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Evaluation of the Effectiveness of Endoscopic, Laparoscopic, and Surgical Treatments in Common Bile Duct Stones; A Single Center Experience

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Abstract

Background: Choledocholithiasis, commonly known as common bile duct stones (CBD), can lead to disorders such as obstructive jaundice, cholangitis, and acute biliary pancreatitis, and requires endoscopic or surgical intervention, whether laparoscopic or open, for the effective removal of stones from the CBD. Timely treatment is essential to prevent complications and improve patient outcomes, making it critical to employ appropriate diagnostic tools and therapeutic strategies in managing this condition. The aim of this study is to report on our experience in the management of choledocholithiasis by evaluating the effectiveness of various diagnostic and therapeutic approaches employed at our center.

Methods: This study is a retrospective analysis of prospectively collected data from all patients treated with diagnoses with choledocholithiasis at the Department of General Surgery, Clinic III, at the University Hospital Center “Mother Teresa” from January 1, 2024 to December 31, 2024, the investigation encompasses

a comprehensive cohort of 448 patients who underwent a total of 535 interventional procedures for biliary stone disease.

Results: There were 448 patients diagnosed with choledocholithiasis, who underwent a total of 535 interventional procedures. Endoscopic retrograde cholangiopancreatography (ERCP) was the primary method, utilized in 509 instances (95.1%). Among these, 61 patients had papillotomy alone, while 243 cases involved papillotomy combined with stone extraction. Biliary lavage was performed in 15 patients, and stent placement was necessary for 84. Despite a high success rate, 67 ERCP procedures were unsuccessful, resulting in a failure rate of approximately 13%. This necessitated further ERCP attempts or surgical treatment. The laparoscopic cohort included eight procedures, primarily choledochotomies, with five patients having had prior unsuccessful ERCP. Open surgical interventions occurred in 18 patients, representing only 3% of total cases, highlighting the effectiveness of minimally invasive techniques in managing choledocholithiasis.



Conclusion: Effective management of choledocholithiasis requires patient centered, multidisciplinary approach, with treatment strategies tailored to the patient's clinical status, available resources, and institutional expertise.

Keywords: Choledocholithiasis, ERCP, laparoscopic intervention, open surgical intervention

Introduction

Choledocholithiasis, commonly known as common bile duct stones (CBD), can lead to disorders such as obstructive jaundice, cholangitis, and acute biliary pancreatitis, and requires endoscopic or surgical intervention, whether laparoscopic or open, for the effective removal of stones from the CBD. Timely treatment is essential to prevent complications and improve patient outcomes, making it critical to employ appropriate diagnostic tools and therapeutic strategies in managing this condition. The aim of this study is to report on our experience in the management of choledocholithiasis (common bile duct stones) by evaluating the effectiveness of various diagnostic and therapeutic approaches employed at our center. Choledocholithiasis continues to be a prevalent and clinically significant issue within hepato-biliary surgery and may be present clinically from asymptomatic to major cholangitis and predictors of CBD may vary but increased liver function test (LFT) are most common in patients with symptomatic gallbladder disease and elevated liver function tests (LFTs). This study¹ examined 354 patients who underwent cholecystectomy and revealed that 32% had confirmed choledocholithiasis, with biliary colic showing the highest prevalence at 47%. γ -Glutamyl transferase and direct bilirubin were identified as the most sensitive markers for CBD stones; however, their reliability was compromised by high false-positive and false-negative rates, especially in acute cholecystitis patients, where LFTs had a predictive value of less than 40%. Overall, despite higher sensitivities, LFTs were found to be insufficient for reliable prediction of CBD stones. Others on the other hand another study² found that increased LFT values on initial admission and the changes in LFT values over time are more reliable predictors of CBD stones in patients with AC and CBD stones. In this study, 854 patients presenting to the emergency room with gallbladder-related symptoms were analyzed, categorized into three groups: 556 patients with

acute cholecystitis (AC) without common bile duct (CBD) stones, 98 patients with AC and CBD stones, and 200 patients with cholecystitis without CBD stones. The analysis compared liver function test (LFT) values at admission and their changes over time. Results indicated that LFT values were significantly higher in the AC + CBD group than in the AC - CBD group, with γ -glutamyl transpeptidase emerging as the most reliable predictor of CBD stones, showing a sensitivity of 80.6% and a specificity of 75.3% at a cutoff of 224 IU/L. Furthermore, while LFT values decreased significantly in the AC - CBD group before cholecystectomy, they remained unchanged in the AC + CBD group prior to stone removal. The condition typically arises from two main processes: secondary choledocholithiasis, where gallstones migrate from the gallbladder into the CBD, and primary stone formation within the biliary ducts driven by bile stasis, infections, or anatomical abnormalities. Incidence rates tend to increase with advancing age and are especially common among individuals with prior gallstone histories.

In recent decades, significant advancements have been made in both the diagnostic and therapeutic approaches to managing choledocholithiasis. Imaging modalities such as abdominal ultrasound, magnetic resonance cholangiopancreatography (MRCP), and endoscopic ultrasound have greatly enhanced the accuracy of preoperative diagnosis.

In recent decades, significant advancements have been made in both the diagnostic and therapeutic approaches to managing choledocholithiasis. Imaging modalities such as abdominal ultrasound, magnetic resonance cholangiopancreatography (MRCP), and endoscopic ultrasound have greatly enhanced the accuracy of preoperative diagnosis. While MRCP is highly prevalent in most centers, and it may reduce the need for and unnecessary ERCP³. In a study of 707 patients with suspected CBD sludge or stones, with a predominantly female cohort and a median age of 59 years, 22% of ERCP procedures yielded negative results for CBD pathology. Those with positive ERCPs were more likely to have undergone pre-procedural imaging via endoscopic ultrasonography (EUS) or magnetic resonance cholangiopancreatography (MRCP)—44% versus 35%, respectively ($P = 0.045$). Moreover, the likelihood of detecting sludge and stones during ERCP increased significantly when the interval between EUS/MRCP and ERCP was under 2 days, with an odds ratio of 2.35 (95% CI 1.25-4.44; $P = 0.008$; number

needed to harm 7.7). Thus, while one in five ERCPs for suspected CBD stones may be unnecessary, conducting pre-procedural EUS or MRCP can reduce this proportion, and scheduling these imaging techniques within 2 days of the ERCP enhances diagnostic yield.

This study investigated the diagnostic performance of magnetic resonance cholangiopancreatography (MRCP) in patients with acute cholecystitis suspected of having choledocholithiasis, compared to intraoperative cholangiography, endoscopic retrograde cholangiopancreatography (ERCP), or choledochoscopy. Conducted at Central Finland Hospital Nova from January to December 2019, the prospective feasibility study included 180 patients who underwent index admission cholecystectomy for acute cholecystitis. Out of these, MRCP was performed on 113 patients, revealing a 29.2% incidence of choledocholithiasis.

Other study showed that MRCP had a sensitivity of 76.2% to 85.7% and a specificity of 84.3% to 92.2%, which aligns well with existing literature on unselected patient⁴. The best visibility of the biliary tree, particularly for detecting stones, was found in the common hepatic duct, inferior common bile duct, and central hepatic duct. The study also noted excellent interobserver reliability among three experienced radiologists for assessing the size and quantity of CBD stones. The conclusion highlights that MRCP presents a high negative predictive value for detecting choledocholithiasis in acute cholecystitis, thereby serving as an effective preoperative imaging modality for evaluating potential CBD stones. CBD frequently results in obstructive jaundice, cholangitis, and biliary pancreatitis. While some cases present without symptoms and are identified incidentally, others can lead to acute, severe complications that necessitate urgent treatment⁵. The study investigated the incidence of common bile duct stones (CBDS) in patients with acute cholecystitis (AC) and highlighted the importance of biliary imaging. A systematic review of literature included 19 studies with 4,057 AC patients, finding a pooled CBDS incidence of 13.7%. Interestingly, 1.1% of patients had unsuspected retained CBDS. The research noted that the mean common bile duct diameter was larger in patients with both AC and CBDS (7.2 mm) compared to those without (5.8 mm). Liver function tests were more frequently abnormal in those with CBDS, with gamma-glutamyltransferase being the most reliable marker. The conclusion emphasizes the significant prevalence of CBDS in AC and suggests the need for routine biliary imaging in such cases.

The management of common bile duct stones (CBDS) has undergone major transformation over the last few decades and today is determined by the presence of cholangitis. In cases without cholangitis, endoscopic retrograde cholangiopancreatography (ERCP) is the first-line treatment for both diagnosis and stone retrieval, followed by laparoscopic cholecystectomy to prevent recurrence. Conversely, in the presence of cholangitis, immediate intervention is critical. This includes intravenous fluid resuscitation, broad-spectrum antibiotics, and urgent ERCP for biliary drainage and stone removal. After clinical stabilization and normalization of pancreatic enzymes, laparoscopic cholecystectomy should be performed at the same hospitalization. Prompt recognition and tailored management are essential to optimize outcomes and reduce complications associated with CBDS and cholangitis.

Endoscopic retrograde cholangiopancreatography (ERCP) was first developed in 1968 as a diagnostic method, where patients would receive a dye injection and, if necessary, be referred to an interventional radiologist or surgeon for further treatment⁶. In this historical treatise the history of ERCP was described. The first successful ERCP was performed by Dr. William S. McCune, an obstetrician, who utilized a fiber duodenoscope equipped with an external accessory channel and a balloon for cannulation. In 1972, Dr. Peter Cotton documented successful cannulation in 60 patients⁷. Since those early developments, ERCP has transformed from a purely diagnostic procedure into a valuable therapeutic tool. While the ERCP has emerged as the primary therapeutic modality (performed either by gastroenterologist or surgeons) due to its minimally invasive nature and high efficacy in stone extraction. When to do an ERCP has been debated, that is should it be done before after cholecystectomy. Most experts agree that it should be done before cholecystectomy, however, others do ERCP post cholecystectomy, after intraoperative cholangiogram in case stones are identified and cannot be removed intraoperatively, or post cholecystectomy bile leaks. Recent study⁸ that reviewed 16 studies involving 8,644 participants for length of stay (LOS) and 41 studies with 19,756 participants for postprocedural complications found that one-stage approaches, particularly laparoscopic common bile duct (CBD) exploration and intraoperative ERCP, led to a reduced LOS compared to two-stage approaches. Laparoscopic CBD exploration also displayed a lower overall complication rate than preoperative ERCP,

although no significant differences were found in complication risks across other comparisons. Notably, specific postprocedural complications varied among the four different methods for managing CBD stones. This study indicates that both laparoscopic CBD exploration and intraoperative ERCP yield favorable outcomes and offer a single-anesthesia pathway that shortens hospital stay compared to two-stage methods. Similarly, another study⁹ demonstrated that LC-IntraERCP and LC-LCB-DE comparable efficacies regarding surgical success rates, overall postoperative complications, conversion to laparotomy, and operative time. However, LC-IntraERCP may be more effective in reducing the incidence of retained stones.

Given the variety of available treatment options and the diversity of clinical scenarios, selecting the optimal treatment strategy requires a personalized approach that balances efficacy, invasiveness, risk of complications, and resource availability. For the past two decades, the Department of General Surgery at the University Hospital Center “Mother Teresa” in Tirana, Albania, has utilized endoscopic retrograde cholangiopancreatography (ERCP) as the primary technique for the removal of common bile duct (CBD) stones. (This approach allows for effective management of CBD stones, often serving as an initial intervention before proceeding with laparoscopic cholecystectomy. By employing ERCP in conjunction with laparoscopic techniques, the department has aimed to optimize patient outcomes and promote efficient surgical practices in the treatment of biliary disorders.

Materials and Methods

This investigation was designed as a retrospective descriptive and analytical study conducted at the Department of General Surgery, Clinic III, at the University Hospital Center “Mother Teresa.” The study included data from patients treated for choledocholithiasis between January 1 and December 31, 2024. The final analysis encompassed a cohort of 448 patients who underwent a total of 535 interventional procedures aimed at treating biliary stone disease, with 67 individuals returning for multiple procedures (2–3 times).

The procedures performed were categorized into three main types: the majority being ERCP, with 509 interventional procedures carried out. A total of 61 patients underwent papillotomy alone, while 243 patients had papillotomy followed by stone extraction. In some cases, stent placement was necessary for 84 patients. Additionally, 15

patients received treatment with biliary lavage only. Despite the high success rate associated with ERCP, 67 procedures were identified as unsuccessful, prompting subsequent management strategies for these patients which included either scheduling a second ERCP or referring them for laparoscopic or open surgical intervention.

Laparoscopic surgery was performed in eight patients, representing approximately 1.35% of the total cases. Within this group, six underwent choledochotomy and two had choledocho-duodenal anastomoses, with five of the patients having previously undergone unsuccessful ERCP. Open surgical intervention was conducted in 18 cases, which accounted for about 3.04% of the total interventions. Among these, 13 patients underwent choledochotomy, and five had choledocho-duodenal anastomoses. Notably, three of these cases followed failed ERCP attempts, one followed a failed laparoscopic procedure, while twelve were planned interventions, and six were performed in emergent situations.

Results

The data revealed that most of the procedures, specifically 509 interventions (95.1%), were performed using ERCP, thus establishing it as the most frequently employed and preferred method for managing common bile duct stones. Among these ERCP procedures, 61 patients underwent papillotomy alone without further interventions. In 243 patients, papillotomy was combined with stone or biliary sludge extraction, illustrating the high success rate of ERCP in alleviating biliary obstruction. Biliary lavage was performed on 15 patients, and stent placement was required in 84 cases to ensure adequate drainage of the bile duct. Furthermore, 17 patients returned for stent removal, demonstrating a staged treatment approach, particularly in cases involving significant obstruction or large stones.

Despite ERCP being the primary intervention of choice, it was unsuccessful in 67 procedures, equating to a failure rate of approximately 13%. This finding is consistent with international literature, which reports failure rates ranging from 5% to 15%. The management of these patients typically involved further attempts at ERCP or referrals for laparoscopic or open surgical interventions for cases deemed more complex.

In the laparoscopic cohort, eight surgical procedures were successfully executed, with six involving choledochotomies and two involving choledocho-duodenal anastomoses. Notably, five patients in this group had previ-

ously undergone an unsuccessful ERCP, highlighting the sequential approach often needed in the management of choledocholithiasis. Open surgical procedures were performed in 18 patients, including one case that followed a failed laparoscopic attempt, which included 13 choledochotomies and five choledocho-duodenal anastomoses. The low rate of open surgery, at just 3% of cases, underscores the effectiveness and preference for minimally invasive techniques such as ERCP and laparoscopy.

ERCP Failure

The failure of ERCP in the management of choledocholithiasis occurred in 67 interventional procedures, which corresponds to a failure rate of approximately 13%, aligning with findings in the existing literature. The principal causes of ERCP failure include difficulty in cannulating the papilla of Vater due to anatomical variations, large or multiple bile duct stones that exceed the capabilities of standard extraction tools, and the presence of benign or malignant strictures in the distal CBD that prevent access to the biliary system. Additionally, patients with altered surgical anatomy, such as those with a history of gastrectomy, encounter significant technical challenges during ERCP procedures.

Intra-procedural complications, including bleeding, perforation, or acute pancreatitis, may also necessitate termination of the ERCP attempt. Moreover, some patients' general condition may not permit successful sedation or procedural tolerability, particularly among those with severe comorbidities, which poses an additional hurdle in managing cases of choledocholithiasis.

Challenges in the Laparoscopic Approach

Failure in the laparoscopic management of choledocholithiasis occurred in approximately 12% of cases analyzed, primarily attributed to several factors. A significant cause of failure was the inability to extract stones, particularly when faced with large or numerous stones located in challenging positions. Cases with unclear or altered anatomy due to previous surgical interventions further complicated laparoscopic attempts, as did technical difficulties in exploring and manipulating the CBD. Intraoperative complications such as bleeding or injury to adjacent structures could necessitate conversion to open surgical techniques.

In the rare occurrence of stones migrating into the intrahepatic ducts, laparoscopic choledochotomy may also become ineffective. These challenges illustrate the

necessity for careful case selection and individualized treatment plans for patients suffering from choledocholithiasis.

Clinical Observations and Outcomes

The analysis indicates that ERCP significantly improved biliary drainage and led to symptom relief in 90% of patients, with most reporting substantial reductions in pain and jaundice. For patients unable to undergo definitive surgical treatments due to the size of stones or the presence of significant comorbidities, ERCP with biliary stenting emerged as a safe and effective management strategy that mitigates the risk of acute complications.

With 67 unsuccessful ERCP procedures, many patients required follow-up treatments, such as additional ERCP attempts or surgical interventions, emphasizing the need for continuous monitoring and evaluation in certain cases. Compared to other methods, the non-invasive nature of ERCP facilitates a reduction in the necessity for open surgical intervention, thus minimizing the associated risks. Additionally, both ERCP and laparoscopic choledochotomy were associated with shorter hospital stays when compared to open surgical procedures, resulting in lower hospitalization costs and a reduced risk of postoperative complications.

Discussion

The data presented herein clearly demonstrate that ERCP is the prevailing and most effective method for treating choledocholithiasis. Its high success rate in stone extraction and biliary drainage, coupled with its minimally invasive nature, makes it the preferred approach for managing this condition. Nonetheless, the study identified 67 cases of ERCP failure, highlighting that while ERCP is typically the first-line treatment, there is still a considerable need for alternative strategies, whether through repeat procedures or surgical interventions such as open common bile duct exploration or laparoscopic cholecystectomy combined with laparoscopic common bile duct exploration (LC + LCBDE)¹⁰. Alternatively, treatment can be performed in two stages using endoscopic retrograde cholangiopancreatography (ERCP) before or after cholecystectomy, typically accompanied by procedures such as sphincterotomy (the most common approach) or sphincteroplasty (papillary dilation) to clear the common bile duct. The advantages and disadvantages of these various methods remain unclear.

The European Society of Gastrointestinal Endoscopy (ESGE)¹¹ recommends stone extraction for all patients with common bile duct stones, regardless of symptoms, if they are fit for the procedure. Initial diagnostic steps should include liver function tests and abdominal ultrasonography, with further imaging like endoscopic ultrasonography or magnetic resonance cholangiopancreatography advised when suspicion remains despite these tests. Timely biliary drainage is crucial in cases of acute cholangitis, with specific timelines based on severity: as soon as possible for severe cases, within 48-72 hours for moderate cases, and electively for mild cases¹². The placement of temporary biliary stents is recommended for stones that cannot be retrieved, and a combination of sphincterotomy and balloon dilation should be the first-line approach for difficult stone extractions. Additionally, performing laparoscopic cholecystectomy within two weeks following endoscopic retrograde cholangiopancreatography (ERCP) is advised to reduce the risk of recurrent biliary events. We do not agree with this recommendation, and most patients undergo laparoscopic/robotic cholecystectomy within the same hospitalization, once the pancreatic enzymes are normalized¹³.

The efficacy of various forms of bile duct stone clearance has been studied. The Cochrane review¹⁴ evaluated sixteen randomized clinical trials involving a total of 1,758 participants to compare the efficacy of open surgery versus endoscopic clearance, as well as laparoscopic surgery versus endoscopic methods for managing common bile duct stones. The analysis included various participant groupings, with eight trials focusing on open surgical clearance compared to endoscopic retrograde cholangiopancreatography (ERCP), five trials examining laparoscopic clearance against pre-operative ERCP, and additional studies comparing laparoscopic approaches with post-operative ERCP.

The review found no significant differences in mortality or morbidity between the different treatment modalities; however, open surgery was associated with fewer retained stones compared to ERCP. Furthermore, it indicated that laparoscopic bile duct clearance did not demonstrate significant advantages over endoscopic options, and there were no notable distinctions in morbidity, mortality, or stone retention rates between single-stage laparoscopic clearance and two-stage endoscopic management. The authors concluded that more rigorous randomized clinical trials are necessary to confirm these findings and reduce potential biases in the existing

literature. In our study, laparoscopic approaches, although less frequently employed than ERCP, provide an effective alternative with reduced invasiveness compared to open surgery. Furthermore, laparoscopic common bile duct exploration (LCBDE) has been reported safe even in elderly¹⁵. In this study 376 patients from January 2012 to November 2015, dividing them into two groups based on age: those younger than 70 years ($n = 253$) and those 70 years or older ($n = 123$). The researchers analyzed various factors, including demographics, clinical characteristics, laboratory data, operative parameters, and outcomes. The results indicated that elderly patients had a higher prevalence of chronic diseases and risk factors, such as hypertension and heart conditions ($P < 0.05$). However, the success rate of LCBDE was similarly high in both groups, with 100% in elderly patients compared to 98.8% in younger patients ($P = 0.554$). Additionally, factors such as operating time, intraoperative blood loss, postoperative hospital stay, total costs, and overall complications showed no significant differences between the two age groups ($P > 0.05$). Importantly, there were no major bile duct injuries or deaths reported in either group. The conclusion drawn is that despite the higher prevalence of coexisting disorders in elderly patients, LCBDE is a safe and effective procedure for treating choledocholithiasis in this population.

Moreover, LCBDE is safe in patients with cirrhosis when compared with open CBDE¹⁶. This study evaluated the safety and benefits of laparoscopic common bile duct exploration (LCBDE) compared to open common bile duct exploration (OCBDE) in cirrhotic patients with choledocholithiasis. A total of 113 cirrhotic patients underwent CBD explorations from January 2009 to December 2012, and they were divided into two groups: LCBDE ($n = 61$) and OCBDE ($n = 52$). The researchers retrospectively analyzed demographic characteristics, surgical data, postoperative outcomes, and long-term results. Both groups showed no significant differences in demographic or preoperative status, surgical time, stone clearance rates, short-term complication rates, or recurrent stone rates.

However, the LCBDE group experienced significantly less blood loss and shorter hospital stays compared to the OCBDE group, with results showing 95 mL versus 200 mL of blood loss and average hospital stays of 4.7 days versus 11.3 days, respectively. Although there were conversions in four LCBDE cases due to severe inflammation and adhesions, there were no reported

mortalities, biliary injuries, or strictures during the follow-up period. The conclusion drawn is that LCBDE is a safe and efficient option for treating choledocholithiasis in patients with Child-Pugh A or B cirrhosis, offering advantages in terms of reduced bleeding and shorter hospitalization compared to the open approach. The findings emphasize that open surgical intervention should remain an option for the most complex cases, including those with substantial stone burdens, challenging anatomy, or emergency situations where other approaches have been unsuccessful.

The advantages of ERCP are pronounced, including its minimally invasive nature that allows for short recovery times, often enabling patients to be discharged within 24 hours following the procedure. ERCP also presents simultaneous diagnostic and therapeutic capabilities, contributing to its robustness as a first-line treatment choice. Moreover, it is generally well tolerated by elderly patients and those with significant comorbidities, further enhancing its appeal in clinical practice.

Strengths and weaknesses

The strengths of this study include its comprehensive review of current literature and clinical practices regarding choledocholithiasis, which provides valuable insights into various diagnostic and therapeutic modalities. Additionally, the study benefits from a substantial sample size, drawing from 448 patients and 535 interventional procedures, increasing the reliability and generalizability of the findings. Furthermore, the evaluation of various treatment strategies offers important information on their efficacy and appropriate contexts for use.

However, the study also has noteworthy weaknesses. Its retrospective, although data were collected prospectively in medical records, design may introduce biases, such as selection or recall bias, potentially affecting the strength of the conclusions. The limited data on surgical interventions, with only a small percentage of patients undergoing laparoscopic (1.35%) or open surgical (3.04%) techniques, could restrict the generalizability of findings related to surgical outcomes. Additionally, being a single-center study may limit the diversity of the patient population and institutional practices, impacting the applicability of the results to broader healthcare settings. There may also be unaccounted confounding variables, such as differences in surgeon experience or patient comorbidities, which could influence treatment outcomes. Lastly, if the follow-up period was not extensive, it may

not adequately capture long-term outcomes or recurrence rates, further limiting the comprehensiveness of the study's findings.

In conclusion, this study on choledocholithiasis underscores the importance of a tailored, multidisciplinary approach to the management of common bile duct stones, highlighting the varied clinical presentations and the necessity for prompt diagnosis and treatment. The findings illustrate that while endoscopic retrograde cholangiopancreatography (ERCP) remains the preferred non-invasive intervention for managing bile duct stones, surgical options are crucial for more complex cases or when endoscopic efforts fail and should not be forgotten.

Ultimately, the successful management of choledocholithiasis is contingent upon a collaborative and personalized approach that aligns treatment strategies with the specific clinical context, thereby enhancing both patient safety and healthcare resource utilization.

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