OPEN

Comparison of 1-stage and 2-stage Managements for Common Bile Duct Stones and Gallstones (CBDS)

A Retrospective Study

Jie Zhou, MD, Ye Chen, MD,† Songlin Yu, MD,‡ Hui Wang, MD,‡ Yufeng Wang, MD,‡ and Quanning Chen, MD‡*

Objective: The aim of this study was to evaluate the efficacy, safety, and surgical outcomes of 2-stage management, namely preoperative endoscopic retrograde cholangiopancreatography (ERCP) + laparoscopic cholecystectomy (ERCP+LC) or LC + postoperative ERCP (LC+ERCP), as well as 1-stage management, LC + laparoscopic common bile duct exploration (LCBDE) for treating patients with gallstones and common bile duct stones (CBDS).

Methods: This retrospective study analyzed the data of 180 patients with common bile duct stones (CBDS) who were admitted to the Department of General Surgery at Tongji Hospital, Tongji University, between January 2019 and June 2021. The study included 3 groups: ERCP+LC (group 1), LC+ERCP (group 2), and LC +LCBDE (group 3), each consisting of 60 patients. Clinical metrics of the patients were collected and compared among the groups.

Results: Group 3 had the shortest operation duration and hospital stay compared with group 1 and group 2. In addition, group 3 had the lowest long-term postoperative complications, particularly the recurrence rate of CBDS. The total cost was also the lowest in group 3. Furthermore, patients in group 3 had the lowest postoperative amylase levels. All patients in the study achieved successful stone clearance. There were no significant differences in the conversion to other procedures rate, postoperative alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin, and mortality among the three groups ($P > 0.05$).

Conclusions: Both 1-stage management and 2-stage management are effective treatments for CBDS. The LC+LCBDE management is a safe treatment option, offering shorter hospital stays and operation duration, lower costs, and fewer complications.

Key Words: laparoscopic common bile duct exploration, endoscopic retrograde cholangiopancreatography, laparoscopic cholecystectomy, common bile duct stones

Received for publication November 30, 2023; accepted March 17, 2024.

From the *Department of Hematology, Tongji Hospital of Tongji University, Tongji University School of Medicine; †Department of Gastroenterology, Tongji Hospital of Tongji University, Tongji University School of Medicine; and ‡Department of General Surgery, Tongji Hospital of Tongji University, Tongji University School of Medicine, Shanghai, China.

J.Z. and Y.C. contributed equally to this work.

The authors declare that they have nothing to disclose.

Address correspondence to: Quanning Chen, MD, Department of General Surgery, Tongji Hospital of Tongji University, Tongji University School of Medicine, No. 389, Xincun Road, Putuo District, Shanghai, China (e-mail: qnchen@tongji.edu.cn), and Yufeng Wang, MD, (e-mail: wangyufeng730@gmail.com)

DOI: 10.1097/MCG.0000000000002009

(*J Clin Gastroenterol* 2025;59:269–275)

Gallstones are a prevalent cause of abdominal pain, affecting ~15% of the population. These stones can result in serious complications, including pancreatitis, common bile duct stones (CBDS), and cholecystitis. CBDS occurs in 3% to 10% of patients with cholelithiasis,[1] and it can lead to severe consequences such as acute pancreatitis, cholangitis, and infectious shock. The diagnosis of CBDS can be made through the clinical presentation, blood comprehensive metabolic panel, and radiologic findings. Magnetic resonance cholangiopancreatography (MRCP) is considered the most accurate method for diagnosing CBDS, with a sensitivity of ~85% to 92% and a specificity of 93% to 97%.[2,3]

There are 3 main approaches to the treatment of CBDS: open cholecystectomy combined with choledochotomy,[4] a 2-stage management involving cholecystectomy and preoperative or postoperative endoscopic retrograde cholangiopancreatography (ERCP), and a 1-stage management involving cholecystectomy and choledochotomy.[5] A study by Grubnik et al[6] found that the rate of complications in the open surgical group was twice as high as that in the laparoscopic common bile duct exploration (LCBDE) group (6.5% for LCBDE vs. 12.7% for open choledochotomy, $P < 0.05$). As a result, open cholecystectomy combined with choledochotomy has been replaced by the other 2 methods due to higher complication rates. Furthermore, since the 1970s, ERCP has become the most common treatment strategy for CBDS.[7] However, despite its safety and effectiveness, ERCP is still associated with various complications, including pancreatitis, hemorrhage, perforation, duodenal reflux, and stone recurrence.[8] Moreover, the latest consensus guidelines, including those established by the European Society of Gastrointestinal Endoscopy and the American Society for Gastrointestinal Endoscopy,[9,10] have indicated that there is currently insufficient evidence to determine the most effective approach for CBDS.

The purpose of this retrospective study was to evaluate the efficacy, safety, and surgical outcomes of 3 different treatment approaches: preoperative ERCP + laparoscopic cholecystectomy (LC) (ERCP + LC), LC + postoperative ERCP (LC + ERCP), and LC + LCBDE. The study measured various outcomes, including postoperative blood comprehensive metabolic panel, alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin, and serum amylase levels. In addition, it analyzed complications occurring one month after the surgery, such as bile leak, bleeding, pancreatitis, wound infection, and duodenal perforation. Furthermore, the study examined long-term complications (4 to 5 years after treatment), including biliary stricture, recurrent CBDS, and common bile duct (CBD) cancer.

MATERIALS AND METHODS

Patients

This retrospective study included 180 patients with gallstones and CBDS admitted to the Department of General Surgery of Tongji Hospital, Tongji University, from January 2019 to June 2021. The inclusion criteria for this study were patients with gallstones who exhibited common clinical manifestations such as abdominal pain, fever, jaundice, nausea, or vomiting. In addition, patients were diagnosed with possible or definite CBDS based on blood and liver function tests (ALT, AST) or radiological examination results [including ultrasonography, computed tomography (CT), and magnetic resonance cholangiopancreatography (MRCP)]. To confirm the presence of CBDS, all patients underwent MRCP examination before surgery. Exclusion criteria included patients who had not undergone ERCP, had organ dysfunction, were pregnant, had advanced tumors, had acute pancreatitis, had severe cholangitis, or had septic shock. Patients who could not tolerate the procedure were also excluded. The characteristics of the patients in each group are summarized in Table 1.

The study included 3 groups: ERCP+LC (group 1), LC +ERCP (group 2), and LC+LCBDE (group 3), each consisting of 60 patients. Clinical metrics, including demographic data, the success rate of stone removal, conversion rate to other procedures, total operative time, postoperative complications, mortality, length of hospital stay, and cost-effectiveness of the patients, were collected and compared among the groups.

Endoscopic or Surgical Procedure

Surgical Procedure of LC

Under general anesthesia and abdominal skin sterilization, the patient was positioned in the reverse Trendelenburg position. The procedure was conducted using a standard 3-cannula technique. Initially, a 10-mm trocar was inserted in the subumbilical region for carbon dioxide insufflation and 30-degree angled laparoscopy. Subsequently, under laparoscopic guidance, additional trocars were inserted in the anomalous area: a 10-mm trocar below the xiphoid process and a 5-mm trocar in the midclavicular line-subcostal margin. Dissection was initiated around the Carlo triangle. The bladder catheter and bladder artery were clipped using Hem-o-lok. The gallbladder was then differentiated from the gallbladder bed and removed through the trocar under the carina. Bipolar electrocoagulation was performed if necessary to control bleeding. In cases of severe inflammation, a drain was inserted. Postoperatively, patients were followed up at approximately 1 month and 5 years.

Surgical Procedure of LCBDE

After administering general anesthesia and sterilizing the patient's abdominal skin, they were positioned in the reverse Trendelenburg position. The surgery was conducted using a standard 4-trocar surgical technique. The first 10-mm trocar was inserted in the subumbilical region for carbon dioxide insufflation and placement of a 30° angled laparoscope. With the guidance of the laparoscope, additional trocars were inserted in the anomalous area: a 10-mm trocar below the xiphoid process and the remaining two 5-mm trocars in the midclavicular line-subcostal margin and axillary fossa anterior line-subcostal margin, respectively. The CBD was dissected and opened using laparoscopic scissors for a length of 1 to 1.5 cm. Stones in the CBD were removed by rinsing with sterile saline or by using forceps. To ensure complete removal of the stones, choledochoscopy was performed using a flexible choledochoscope inserted into the CBD, and any remaining stones in the CBD or right and left hepatic ducts were removed with a basket. A T-tube was then inserted into the CBD. The common bile duct was closed using an absorbable Vicryl 3-0 suture. The gallbladder was removed through the trocar below the styloid

TABLE 1. Demographic and Clinical Characteristics of 3 Groups of Patients

Characteristics	Group 1 (n = 60) (ERCP+LC)	Group 2 (n = 60) (LC+ERCP)	Group 3 (n = 60) (LC+LCBDE)	*P*
Sex (M/F)	30/30	31/29	32/28	0.936
Age (y)	61.03 ± 11.89	61.63 ± 12.44	61.72 ± 14.06	0.951
Clinical manifestation, n (%)				
Abdominal pain	57 (95)	57 (95)	56 (93.3)	0.901
Jaundice	4 (6.7)	6 (10)	11(18.3)	0.123
Fever	4 (6.7)	3 (5)	10 (16.7)	0.061
Nausea/vomiting	5 (8.3)	5 (8.3)	11 (18.3)	0.145
Blood test				
WBC	7.64 ± 3.05	7.24 ± 2.53	6.95 ± 3.95	0.501
CRP	14.4 ± 14.38	13.88 ± 18.25	14.85 ± 24.39	0.964
ALT	117.85 ± 113.12	108.62 ± 101.17	107.82 ± 84.94	0.831
AST	86.83 ± 71.88	78.6 ± 71.9	73.28 ± 68.87	0.574
Total bilirubin	45.65 ± 39.87	48.95 ± 35.7	41.63 ± 43.95	0.605
Amalyse	78.35 ± 37.26	79.23 ± 32.49	79.17 ± 34.87	0.988
Imaging (MRCP)				
Diameter of CBD (cm)	1.18 ± 0.24	1.21 ± 0.25	1.2 ± 0.29	0.804

ALT indicates alanine aminotransferase; AST, aspartate aminotransferase; CRP, C-reactive protein; ERCP+LC, endoscopic retrograde cholangiopancreatography followed by laparoscopic cholecystectomy; LC+ERCP, laparoscopic cholecystectomy followed by endoscopic retrograde cholangiopancreatography; LC+LCBDE, laparoscopic cholecystectomy and laparoscopic common bile duct exploration; MRCP, magnetic resonance cholangiopancreatography; WBC, white blood cell.

process. A drain was left in place at the Winslow foramen for 2 to 5 days.

For patients with a T-tube, cholangiography was performed after 3 to 4 weeks. If the cholangiogram showed no remaining stones, the T-tube would be removed. If there were any remaining stones, a choledochoscope was used to remove them via the T-tube tract.

Surgical Procedure of ERCP

The patient was positioned in the left lateral position and given intravenous anesthesia. A duodenoscope was then inserted into the duodenum. To determine the location, size, and number of stones in the CBD, 38% meglumine dihydrochloride was injected into the bile ducts for cholangiography. If necessary, sphincterotomy was performed. CBD stones were subsequently removed using a basket or Fogarty catheter, with larger stones requiring mechanical lithotripsy before removal. An endoscopic nasobiliary drain (ENBD) was inserted. After 2 to 5 days, cholangiography was performed through the ENBD tube to check for residual stones, which were removed if found. If no stones were found, the ENBD tube was removed.

In group 1 patients, the LC procedure was performed after the removal of the ENBD tube. In group 2 patients, ERCP was performed 2 to 4 days after LCBDE, depending on the general condition of the patients.

It is important to state that patients in one of the groups may need shifting to another group as the condition requires. For example, postop CBD stricture in the LC +CBDE group will need ERCP for stent placement. Or, perforation/hemorrhage following ERCP may need surgical intervention. In addition, ERCP may be the only direct therapeutic option in conditions such as biliary pancreatitis, especially when accompanied by cholangitis. Therefore, such patients were excluded from the analysis of this present study.

The duration of the ERCP operation is measured from the insertion of the duodenoscope into the mouth until its removal. Similarly, the duration of the LC operation is measured from the start of the skin incision until the completion of the skin suturing. In the ERCP + LC group or LC + ERCP group, the total operation time is the combined duration of both the ERCP and LC procedures. In group 3, the operation time is measured from the beginning of the skin incision to the end of the skin suturing. All ERCPs are performed by the same professor, and both LC and LCBDE are performed by senior chief physicians.

Follow-up

The study followed 3 groups of patients at 3 different time points: on the day of surgery, 1 month after surgery, and 5 years after surgery. On the day of surgery, the follow-up indicators included ALT, AST, total bilirubin, and serum amylase levels. At 1 month postoperatively, the follow-up indicators included bile leak, bleeding, pancreatitis, wound infection, and duodenal perforation. The diagnostic criteria for pancreatitis required the presence of at least 2 of the following features: abdominal pain, serum amylase level greater than 3 times the upper normal limit, and imaging studies confirming the existence of pancreatitis. Long-term follow-up indicators (4 to 5 years postoperatively) included the occurrence of biliary stricture, recurrent common bile duct stones, and common bile duct cancer. The cost-effectiveness analysis in the present study was performed according to the patients' tariff in our hospital; therefore, the result of cost-effectiveness analysis might vary from center to center. Moreover, the cost for patients in group 3 included the cost of follow-up T-tube cholangiogram and removal in our present study.

Statistical analysis

All statistical analyses were conducted using SPSS 13.0 software (IBM Corporation). The significance of the difference between the 2 independent groups was tested using an unpaired Student t test, while ANOVA was used to determine the significance of the difference between the 3 groups. A P-value of <0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics of Patients

From January 2019 to January 2021, our department admitted a total of 265 patients with CBDS combined with gallstones, based on the inclusion criteria. Among these patients, some were excluded based on the exclusion criteria. Specifically, 50 patients with acute pancreatitis, 23 patients with acute septic cholangitis who underwent emergency ERCP, 8 patients with previous ERCP, 3 patients with hepatocellular carcinoma, and 1 pregnant patient were excluded (a total of 85 patients). Therefore, a total of 180 patients were included in this study. Out of these, 60 patients were managed by the ERCP+LC surgical approach, 60 patients were managed by the LC+ERCP surgical approach, and 60 patients were managed by the LC+LCBDE surgical approach. The demographic data, laboratory outcomes, and MRCP results of the patients in all 3 groups are summarized in Table 1. There were no significant differences in demographic data, clinical manifestations (including abdominal pain, jaundice, fever, and nausea/vomiting), as well as laboratory outcomes, and MRCP results among the 3 groups (all $P>0.05$).

Comparison of Outcomes of ERCP + LC, LC + ERCP, and LC + LCBDE

The stone clearance rate was similar across all groups, with group 1 at 93.3%, group 2 at 98.3%, and group 3 at 95%. In addition, the LCBDEâ+âLC group had lower postoperative hospital stays, expenses, and incidence of postoperative hyperamylasemia, pancreatitis, cholangitis, reoperation, and recurrence compared with the ERCP +â LC group. However, the ERCPâ+âLC group had a shorter postoperative drainage time. There were no significant differences in the occurrence of conversion to open surgery, postoperative bile leakage, and bile duct stricture between the 2 groups. Univariate and multivariate regression analyses yielded consistent results (Table 2). In group 1, 2 patients (3.33%) were converted to LC+LCBDE due to impacted stones in the ampulla. In group 2, 3 cases (5%) were converted to other procedures, with 2 being converted to open CBD exploration due to a narrow CBD and 1 being converted to LC+LCBDE due to post-ERCP bleeding. In group 3, 2 cases (1.67%) were converted to open CBD exploration due to severe adhesions. Unfortunately, 1 patient who was 81 years old died of multiple organ dysfunction syndrome after ERCP in group 1. The mean operative time for group 1 was 162 ± 43.24 minutes, for group 2, it was 160.67 ± 38.65 minutes, and for group 3, it was 116.43 ± 42.91 min, which was the shortest. The mean length of hospital stay was approximately the same for

TABLE 2. Comparison of Outcomes of Patients of ERCP + LC, LC + ERCP, and LC + LCBDE Groups

	Group 1 (n = 60) (ERCP+LC)	Group 2 (n = 60) (LC+ERCP)	Group 3 (n = 60) (LC+LCBDE)
Stones clearance, n (%)	56 (93.3)	59 (98.3)	57 (95)
Conversion to other procedures rate, n (%)	2 (3.33)	3 (5)	2 (3.33)
Mortality, n (%)	1 (1.67%)	0	0
Operative time*	162 ± 43.24	160.67 ± 38.65	116.43 ± 42.91
Length of hospital stay*	13.05 ± 5.74	13.08 ± 7.45	10.52 ± 4.59
Cost-effectiveness*	41381.18 ± 8305.90	42522.55 ± 6954.85	34128.09 ± 11630.18

*Group 1 and group 2, $P > 0.05$; group 1 and group 3, $P < 0.05$; group 2 and group 3, $P < 0.05$.

group 1 (13.05 ± 5.74 days) and group 2 (13.08 ± 7.45 days), but it was 10.52 ± 4.59 days for group 3. The average total costs for group 1 and group 2 were calculated as 41381.18 ± 8305.90 Chinese Yuan (CNY) and 42522.55 ± 6954.85 CNY, respectively, compared with 34128.09 ± 11630.18 CNY for Group 3, which was significantly lower ($P < 0.05$).

The comparison of postoperative blood tests of patients of ERCP + LC, LC + ERCP, and LC + LCBDE groups is shown in Table 3. There was no significant difference in the postoperative ALT levels among the 3 groups (80.55 ± 37.33 vs. 77.62 ± 57.39 vs. 81.33 ± 37.47 U/L, $P = 0.893$). Similarly, the postoperative AST levels were also similar across the three groups (70.65 ± 29.61 vs. 74.33 ± 35.59 vs. 70.88 ± 20.34 U/L, $P = 0.742$). The postoperative total bilirubin levels were 30.27 ± 11.51 μmol/L in group 1, 29.82 ± 12.43 μmol/L in group 2, and 30.55 ± 13.05 μmol/L in group 3, with no significant difference observed ($P = 0.948$). While the postoperative amylase levels were almost similar between group 1 and group 2 (174.03 ± 153.97 vs. 174.8 ± 167.71 U/L, $P > 0.05$), they were slightly lower in group 3 (89.85 ± 47.74 U/L, $P < 0.001$) compared with group 1 or group 2. The LC and LCBDE groups had significantly lower serum amylase levels compared with the groups undergoing 2-stage management, which might lead to lower morbidity of postoperative pancreatitis as well as hyperamylasemia.

Comparison of Short-term (within 1 Month) and Long-term (4 to 5 Years After Treatment) Complications of Patients

All patients who were alive attended a short-term (within 1 month) follow-up. Postoperative short-term complications (Table 4) were observed in 4 patients in group 1. These complications included 1 patient with post-ERCP bleeding, 2 patients with pancreatitis, and 1 patient with duodenal perforation. Patients with bleeding and pancreatitis were treated conservatively, while the patient with duodenal perforation required surgery for assistance. In group 2, short-term complications were observed in 6 patients. These complications included 2 patients with post-ERCP bleeding, 3 patients with pancreatitis, and 1 patient with a wound infection after LC. One patient, who had pancreatitis due to a retained stone in the CBD, underwent a second ERCP to successfully remove the stone. The remaining patients recovered through conservative treatment. In group 3, 3 patients had bile leak, and 1 patient had a wound infection. They were treated conservatively. In summary, there were no significant differences in the short-term complication rate among the 3 groups.

Long-term follow-up (4 to 5 years after treatment) results were presented in Table 5. Group 1 had 58 patients attending, group 2 had 57 patients undergoing long-term follow-up, and group 3 had 59 attending patients. Recurrent CBDS was observed in 6 patients in group 1, 5 patients in group 2, and 1 patient in group 3. The 2-step treatment showed a higher rate of recurrent CBDS compared with the 1-step treatment ($P < 0.001$). In group 3, 2 patients experienced biliary stricture, while no cases of CBD cancer were reported in any of the 3 groups.

DISCUSSION

In our study, we found that the LCBDE + LC group exhibited lower postoperative hospital stays, expenses, and incidence of postoperative hyperamylasemia, pancreatitis, cholangitis, reoperation, recurrence, operative time, mean length of hospital stay, average total costs, and postoperative amylase levels compared with the ERCP + LC group. The ERCP + LC group had the shortest postoperative drainage time. There was no significant difference in the postoperative ALT, AST, total bilirubin levels, and short-term complication rate among the 3 groups. The 2-step treatment showed a higher rate of recurrent CBDS compared with the 1-step treatment. LCBDE + LC is a safe therapeutic approach for patients with gallstones and common bile duct stones. It offers advantages such as shorter length of hospital stay and operative time, lower cost, and fewer complications.

Cholelithiasis with common bile duct stones is very common clinically. Although laparoscopic cholecystectomy

TABLE 3. Comparison of Postoperative Blood Test of Patients of ERCP + LC, LC + ERCP, and LC + LCBDE Groups

	Group 1 (n = 60) (ERCP+LC)	Group 2 (n = 60) (LC+ERCP)	Group 3 (n = 60) (LC+LCBDE)
Postoperative ALT	80.55 ± 37.33	77.62 ± 57.39	81.33 ± 37.47
Postoperative AST	70.65 ± 29.61	74.33 ± 35.59	70.88 ± 20.34
Postoperative Total bilirubin	30.27 ± 11.51	29.82 ± 12.43	30.55 ± 13.05
Postoperative amylase*	174.03 ± 153.97	174.8 ± 167.71	89.85 ± 47.74

*Comparison of postoperative amylase between group 1+ group 2 (2-stage management) vs. group 3 (1-stage management), $P < 0.05$.

TABLE 4. Short-term (Within 1 Month) Complications of Patients

	Group1 (n = 59) (ERCP+LC)	Group2 (n = 60) (LC+ERCP)	Group3 (n = 60) (LC+LCBDE)	*P*
Bile leak	0	0	3	—
Bleeding	1	2	0	—
Pancreatitis*	2	3	0	—
Wound infection	0	1	1	—
Duodenal perforation	1	0	0	—
Total	4	6	4	0.737

*The diagnostic criteria of pancreatitis (required 2 of the following features): (1) abdominal pain; (2) serum amylase level > 3 times the upper normal limit; (3) imaging studies to prove the existence of pancreatitis.

has been established as the standard treatment for symptomatic gallstones, the optimal surgical method for the treatment of bile duct stones remains open to debate.[11] Four strategies are currently available for the treatment of CBDS: preoperative endoscopic retrograde cholangiopancreatography (PreERCP) plus LC; LC plus LCDBE; LC plus intraoperative ERCP (IntraERCP); and LC plus post-operative ERCP (PostERCP).[12] A previous systematic review and network meta-analysis showed that the combined LC and IntraERCP approach had the greatest odds to be the safest and appears to be the most successful and that LC + LBCDE appears to reduce the risk of acute pancreatitis but may be associated with a higher risk of biliary leak.[13] However, in our present study, there were no significant differences for LC and preoperative or post-operative ERCP groups in terms of successful stones clearance rate, conversion to other procedures rate, total operative time, postoperative complication rate, mortality, length of hospital stay, and cost-effectiveness.

After a successful ERCP, if patients still had CBDS identified by cholangiography during LC, further consideration was needed for a second operation. This could involve performing an LCBDE, postoperative ERCP, or open CBD exploration. Post-operative ERCP was a potential option to remove the CBDS. However, it was often challenging to remove impacted stones using this method, which is why an alternative surgical approach was necessary.[14] Bansal et al[15] reported stone clearance rates of 88.1% and 91.7% for the 2-stage procedures and LCBDE, respectively. In a study by Lan et al[16] no significant difference was seen between the ERCP + LC group and LCBDE + LC group in terms of stone clearance. However, study by Lyu et al[17] showed a significantly higher CBD stone clearance rate for pre-ERCP+LC than LCBDE+LC. The existing literature also supports comparable stone clearance rates for both one-stage management and 2-stage management. Our present study yielded similar results in terms of the rate of stone clearance among the 3 groups, suggesting that stone clearance rates may be influenced by various factors. However, considering the advantages of shorter hospital stays and better cost-effectiveness, 1-stage management is more commonly preferred over ERCP + LC. There is no significant difference in terms of mortality between the 2 management, according to current studies. A meta-analysis conducted by Ricci et al[13] reported a similar overall mortality of both the 2 methods. Our present study also did not observe any significant difference in mortality between the 3 groups.

Operation duration is widely recognized as a critical factor in evaluating the success of a surgical procedure. Prolonged operation duration has been linked to increased risks of complications, mortality, and longer hospital stays.[18] Lu et al[19] conducted a study comparing operative times in two groups: 126.9 ± 19.5 minutes for 2-stage management and 98.7 ± 9.7 minutes for 1-stage management ($P < 0.001$). The findings revealed that the 1-step management approach had a shorter operative time compared with the other group. This observation was also supported by Bansal et al[15] in their study (135.7 ± 36.6 minutes vs. 72.4 ± 27.6 minutes, $P < 0.001$). It is important to note that the operation duration in the ERCP and LC group includes both the total operation duration of ERCP and the operation duration of LC. Furthermore, our present research demonstrated a significantly lower operative time for the 1-step management approach compared with the 2-step management approach ($P < 0.05$). In our study, we found that the length of hospital stay was shorter in the 1-step group with the lowest total costs. Our findings align with previous studies conducted by Zou et al[20] and Docimo Jr et al,[21] which also reported significantly lower total costs and shorter hospital stays in the 1-step group for LC and LCBDE procedures. As for the practice timeline for ERCP + LC (group 1) and LC + ERCP (group 2), fasting is typically done after ERCP, and blood amylase levels are tested the following day in our present study. If the result of blood tests is normal, LC surgery is scheduled for the next day as a routine practice. However, if the result is abnormal or if there are complications such as mild pancreatitis, the surgery is postponed until the clinical condition improves, usually within 2 to 4 days. Similarly, after LC surgery, the patient needs to fast, receive intravenous infusion, and have their liver function monitored. The patient can start eating

TABLE 5. Long-term (4 to 5 Years After Treatment) Complications of Patients

	Group1 (n = 58) (ERCP+LC), n (%)	Group2 (n = 57) (LC+ERCP), n (%)	Group (n = 59) (LC+LCBDE), n (%)
Biliary stricture	0	0	2 (3.4)
Recurrent CBDS*	6 (10.3)	5 (8.8)	1 (1.7)
CBD cancer	0	0	0

*Group 1 and group 2, $P > 0.05$; group 1 and group 3, $P < 0.05$; group 2 and group 3, $P < 0.05$.

again after being ventilated. The next step of ERCP surgery will only be considered if there is no abdominal pain or distension after eating and no significant increase in jaundice. A meta-analysis conducted by Napaphat Poprom,[22] which included 4 randomized controlled trial studies and 4 retrospective studies, found that hospital stay, complication rates, and operative time were similar whether the LC surgery was performed within 1 day or 72 hours after ERCP. Therefore, the results of hospital stays in our study hold equal reference value compared with other centers.

Recent studies have yielded different conclusions in terms of complications between 1-step and 2-step management. In a retrospective case-control study conducted by Morton et al[23], LCBDE + LC was associated with low rates of postoperative complications compared with LC with either preoperative or postoperative ERCP. Another retrospective cohort study conducted by Yan et al[24] analyzed 80 patients and reported total complication rates of 9.4% in the 2-step group and 10.7% in the 1-step group with no significant difference. In our study, we found that there was no significant difference in short-term complications between the 1-step and 2-step management approaches. However, during a long-term follow-up, we observed a higher recurrence of CBDS in the 2-step management group. It is important to note that duodenobiliary reflux is a major risk factor for the formation of CBDS.[25] Sphincterotomy can damage the sphincter of Oddi, resulting in the loss of sphincter function and potentially leading to duodenal bile reflux, which in turn may cause the recurrence of CBDS. During postoperative follow-up, 2 patients in group 3 were diagnosed with biliary strictures. However, both patients showed improvement after undergoing ERCP biliary stenting. Currently, these 2 patients exhibit normal liver function and are free from symptoms such as fever, abdominal pain, or jaundice. It is important to note that biliary stricture may be a specific complication of LCBDE surgery that can increase the cost of treatment. Recent studies have shown that bile duct stricture is uncommon in LCBDE patients.[26,27] Therefore, the reasons for the development of biliary stenosis in the 2 patients in our study still require further study, and thus patients should be carefully selected for LCBDE based on clinical conditions.

To date, there is a lack of sufficient research comparing the outcomes of postoperative blood biochemistry tests between the one-stage and 2-stage management. According to the findings presented in Table 3, there was no notable disparity in the postoperative levels of alanine aminotransferase, glutamine aminotransferase, and total bilirubin across the 3 groups. However, it is worth mentioning that the 2-stage management group exhibited a higher postoperative amylase level. Cotton et al[28] reported that patients are diagnosed with post-ERCP pancreatitis when they experience clinical evidence of pancreatitis after ERCP associated with a 3-fold increase of serum amylase at $\geq$24 hours and necessitating hospital admission or prolonged hospital stay. On the other hand, patients with high serum amylase levels but without abdominal pain are diagnosed with post-ERCP hyperamylasemia.[29] Although the level of serum amylase does not necessarily indicate the severity of pancreatic diseases, it does suggest some extent of early-stage damage to the pancreas. Norouzi et al[30] reported that post-ERCP hyperamylasemia occurred in 18.2% of the patients, and several studies[31,32] have reported painless pancreatitis. Uchino et al[33] found that 37% of post-ERCP hyperamylasemia cases had painless pancreatitis based on CT findings. In our study, we did not perform CT scans on the post-ERCP hyperamylasemia patients to confirm if they had pancreatitis because most of them recovered after several days. However, it is evident that post-ERCP hyperamylasemia is a common complication of ERCP. Our study demonstrated that the LC and LCBDE groups had significantly lower serum amylase levels compared with the groups undergoing 2-stage management. This suggests that LC+LCBDE is a safer therapeutic approach for CBDS, leading to lower morbidity of postoperative pancreatitis as well as hyperamylasemia.

In conclusion, both one-stage and two-stage management for CBDS were efficient therapeutic management options. However, LC+LCBDE offers a safer therapeutic approach with a shorter length of hospital stay and operative time, lower cost, and fewer complications.

REFERENCES

1. Prevost GA, Huber C, Schnell B, et al. Feasibility and safety of intraoperative bile duct clearance by antegrade transcystic balloon sphincteroplasty: a prospective observational pilot study. *J Trauma Acute Care Surg*. 2024;96:666–673.
2. Suzuki M, Sekino Y, Hosono K, et al. Endoscopic ultrasound versus magnetic resonance cholangiopancreatography for the diagnosis of computed tomography-negative common bile duct stone: prospective randomized controlled trial. *Dig Endosc*. 2022;34:1052–1059.
3. Mattila A, Helminen O, Pynnönen E, et al. Preoperative MRCP can rule out choledocholithiasis in acute cholecystitis with a high negative predictive value: prospective cohort study with intraoperative cholangiography. *J Gastrointest Surg*. 2023; 27:2396–2402.
4. Hess GF, Sedlaczek P, Zeindler J, et al. The short- and long-term outcome after the surgical management of common bile duct stones in a tertiary referral hospital. *Langenbecks Arch Surg*. 2023;408:288.
5. Tan C, Ocampo O, Ong R, et al. Comparison of one stage laparoscopic cholecystectomy combined with intra-operative endoscopic sphincterotomy versus two-stage pre-operative endoscopic sphincterotomy followed by laparoscopic cholecystectomy for the management of pre-operatively diagnosed patients with common bile duct stones: a meta-analysis. *Surg Endosc*. 2018;32:770–778.
6. Grubnik VV, Tkachenko AI, Ilyashenko VV, et al. Laparoscopic common bile duct exploration versus open surgery: comparative prospective randomized trial. *Surg Endosc*. 2012; 26:2165–2171.
7. Bang JY, Wilcox CM, Navaneethan U, et al. Orlando protocol for single session ductal clearance of common bile duct stones at ERCP. *Dig Endosc*. 2023. doi:10.1111/den.14719. Online ahead of print
8. Hedström J, Nilson J, Anderson B. Cholecystectomy and ERCP in pregnancy: a nationwide register-based study. *Int J Surg*. 2024;110:324–331.
9. Manes G, Paspatis G, Aabakken L, et al. Endoscopic management of common bile duct stones: European Society of Gastrointestinal Endoscopy (ESGE) guideline. *Endoscopy*. 2019;51:472–491.
10. Buxbaum JL, Abbas Fehmi SM, Sultan S, et al. ASGE guideline on the role of endoscopy in the evaluation and management of choledocholithiasis. *Gastrointest Endosc*. 2019; 89:1075–1105.e1015.
11. Gavriilidis P, Catena F, de'Angelis G, et al. Consequences of the spilled gallstones during laparoscopic cholecystectomy: a systematic review. *World J Emerg Surg*. 2022;17:57.
12. Zhu J, Wang G, Xie B, et al. Minimally invasive management of concomitant gallstones and common bile duct stones: an updated network meta-analysis of randomized controlled trials. *Surg Endosc*. 2023;37:1683–1693.

13. Ricci C, Pagano N, Taffurelli G, et al. Comparison of eficacy and safety of 4 combinations of laparoscopic and intraoperative techniques for management of gallstone disease with biliary duct calculi: a systematic review and network meta-analysis. *JAMA Surg*. 2018;153:e181167.
14. Ali N, Nadeem M, Nauyan F, et al. Laparoscopic management of common bile duct stones: stratifying risks, a district hospital xperience. *J Laparoendosc Adv Surg Tech A*. 2022;32:165–170.
15. Bansal VK, Misra MC, Rajan K, et al. Single-stage laparoscopic common bile duct exploration and cholecystectomy versus two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy for patients with concomitant gallbladder stones and common bile duct stones: a randomized controlled trial. *Surg Endosc*. 2014;28:875–885.
16. Lan WF, Li JH, Wang QB, et al. Comparison of laparoscopic common bile duct exploration and endoscopic retrograde cholangiopancreatography combined with laparoscopic cholecystectomy for patients with gallbladder and common bile duct stones a meta-analysis of randomized controlled trials. *Eur Rev Med Pharmacol Sci*. 2023;27:4656–4669.
17. Lyu Y, Cheng Y, Li T, et al. Laparoscopic common bile duct exploration plus cholecystectomy versus endoscopic retrograde cholangiopancreatography plus laparoscopic cholecystectomy for cholecystocholedocholithiasis: a meta-analysis. *Surg Endosc*. 2019;33:3275–3286.
18. de'Angelis N, Schena CA, Piccoli M, et al. Impact of operation duration on postoperative outcomes of minimally-invasive right colectomy. *Colorectal Dis*. 2022;24:1505–1515.
19. Lu J, Cheng Y, Xiong XZ, et al. Two-stage vs single-stage management for concomitant gallstones and common bile duct stones. *World J Gastroenterol*. 2012;18:3156–3166.
20. Zou Q, Ding Y, Li CS, et al. A randomized controlled trial of emergency LCBDE + LC and ERCP + LC in the treatment of choledocholithiasis with acute cholangitis. *Wideochir Inne Tech Maloinwazyjne*. 2022;17:156–162.
21. Docimo S, Jr., Sucandy I, et al. TAVAC: choledochoscopy disposable scopes, and the single-stage vs. two-stage approach to choledocholithiasis. *Surg Endosc*. 2023;37:6611–6618.
22. Poprom N, Suragul W, Muangkaew P, et al. Timing of laparoscopic cholecystectomy after endoscopic retrograde cholangiopancreatography in cholelithiasis patients: a systematic review and meta-analysis. *Ann Hepatobiliary Pancreat Surg*. 2023;27:20–27.
23. Morton A, Cralley A, Brooke-Sanchez M, et al. Laparoscopic common bile duct exploration by acute care surgeons saves time and money compared to ERCP. *Am J Surg*. 2022;224: 116–119.
24. Yan Y, Sha Y, Yuan W, et al. One-stage versus two-stage management for acute cholecystitis associated with common bile duct stones: a retrospective cohort study. *Surg Endosc*. 2022;36:920–929.
25. Lu X, Wang Y, Liu W, et al. Endoclip papillaplasty (ECPP) versus limited EST plus EPLBD for a decrease in recurrent choledocholithiasis: a prospective cohort study. *Surg Endosc*. 2023;37:7790–7802.
26. Ma Z, Zhou J, Yao L, et al. Safety and efficacy of laparoscopic common bile duct exploration for the patients with difficult biliary stones: 8 years of experiences at a single institution and literature review. *Surg Endosc*. 2022;36:718–727.
27. Lai W, Xu N. Feasibility and safety of choledochotomy primary closure in laparoscopic common bile duct exploration without biliary drainage: a retrospective study. *Sci Rep*. 2023; 13:22473.
28. Cotton PB, Lehman G, Vennes J, et al. Endoscopic sphincterotomy complications and their management: an attempt at consensus. *Gastrointest Endosc*. 1991;37:383–393.
29. Wang G, Xiao G, Xu L, et al. Effect of somatostatin on prevention of post-endoscopic retrograde cholangiopancreatography pancreatitis and hyperamylasemia: a systematic review and meta-analysis. *Pancreatology*. 2018;18:370–378.
30. Norouzi A, Ghasem PE, Kaabe S, et al. Effect of adding intravenous somatostatin to rectal indomethacin on post-endoscopic eetrograde cholangiopancreatography (ERCP) pancreatitis in high-risk patients: a double-blind randomized placebo-controlled clinical trial. *J Clin Gastroenterol*. 2023;57: 204–210.
31. Ahmed A, Shah I, Bocchino R, et al. Natural history, clinical characteristics, outcomes, and long-term follow-up of pain-free chronic pancreatitis. *Gastroenterol Rep (Oxf)*. 2023;11:goad024.
32. D'Haese JG, Hartel M, Demir IE, et al. Pain sensation in pancreatic diseases is not uniform: the different facets of pancreatic pain. *World J Gastroenterol*. 2014;20:9154–9161.
33. Uchino R, Sasahira N, Isayama H, et al. Detection of painless pancreatitis by computed tomography in patients with post-endoscopic retrograde cholangiopancreatography hyperamylasemia. *Pancreatology*. 2014;14:17–20.

