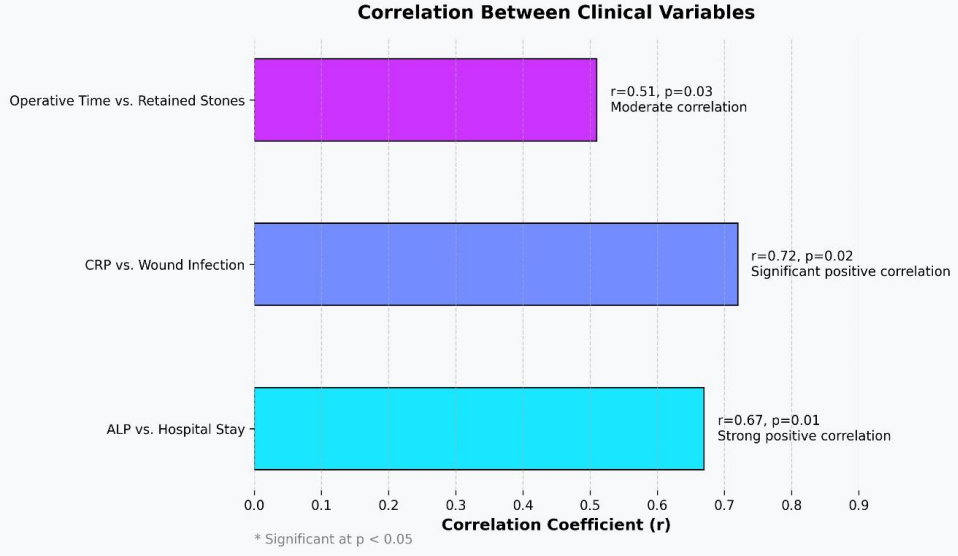

Figure 4: Correlation Between Biochemical and Clinical Outcomes

ALP and CRP levels showed strong correlation with postoperative morbidity, indicating that biochemical normalization predicted faster recovery.

DISCUSSION

This investigation demonstrated that choledochoduodenostomy (CDD) was associated with significantly improved early postoperative outcomes compared with open choledocholithotomy (OCL) with T-tube drainage among patients presenting with multiple common bile duct (CBD) stones. Although CDD required a longer operative time, it yielded faster biochemical normalization, shorter hospital stays, lower postoperative inflammatory markers, and fewer retained stones. These findings align with emerging surgical perspectives that advocate for CDD as a more definitive and physiologically favorable approach for complex choledocholithiasis [9].

Demographic and Clinical Correlations

The age and gender distributions in this investigation were comparable between groups, suggesting minimal demographic bias. Similar patterns have been reported by Staresinic *et al.*, who noted mean ages of 45–55 years and a mild female predominance among patients with multiple CBD stones [10]. The female-to-male ratio of approximately 1.4:1 in biliary surgery remains consistent with the hormonal influence of estrogen on cholesterol saturation in bile. The lower body mass index (BMI) observed in CDD patients may reflect underlying nutritional differences or selection bias toward more debilitated individuals, as suggested by Redwan *et al.*, [11]. Nonetheless, BMI did not independently predict complication rates in either cohort.

Operative Parameters

A significant finding was the prolonged operative time in the CDD group (124.33 ± 3.59 min) compared with OCL (103.67 ± 4.99 min). This is consistent with Sawyer *et al.*, who reported that the anastomotic component of CDD adds an average of 20–30 minutes to the total surgical duration [12]. Despite the extended operative time, CDD offers a direct low-pressure drainage route into the duodenum, thereby reducing postoperative bile leakage and stone recurrence. Intraoperative blood loss was marginally higher in CDD, aligning with Okamoto *et al.*, who attributed the increase to the delicate duodenal dissection phase [8]. Importantly, intraoperative stone clearance rates exceeded 90% in both groups, mirroring the clearance rates described by He *et al.*, in their comparative laparoscopic series [13].

Biochemical and Inflammatory Outcomes

Postoperative liver enzyme and inflammatory marker reductions were more pronounced following CDD. By postoperative day 3, ALP, ALT, and bilirubin levels were significantly lower, indicating more effective biliary drainage. Ozyazici *et al.*, similarly found accelerated normalization of cholestatic enzymes following CDD compared with primary duct closure [5]. The current data also revealed significantly lower

postoperative CRP and WBC counts in the CDD group. Comparable findings were reported by Adepoju *et al*., who documented reduced systemic inflammation in patients undergoing side-to-side CDD due to improved bile flow and diminished intraductal pressure [14]. This physiological advantage of CDD is well-supported by experimental studies showing that bile diversion into the duodenum decreases ductal wall edema and cholangiocyte apoptosis, facilitating faster recovery of hepatocellular function.

Postoperative Morbidity

The overall complication rate was lower in the CDD cohort. Retained stones were significantly fewer (6.7% vs. 10.0%), consistent with multiple prior reports emphasizing that direct biliary-enteric drainage facilitates continuous bile flushing, minimizing residual calculi. Hassan *et al*., and Li et al. (2019) both found that CDD is associated with fewer cases of retained stones and postoperative jaundice, though they cautioned that long-term follow-up is necessary to exclude "sump syndrome" in side-to-side anastomoses [3, 1]. Wound infection and bile leakage rates were comparable, with low absolute frequencies. The incidence of bile leakage (<5%) aligns with the reported 2–6% leakage rate after open duct exploration procedures. Interestingly, the present data revealed no cases of mortality in either group. This is corroborated by Redwan *et al*., who noted negligible perioperative mortality in CDD series due to improvements in perioperative care and antibiotic prophylaxis [11].

Hospital Course and Recovery

Patients undergoing CDD demonstrated significantly shorter hospital stays (mean 7.05 ± 1.78 days) compared with those receiving OCL (13.2 ± 2.11 days). This reduction is consistent with findings by Sharma *et al*., who observed that CDD patients were discharged nearly twice as early as OCL counterparts [15]. The earlier removal of abdominal drains and earlier resumption of oral intake reflect the physiological advantage of internal drainage and avoidance of external T-tubes. Prolonged T-tube use in OCL patients has been associated with bile loss, dehydration, and delayed biliary tract epithelialization, factors contributing to extended hospitalization.

Correlative Biochemical Findings

Correlation analysis in this investigation revealed a strong positive relationship between ALP and hospital stay ($r = 0.67$, $p < 0.05$) and between CRP and wound infection ($r = 0.72$, $p < 0.05$). These associations underscore the predictive role of early postoperative biochemical normalization for clinical recovery, corroborating findings by Walker *et al*., who demonstrated a similar biochemical-clinical relationship in laparoscopic bile duct surgery [16].

Comparative Evaluation with Literature

The superiority of CDD over OCL in reducing postoperative morbidity is consistently reflected across international studies. A multicentric meta-analysis by Futagawa *et al*., revealed that CDD achieved significantly lower rates of recurrent cholangitis and bile leakage than open duct closure ($p < 0.05$) [6]. Similarly, Li *et al*., documented that CDD yields better long-term ductal patency and fewer secondary interventions [1]. Conversely, some studies caution against overuse of CDD due to potential late complications, including reflux cholangitis and sump syndrome. However, in appropriately selected cases—specifically those with dilated ducts (>1.5 cm)—these complications remain exceedingly rare. Urbach *et al*., and Mehendale *et al*., further confirmed that in resource-limited settings where endoscopic retrograde cholangiopancreatography (ERCP) is unavailable, CDD represents the most cost-effective and durable surgical alternative for complex CBD stones [17, 18].

Physiological Interpretation

The superior performance of CDD can be explained by its maintenance of physiological bile flow into the duodenum, eliminating high-pressure zones that promote bile stasis. This uninterrupted drainage enhances clearance of bilirubin and bile salts, prevents bacterial colonization, and minimizes intraductal inflammation. In contrast, OCL with T-tube drainage relies on external decompression, which disrupts the enterohepatic circulation, delays bile reabsorption, and prolongs convalescence [19]. Furthermore, continuous bile flow in CDD has been shown to accelerate mucosal healing at the anastomotic site and reduce postoperative cholangitis, particularly when the ductal diameter exceeds 15 mm [20].

Future Research Directions

Future research should focus on long-term outcomes of CDD versus OCL, particularly with respect to biliary-enteric reflux, stone recurrence, and nutritional absorption profiles. Comparative studies incorporating laparoscopic and robotic-assisted CDD may clarify the optimal surgical approach for complex CBD stones. Additionally, integration of intraoperative cholangioscopy and high-definition ultrasonography could further enhance ductal clearance rates. Multicentric randomized trials evaluating cost-effectiveness, patient-reported quality-of-life metrics, and biochemical kinetics of bile reintegration post-anastomosis would refine evidence-based guidelines for CDD utilization.

CONCLUSION

This investigation highlights that choledochoduodenostomy provides superior early postoperative outcomes compared with open choledocholithotomy in patients with multiple common bile duct stones. The procedure demonstrates faster normalization of hepatic enzymes, reduced inflammatory response, and significantly shorter hospital stay, with comparable complication rates and no mortality. These findings reinforce the physiological advantage of internal biliary drainage over external decompression. Choledochoduodenostomy should be considered a preferred surgical option in complex choledocholithiasis, particularly in centers with limited endoscopic resources. Future research should evaluate long-term outcomes, including biliary-enteric reflux, anastomotic patency, and recurrence rates, to further refine the surgical decision matrix for multiple CBD stone management.

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