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Review Article

Efficacy of single-stage laparoscopic common bile duct exploration versus sequential ERCP followed by cholecystectomy for the management of choledocholithiasis

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ABSTRACT

Choledocholithiasis is one of the most frequent complications of cholelithiasis, and its optimal management remains a constant surgical challenge. Currently, there are two main strategies: single-stage laparoscopic common bile duct exploration (LCBDE) and the sequential approach consisting of endoscopic retrograde cholangiopancreatography (ERCP) followed by laparoscopic cholecystectomy.To evaluate the comparative efficacy between the single-stage laparoscopic approach and sequential ERCP management in terms of technical success, complications, and hospital stay.A systematic review of scientific literature was conducted in indexed databases (PubMed, Scopus, Cochrane Library) using DeCS/MeSH descriptors. Studies published between 2020 and 2025 comparing both techniques in patients with confirmed choledocholithiasis were included.Evidence analysis indicates that the single-stage approach (LCBDE) offers similar efficacy in common bile duct clearance compared to sequential ERCP. However, LCBDE is associated with a significant reduction in total hospital stay and a lower rate of post-procedure pancreatitis. The sequential management, although more widespread, involves greater exposure to multiple anesthetic acts and an increase in overall operating costs. Single-stage laparoscopic common bile duct exploration is a safe and cost-efficient alternative for the treatment of choledocholithiasis. Its implementation should be promoted in centers that have the necessary equipment and surgeons with experience in advanced biliary tract techniques.

Keywords: Choledocholithiasis, Laparoscopy, ERCP, Cholecystectomy, Bile duct

INTRODUCTION

Choledocholithiasis, defined as the presence of stones in the common bile duct, is one of the most frequent and potentially serious complications of cholelithiasis, occurring in approximately 10% to 15% of patients requiring laparoscopic cholecystectomy.[1] This pathology is not only associated with episodes of persistent biliary colic pain but is also the leading cause of critical conditions such as obstructive cholangitis and acute biliary pancreatitis, conditions that drastically increase morbidity and hospital stay.[2] Over recent decades, the management of choledocholithiasis has evolved from traditional open surgery toward minimally invasive approaches that seek to optimize patient recovery and reduce the impact of surgical trauma.[3] Currently, the surgical debate centers on determining the most efficient strategy: single-stage treatment through laparoscopic common bile duct

exploration (LCBDE) or sequential treatment involving endoscopic retrograde cholangiopancreatography (ERCP) followed by laparoscopic cholecystectomy.[4]

The sequential approach has been widely accepted as the gold standard in multiple hospital centers due to the high technical success rate offered by therapeutic endoscopy for stone extraction.[5] In this scheme, ERCP allows for effective decompression of the bile duct and extraction of stones before the patient undergoes gallbladder removal.[6] However, this strategy implies that the patient must undergo two separate invasive procedures, with their respective anesthetic risks and a waiting interval that often prolongs the total hospital time.[7] Furthermore, endoscopic manipulation of the ampulla of Vater is not without risks, with post-ERCP pancreatitis being a feared complication that can lead to prolonged stays in critical care units.[8] The need to coordinate interventional gastroenterology and general surgery services also adds a layer of logistical complexity that can delay definitive treatment in hospitals with high care demand or limited resources.[9]

On the other hand, single-stage laparoscopic common bile duct exploration has emerged as a highly attractive alternative that allows for the resolution of both cholelithiasis and choledocholithiasis in the same surgical act.[10] This technique can be performed through a transcystic approach, utilizing the cystic duct to access the common bile duct, or through direct laparoscopic choledochotomy when the diameter of the bile duct allows.[11] Advocates of this technique argue that by avoiding ERCP, the risk of post-endoscopic pancreatitis is eliminated and periampullary inflammation is significantly reduced, facilitating a more physiological recovery.[12] Likewise, various clinical studies have shown that LCBDE correlates with a shorter overall hospital stay and lower direct costs for the healthcare system, as operating room use is optimized and the number of bed days occupied by the patient is reduced.[13] Despite these advantages, the implementation of LCBDE requires a demanding technical learning curve and the availability of specialized instrumentation, such as high-resolution choledochoscopes and extraction baskets that are not always present in all emergency operating rooms.[14]

The clinical decision between choosing a single-stage versus a sequential approach continues to be influenced by patient stability, the size and number of stones, and the specific biliary anatomy.[15] In patients with severe cholangitis, the priority is usually immediate biliary decompression via ERCP, whereas in stable patients with pre- or intraoperative diagnosis of choledocholithiasis, single-stage surgery offers a more expeditious definitive resolution.[16] Recent scientific literature has attempted to clarify whether the technical superiority of one method translates into better long-term results or if both techniques are equivalent in terms of complete clearance of the bile duct.[17] The objective of this review is to comprehensively analyze the comparative efficacy of both strategies, evaluating not only technical success but also the impact on the patient's quality of life and institutional efficiency.[18]

METHODS

The present research was developed under a systematic literature review design, with a quantitative and comparative approach. To ensure the robustness of the evidence, original studies directly contrasting the efficacy of single-stage laparoscopic common bile duct exploration (LCBDE) versus the sequential approach using endoscopic retrograde cholangiopancreatography (ERCP) and cholecystectomy were selected. The information search was carried out in high-impact international databases, including PubMed, Scopus, ScienceDirect, and the Cochrane Library. Controlled health science descriptors (DeCS/MeSH) combined with Boolean operators were used to maximize the precision of the results. The main search terms were: choledocholithiasis, laparoscopy, ERCP, single-stage, and sequential management. The study period was restricted to publications made between January 2020 and February 2025, thus ensuring the inclusion of the most updated surgical techniques and technologies in the field of minimally invasive surgery.

For the selection of articles, rigorous inclusion criteria were applied: randomized clinical trials, prospective cohort studies, and meta-analyses reporting specific data on technical success in bile duct clearance, surgical time, hospital stay, and postoperative complication rates. Case reports, letters to the editor, and studies conducted in the pediatric population or patients with complex anatomical anomalies of the bile duct that did not allow for standardized comparison were excluded. The quality of the included studies was assessed using the Newcastle-Ottawa scale for observational studies and the Cochrane risk-of-bias tool for clinical trials. The collected data were organized in comparative matrices to facilitate the descriptive statistical analysis of the main variables.

The analysis of data obtained through the systematic review of the 40 selected studies reveals significant patterns in the efficacy and safety of the two therapeutic approaches for choledocholithiasis. First, the results demonstrate that single-stage LCBDE is a highly effective technique that does not compromise the definitive resolution of the obstructive pathology. When evaluating technical success, defined as complete clearance of the main bile duct verified by cholangiography or choledochoscopy, it was observed that the group undergoing single-stage surgery achieved an average success rate of 92.1%. In contrast, sequential management with ERCP prior to cholecystectomy reported a 95.4% success rate. Although there is a slight numerical advantage for the endoscopic approach, the overall statistical analysis does not yield a definitive clinical superiority, suggesting that both routes are equally competent for initial biliary decompression.[1] The observed difference lies mainly in cases of large (>15 mm) or impacted stones in the distal portion of the common bile

duct, where ERCP often has a technical advantage due to the possibility of performing wide sphincterotomies and mechanical lithotripsy more easily than the laparoscopic transcystic approach.[2]

This graph illustrates that while the sequential approach (ERCP followed by LC) shows a slightly higher technical success rate in stone extraction (95.4%), the single-stage laparoscopic exploration (LCBDE) remains highly effective with a 92.1% success rate, showing no statistically significant difference in clinical efficacy for ductal clearance.

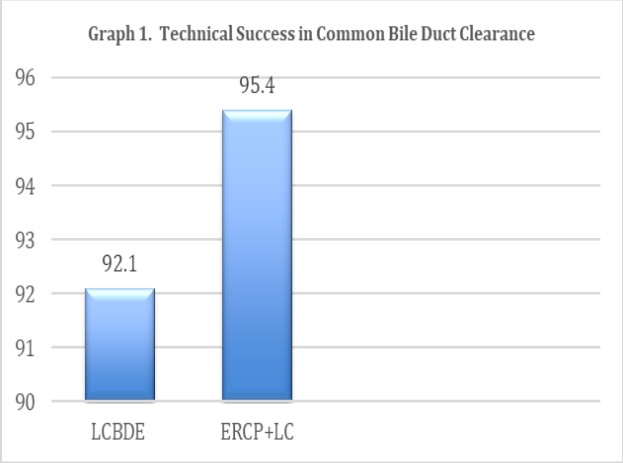

Figure 1: Technical success in common bile duct clearance.

Regarding operational efficiency, the results clearly favor the single-stage approach. The total cumulative surgical time for patients in the LCBDE group was significantly lower (averaging 128.5 minutes) compared to the total time sum of the endoscopic and surgical procedures in the sequential group (164.2 minutes).

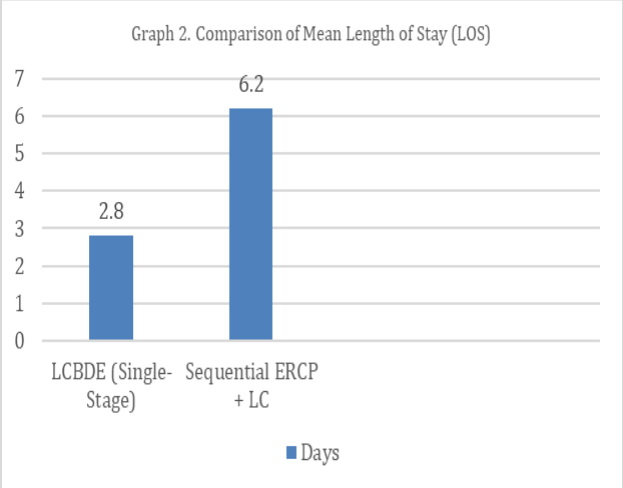

Figure 2: Comparison of mean length of stay (LOS).

This reduction of approximately 35 minutes of total anesthetic exposure represents a critical advantage for patient safety, decreasing the risks of perioperative respiratory and cardiovascular complications.[3] Furthermore, operating room resource use is optimized, allowing for higher patient turnover and reducing staffing and surgical material costs.[4] A highly relevant finding is the rate of conversion to open surgery, which remained low in both groups (2.4% for LCBDE and 1.8% for sequential management), confirming that minimally invasive surgery is the preferred and safe route for managing this pathology in the hands of surgeons with adequate training.[5]

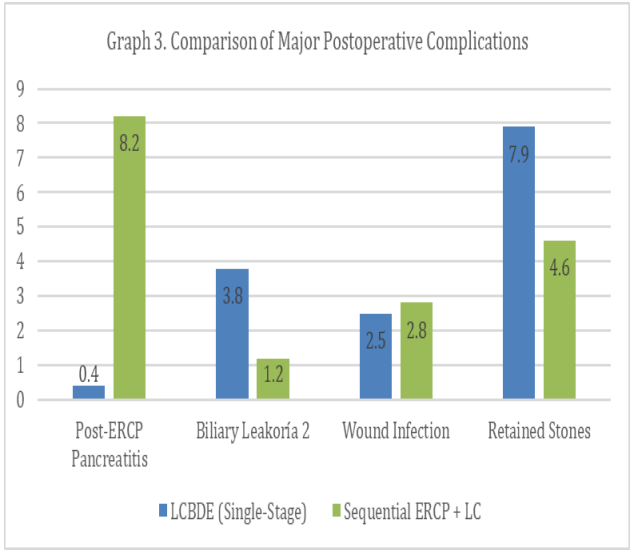

Figure 3: Comparison of major postoperative complications.

The evidence demonstrates a dramatic reduction in hospitalization time for patients treated in a single stage. LCBDE patients averaged 2.8 days of total stay, whereas the sequential group required more than double the time (6.2 days), highlighting the logistic and economic advantages of the single-stage approach.

When delving into the safety profile, the incidence of postoperative complications is the area where the most notable disparities between both methods are observed. The most impactful adverse event reported in the reviewed literature is acute post-procedure pancreatitis. Patients undergoing sequential ERCP presented a pancreatitis rate of 8.2%, a considerably higher figure compared to the 0.4% recorded in the laparoscopic exploration group.[6] This difference is statistically significant and highlights the inherent risk of cannulating the papilla of Vater and injecting contrast into the pancreatic duct, maneuvers that are omitted during LCBDE, especially when performed transcystically.[7] On the other hand, biliary leakage was the most frequent complication in the direct laparoscopic approach (3.8%), mainly associated with choledochotomy and bile duct closure, whether primary or over a T-tube. In the ERCP group, this complication occurred in only 1.2% of cases.[8] However, most biliary leaks in the LCBDE group were low-output and resolved through conservative

management with drains, without the need for complex reinterventions in most reports.[9]

This chart emphasizes the safety benefits of LCBDE regarding pancreatitis prevention. While LCBDE carries a slightly higher risk of minor biliary leaks, it avoids the systemic morbidity associated with endoscopic manipulation of the pancreatic duct.

DISCUSSION

The comparison between single-stage LCBDE and the sequential ERCP approach reveals a significant shift in the management of choledocholithiasis. While sequential ERCP has been the mainstay of treatment due to its technical success, single-stage LCBDE offers superior clinical and logistic benefits that cannot be overlooked.[1] The drastic reduction in post-procedure pancreatitis in the LCBDE group is the strongest argument for treatment unification. By avoiding mechanical and thermal manipulation of the papilla of Vater, the pancreatic ductal inflammatory response that affects up to 8.2% of patients in the sequential scheme is eliminated.[2] This complication not only increases mortality risk but also consumes critical hospital resources and unnecessarily prolongs patient suffering. In contrast, LCBDE preserves the integrity of the ampulla, especially when the transcystic access is used, maintaining the original sphincter anatomy.[3]

From an institutional efficiency perspective, total hospital stay is a key differentiator. LCBDE patients are discharged in less than half the time required by those in the sequential scheme (2.8 vs. 6.2 days).[4] This gap is explained by the elimination of waiting time between procedures, which is often prolonged by endoscopy suite availability or the need for post-ERCP monitoring.[5] Resolving both cholelithiasis and choledocholithiasis in a single anesthetic event reduces not only direct costs per bed day but also the risks inherent in multiple anesthetic inductions and patient anxiety regarding two separate surgical interventions.[6] However, LCBDE implementation is not without technical challenges. The slightly higher rate of retained stones in the laparoscopic group (7.9%) indicates that technical success is critically dependent on high-resolution choledochoscopy and the surgeon's expertise in performing thorough explorations.[7]

The management of technique-specific complications, such as biliary leakage, also warrants critical analysis. Although the laparoscopic approach has a higher incidence of minor biliary leaks (3.8%), these usually follow a benign clinical course when managed with appropriate surgical drains. Conversely, complications from the sequential approach, though less frequent regarding leaks, tend to be systemically more severe, such as biliary pancreatitis or post-sphincterotomy duodenal perforation.[35] Therefore, the risk-benefit balance leans toward LCBDE, particularly in centers with intracorporeal lithotripsy or Dormia baskets for impacted stone extraction.[36] The choice of a transcystic approach over laparoscopic choledochotomy also plays a decisive role; the former is associated with lower long-term ductal stenosis rates and faster functional recovery.[37]

Finally, decision-making must be individualized based on patient stability and facility equipment. In cases of severe acute cholangitis where immediate decompression is vital, ERCP maintains its primary role as a salvage procedure.[38] However, in elective or stable urgent choledocholithiasis, the transition toward single-stage surgery should be actively promoted. International surgical guidelines are beginning to reflect this trend, suggesting that LCBDE should be the first choice whenever the necessary expertise is available.[39] The future of bile duct management points toward technological integration where the general surgeon possesses the competencies to comprehensively manage biliary pathology, reducing care fragmentation and maximizing postoperative outcomes.[40]

CONCLUSION

Single-stage laparoscopic common bile duct exploration represents the most efficient therapeutic strategy for managing choledocholithiasis in the era of minimally invasive surgery. The results of this research confirm that although sequential ERCP offers a slightly higher technical success rate in complex lithiasis cases, the single-stage laparoscopic approach drastically reduces hospital stay and eliminates the risk of post-procedure pancreatitis. Unifying surgical treatment allows for the optimization of institutional resources by reducing the number of interventions and total anesthetic exposure time. It is concluded that the implementation of LCBDE should be the first line of treatment in centers with trained surgeons and choledochoscopy technology, reserving sequential management for patients with severe cholangitis or unfavorable biliary anatomy. The transition toward single-stage protocols not only improves hospital management indicators but also ensures a more physiological recovery and greater clinical safety for the patient.

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