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Re-do laparoscopic common bile duct exploration for recurrent common bile duct stones: a single-center retrospective cohort study

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Purpose: Common bile duct (CBD) stone recurrence after laparoscopic CBD exploration (LCBDE) is relatively common. No studies have been conducted evaluating the safety and feasibility of re-do LCBDE in the treatment of recurrent CBD stones.
Methods: This single-center retrospective study reviewed 340 consecutive patients who underwent LCBDE for CBD stones between January 2004 and December 2020. Patients with pancreatobiliary malignancies and those who underwent other surgical procedures were excluded.
Results: Of the 340 included patients, 45 experienced a recurrence after a mean follow-up period of 24.2 months. Of them, 18 underwent re-do LCBDE, 20 underwent endoscopic intervention, 2 underwent radiologic intervention, and 5 underwent observation. Re-do LCBDE and initial LCBDE showed similar surgical outcomes in terms of operative time (113.1 minutes *vs.* 107.5 minutes, P = 0.515), estimated blood loss (42.5 mL *vs.* 49.1 mL, P = 0.661), open conversion rate (2.9% *vs.* 0%, P = 0.461), postoperative complication (15.3% *vs.* 22.2%, P = 0.430), and postoperative hospital stay (6.5 days *vs.* 6.4 days, P = 0.921). Comparing re-do LCBDE and nonsurgical treatment (endoscopic or radiologic), no statistically significant differences were noted in posttreatment complication (22.2% *vs.* 13.6%, P = 0.477), hospital stay (6.4 days *vs.*7.3 days, P = 0.607), and recurrence (50.0% *vs.* 36.4%, P = 0.385). The clearance rate was higher in the re-do LCBDE group than in the nonsurgical group (100% *vs*. 81.8%, P = 0.057).
Conclusion: Compared to initial LCBDE and endoscopic or radiological treatments, re-do LCBDE for recurrent CBD stones is a treatment option worth considering in selected patients.
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Key Words: Common bile duct, Choledocholithiasis , Gallstones, Laparoscopy, Recurrence

INTRODUCTION

Common bile duct (CBD) stones have been reported in up to 10% of patients undergoing biliary imaging, and are generally silent [1,2]. However, CBD stones may cause serious morbidities, such as acute cholangitis, gallstone pancreatitis, and severe obstructive jaundice [3].

Currently, there are several strategies to treat CBD stones, including endoscopic retrograde cholangiopancreatography (ERCP), laparoscopic CBD exploration (LCBDE), and radiological treatment. However, an optimal treatment approach remains unclear. According to clinical practice guidelines of the European Association for the Study of the Liver [4], ERCP is the preferred treatment. However, in cases of large, multiple, or impacted stones and altered gastric or duodenal anatomy, endoscopic treatment may be difficult or even fail. Surgical treatment should

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be considered if endoscopic treatment fails or is unfeasible. With the gradual development of laparoscopic techniques, LCBDE has become widely used to treat CBD stones. LCBDE does not disrupt the sphincter of Oddi [5]. Finally, when neither endoscopic nor surgical treatment is possible, radiological treatment can be considered, including percutaneous transhepatic biliary drainage (PTBD) and stone removal [6].

The recurrence of CBD stones after treatment is relatively common. The recurrence rate of CBD stones after LCBDE is reported to be relatively high at 2%–13% [7-10]. However, research on the treatment of recurrent biliary stones is lacking. In particular, the only study on reoperation of CBD exploration was published in the 1980s. Unlike recent laparoscopic surgery, it was a study on open surgery and reported high mortality and complication rates [11]. Therefore, this study is significant as the first study on re-do LCBDE. This study aimed to compare the safety and feasibility of re-do LCBDE with the initial LCBDE and endoscopic or radiologic treatment for recurrent CBD stones.

METHODS

Ethics statement

This study was approved by the Institutional Review Board of Konyang University Hospital, and the requirement for informed consent was waived because of the retrospective study design (No. 2023-02-025).

Study population

From January 2004 to December 2020, all consecutive patients who underwent LCBDE for CBD stones at the Konyang University Hospital were evaluated. Regardless of whether it was an initial LCBDE or a re-do LCBDE, all patients were included in the study. Patients with pancreatobiliary malignancies and those who underwent other surgical procedures were excluded. A total of 340 patients who underwent initial LCBDE were included in the study. As mentioned later in the study, among the 45 patients who relapsed CBD stones, 18 patients underwent reoperation and 22 patients received nonsurgical treatment were additionally included in the study at the time of recurrence. The diagnosis of CBD stones was confirmed by preoperative imaging studies, including abdominal ultrasonography (USG), CT, magnetic resonance cholangiopancreatography, and ERCP. A second LCBDE performed in patients with recurrent CBD stones was defined as a re-do LCBDE. To determine the safety and significance of re-do LCBDE in patients with recurrent CBD stones, a comparative study was conducted with 2 control groups: (1) initial LCBDE and (2) nonsurgical treatment, including endoscopic or radiological intervention for recurrent CBD stones.

Surgical technique of initial and re-do laparoscopic common bile duct exploration

Initially cholecystectomy was performed, after which LCBDE was performed using the standard 4-port method. After the CBD was identified, longitudinal choledochotomy was performed in the supraduodenal portion of the CBD. The CBD stones were retrieved under vision using a 5-mm flexible choledochoscope (Olympus) and a wire basket. After all stones were removed, the proximal and distal bile ducts were examined using a choledochoscope to confirm clearance. The choledochotomy site was closed using continuous absorbable 4–0 or 5–0 PDS II sutures (Ethicon Inc.). The detailed surgical technique has been described in our previous study [12].

In the re-do LCBDE, adhesiolysis was first performed because most patients had adhesions around the liver and hepatoduodenal ligament due to a previous surgery (Fig. 1A). After identifying the CBD, only its anterior surface was dissected (Fig. 1B). Choledochotomy was performed at the same location and in the same manner as the initial LCBDE (Fig. 1C). A choledochoscope was used to remove the stones and confirm clearance of the CBD (Fig. 1D, E). The choledochotomy site was closed using continuous absorbable 4–0 or 5–0 PDS II sutures (Fig. 1F). A closed suction drain was placed in the subhepatic space at the end of the surgery.

Endoscopic procedure

Endoscopic procedures included endoscopic sphincterotomy (EST), endoscopic stone extraction, endoscopic nasobiliary drainage, and endoscopic retrograde biliary drainage. Complications after the endoscopic procedure include EST site bleeding and post-ERCP pancreatitis. Endoscopic procedures and findings were analyzed based on formal reports.

Radiologic procedure

Radiological procedures included PTBD, percutaneous transhepatic cholangiography, stone removal, balloon dilatation, and stenting. Complications after the radiological procedure included cholangitis and PTBD site-related complications. Radiological procedures and findings were analyzed based on formal reports.

Variables of demographics and treatment outcomes

The general condition and physical fitness of each patient were evaluated using the American Society of Anesthesiologists physical status (ASA PS) classification [13] for patients who underwent LCBDE, and the Charlson age comorbidity index (CACI) for all patients [14]. The operative time was calculated as the time from skin incision to skin closure. Blood loss estimates were obtained from surgical records. The postoperative hospital stay was defined as the number of days of hospital stay after

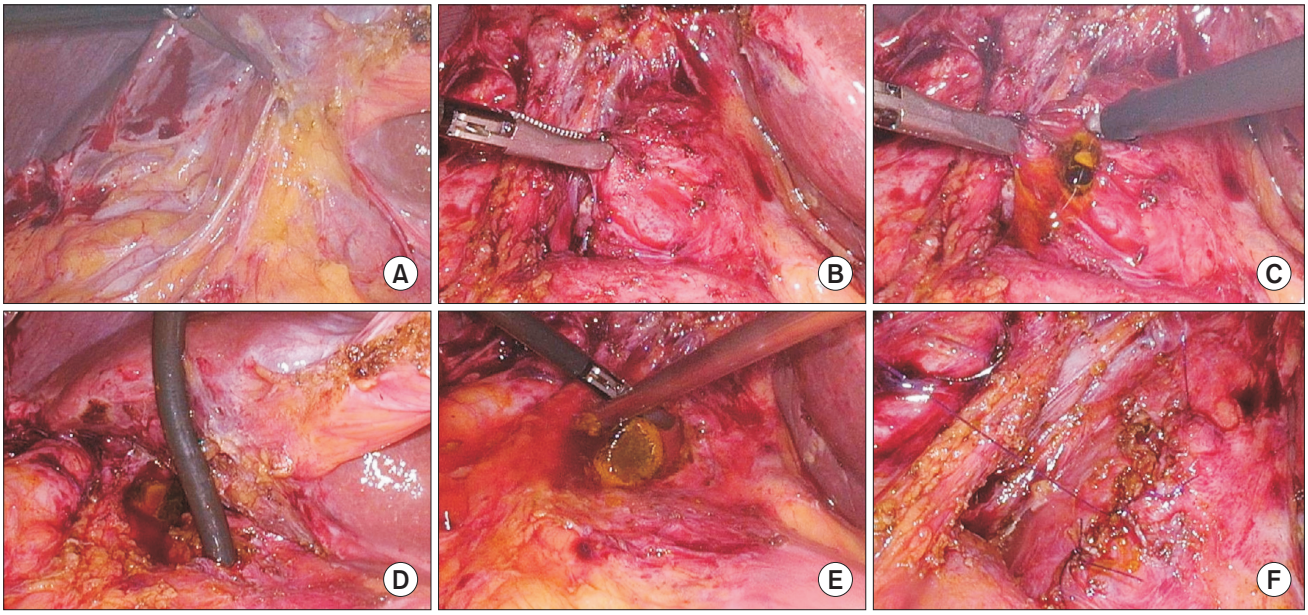

Fig. 1. Surgical view of re-do laparoscopic common bile duct exploration. (A) Adhesions around the liver and hepatoduodenal ligaments from previous surgery. (B) Identification of the anterior surface of the common bile duct. (C) Longitudinal choledochotomy using endo scissors. (D) Choledochoscope insertion. (E) Stone extraction. (F) Closure of the choledochotomy site using 5-0 PDS II sutures (Ethicon Inc.).

LCBDE. Posttreatment hospital stay was defined as the number of days of hospital stay after the first surgical or nonsurgical treatment for recurrent CBD stones. The initial levels of total bilirubin, AST, and ALT, measured at the first outpatient or emergency room visit, were evaluated. All complications were graded according to the Clavien-Dindo classification [15]. Serious complications were higher than grade III according to the Clavien-Dindo classification. Follow-up USG or CT performed 1 month after the initial LCBDE confirmed clearance of the CBD stone. Recurrent CBD stones were defined as the occurrence of stones at least 6 months after the previous complete removal of stones by initial LCBDE.

Statistical analysis

Continuous variables were summarized as mean and standard deviation and compared using the Student t-test. Categorical variables are presented as counts and percentages and were compared using the chi-square test. All tests were 2-sided, and P-values of <0.05 were considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics ver. 27 (IBM Corp.).

RESULTS

Study population

Of the 340 included patients, 45 (13.2%) experienced a recurrence after a mean follow-up period of 24.2 months. Of the 45 patients with recurrent CBD stones, 18 underwent re-do LCBDE, 20 underwent endoscopic intervention, 2 underwent radiologic intervention, and 5 underwent observation only. Nine (50.0%) and 8 (36.4%) patients experienced a 2nd recurrence in the re-do LCBDE group and nonsurgical treatment groups (endoscopic and radiologic interventions), respectively (Fig. 2).

Comparison of initial and re-do laparoscopic common bile duct exploration

The demographics and surgical outcomes of patients who underwent initial and re-do LCBDE are shown in Table 1. No significant differences were noted between the initial and re-do LCBDE groups in terms of age, sex, or body mass index (BMI). Patients in the re-do LCBDE group had higher CACI (≥5; 21.2% *vs.* 44.4%, P = 0.021) and higher ASA PS classification (≥3; 35.3% *vs.* 61.1%, P = 0.027). Patients in the re-do LCBDE group had more previous abdominal surgeries (32.1% *vs.* 100.0%, P < 0.001) and previous cholecystectomies (10.0% *vs.* 100.0%, P < 0.001). Patients in the re-do LCBDE group had a larger CBD diameter than those in the initial LCBDE group (13.7 mm *vs.* 19.6 mm, P < 0.001); however, there were no statistically significant differences in the number of stones and maximum stone size. Laboratory findings showed that AST, ALT, and total bilirubin levels were similar in both groups. Preoperative endoscopic and percutaneous biliary drainage results were also not significantly different between the 2 groups. The presence of combined periampullary diverticulum was more common in the re-do LCBDE group than in the initial LCBDE group (17.9% *vs.* 38.9%, P = 0.027).

Regarding surgical outcomes, no statistically significant

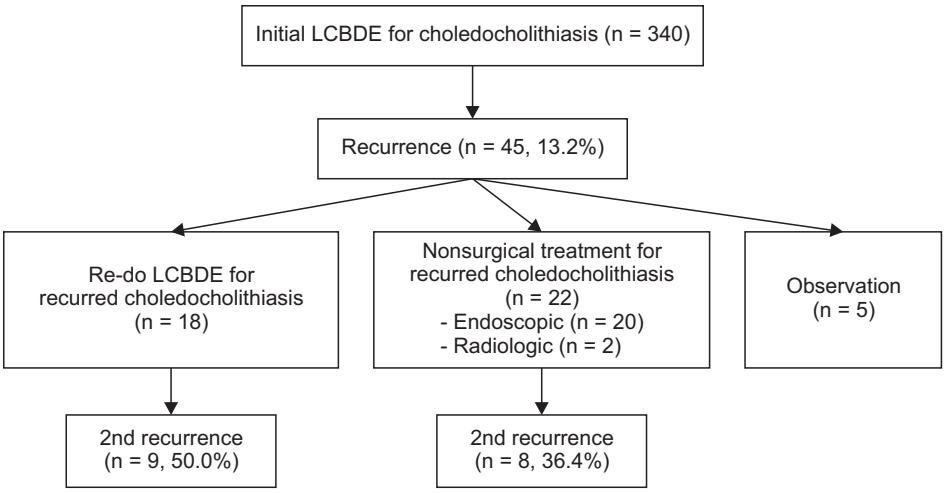

Fig. 2. Study flow diagram. LCBDE, laparoscopic common bile duct exploration.

Table 1. Comparison of patient demographics and surgical outcomes between initial and re-do laparoscopic CBD exploration

Variable	Initial LCBDE	Re-do LCBDE	P-value
No. of patients	340	18	
Age (yr)	72.3 ± 13.5	75.2 ± 9.5	0.242
Female sex	171 (50.3)	8 (44.4)	0.629
Body mass index (kg/m^2)	22.6 ± 3.6	22.7 ± 2.7	0.930
CACI ≥5	72 (21.2)	8 (44.4)	0.021
ASA PS classification ≥III	120 (35.3)	11 (61.1)	0.027
Previous abdominal surgery	109 (32.1)	18 (100)	<0.001
Previous cholecystectomy	34 (10.0)	18 (100)	<0.001
CBD diameter (mm)	13.7 ± 5.3	19.6 ± 4.0	<0.001
No. of stones			0.259
Single	140 (41.2)	5 (27.8)	
Multiple	200 (58.8)	13 (72.2)	
Maximum stone size (mm)	11.9 ± 6.4	14.0 ± 3.1	0.172
Initial total bilirubin (mg/dL)	2.8 ± 2.9	2.8 ± 2.3	0.960
Initial AST (U/L)	196.7 ± 326.2	326.3 ± 415.6	0.209
Initial ALT (U/L)	150.9 ± 176.5	213.7 ± 268.8	0.155
Preoperative ENBD or ERBD	82 (24.1)	6 (33.3)	0.376
Preoperative PTBD	94 (27.6)	7 (38.9)	0.302
Combined PAD	61 (17.9)	7 (38.9)	0.027
Operation time (min)	113.1 ± 51.8	107.5 ± 34.1	0.515
Estimated blood loss (mL)	42.5 ± 88.2	49.1 ± 59.4	0.661
Open conversion	10 (2.9)	0 (0)	0.461
Intraoperative biliary drainage			0.008
Primary repair	200 (58.8)	17 (94.4)	
Antegrade biliary stent	114 (33.5)	0 (0)	
T-tube	26 (7.6)	1 (5.6)	
Postoperative overall complication	52 (15.3)	4 (22.2)	0.430
Postoperative serious complication	24 (7.1)	0 (0)	0.243
Bile leakage	12 (3.5)	0 (0)	0.418
Postoperative hospital stay (day)	6.5 ± 4.8	6.4 ± 2.9	0.921
Clearance of CBD stones	327 (96.2)	18 (100)	0.398
Recurrence of CBD stones	45 (13.2)	9 (50.0)	<0.001
Long-term biliary stricture	1 (0.3)	0 (0)	0.818

Values are presented as number only, mean ± standard deviation, or number (%).
CBD, common bile duct; CACI, Charlson age comorbidity index; ASA PS, American Society of Anesthesiologists physical status; ENBD, endoscopic nasobiliary drainage; ERBD, endoscopic retrograde biliary drainage; PTBD, percutaneous transhepatic biliary drainage; PAD, peripheral artery disease.

differences were noted in the operative time, estimated blood loss, open conversion rate, postoperative complications, or postoperative hospital stay between the 2 groups. In the re-do LCBDE group, primary closure of choledochotomy site was performed without any drainage in most patients (58.8% *vs.* 94.4%, P = 0.008). Bile leakage (3.5% *vs.* 0.0%, P = 0.418) and long-term biliary stricture (0.3% *vs.* 0%, P = 0.818) occurred only in the initial LCBDE group; however, no statistically significant difference was noted between the 2 groups. The clearance rate was similar between the 2 groups (96.2% *vs.* 100%, P = 0.398), while the recurrence rate was higher in the re-do LCBDE group than in the initial LCBDE group (13.2% *vs.* 50.0%, P <0.001).

Comparison of re-do laparoscopic common bile duct exploration and endoscopic or radiologic treatment

The demographics and treatment outcomes of patients who underwent re-do LCBDE and nonsurgical (endoscopic or radiologic) treatment are shown in Table 2. No statistically significant differences were noted between the re-do LCBDE and nonsurgical treatment groups in terms of age, sex, BMI, and CACI. Patients in the re-do LCBDE group had a larger CBD diameter (19.6 mm *vs.* 15.4 mm, P = 0.002) and CBD stone size (14.0 mm *vs.* 11.3 mm, P = 0.023) than those in the nonsurgical treatment group. Laboratory findings showed that AST, ALT, and total bilirubin levels were similar in both groups.

No statistically significant differences were noted in the posttreatment complications or hospital stay. Patients in the re-do LCBDE group received fewer treatments than those in the nonsurgical treatment group (1.0 *vs.* 1.8, P < 0.001). No significant difference was noted in the recurrence rates (50.0% *vs.* 36.4%, P = 0.385) between the 2 groups; however, the clearance rate was marginally higher in the re-do LCBDE group than in the nonsurgical treatment group.

DISCUSSION

Treatment of biliary stones can include surgical, endoscopic, and radiological treatments, and each treatment has advantages and disadvantages. From the perspective of recurrence, there are conflicting opinions that surgical treatment that does not destroy the sphincter of Oddi is better and that endoscopic or radiological treatment that does not cause damage to the CBD is advantageous. According to recently published randomized controlled trials and meta-analyses, many studies indicate that surgical treatment is associated with fewer recurrences than endoscopic treatment [5,9,16], while some studies report no difference between the 2 groups [17]. Therefore, it can be concluded that surgical treatment is not inferior to endoscopic treatment in terms of recurrence.

As laparoscopic techniques have gradually advanced and hepatobiliary surgeons have gained more experience, LCBDE has been increasingly used to treat CBD stones. As a single-stage treatment, LCBDE has advantages in terms of the length of hospital stay and cost incurred without disrupting the sphincter of Oddi [5]. As LCBDE has become widely used, the number of patients with recurrent CBD stones after surgery has also increased, raising concerns about their treatment. Therefore, this

Table 2. Comparison of patient demographics and treatment outcomes between re-do laparoscopic CBD exploration and endoscopic or radiologic treatment

Variable	Re-do LCBDE (n = 18)	Endoscopic or radiologic treatment (n = 22)	P-value
Age (yr)	75.2 ± 9.5	76.4 ± 6.4	0.650
Female sex	8 (44.4)	9 (40.9)	0.629
Body mass index (kg/m^2)	22.7 ± 2.7	21.7 ± 3.0	0.287
CACI ≥5	8 (44.4)	5 (22.7)	0.145
CBD diameter (mm)	19.6 ± 4.0	15.4 ± 3.7	0.002
No. of stones			0.386
Single	5 (27.8)	9 (40.9)	
Multiple	13 (72.2)	13 (59.1)	
Maximum stone size (mm)	14.0 ± 3.1	11.3 ± 4.1	0.023
Initial Total bilirubin (mg/dL)	2.8 ± 2.3	3.2 ± 4.1	0.681
Initial AST (U/L)	326.3 ± 415.6	232.4 ± 399.7	0.474
Initial ALT (U/L)	213.7 ± 268.8	195.4 ± 372.3	0.858
Number of treatments	1.0 ± 0.0	1.8 ± 0.7	<0.001
Posttreatment overall complication	4 (22.2)	3 (13.6)	0.477
Posttreatment serious complication	0 (0)	1 (4.5)	0.360
Posttreatment hospital stay (day)	6.4 ± 2.9	7.3 ± 6.2	0.607
Clearance of CBD stones	18 (100)	18 (81.8)	0.057
Recurrence of CBD stones	9 (50.0)	8 (36.4)	0.385

CBD, common bile duct; CACI, Charlson age comorbidity index.

study is significant because it is the first to report the surgical outcomes of re-do LCBDE for recurrent CBD stones.

First, we compared the results of the initial LCBDE and re-do LCBDE to evaluate the safety and feasibility of performing LCBDE. High CACI (≥5) and ASA PS classification (≥III), indicating poor general condition, were higher in the re-do LCBDE group than in the initial LCBDE group. However, no statistically significant differences were noted in the surgical outcomes, such as the estimated blood loss, operative time, open conversion, postoperative hospital stay, postoperative complications, and clearance rate between the 2 groups. Therefore, we confirmed that re-do LCBDE did not increase the surgical risk compared to that with initial LCBDE.

Second, we compared the re-do LCBDE and nonsurgical treatment groups. No significant differences were noted between the 2 groups in most treatment outcomes such as complications or length of hospital stay. However, the clearance rate in the re-do LCBDE group was higher than that in the nonsurgical treatment group, with marginal significance. In general, surgeons tend to be reluctant to perform re-surgeries because of postoperative adhesions or fibrosis in the surgical field. However, according to our study results, the results of re-do LCBDE were not inferior to those of nonsurgical treatment for recurrent CBD stones. Moreover, several patients with CBD stones are aged >70 years. For patient safety, it is necessary to reduce the number of treatments, not only surgical but also endoscopic or radiological. According to this study, the re-do LCBDE group underwent fewer treatments than the nonsurgical treatment group and showed a higher clearance rate, although the difference was statistically borderline. Therefore, re-do LCBDE should be actively considered in selected patients with recurrent CBD stones.

When performing re-do LCBDE, most surgeons are concerned about adhesions in the hepatoduodenal ligament area due to the first reoperation. Intraabdominal adhesions are an unavoidable challenge in reoperative patients. However, laparoscopic surgery can reduce postoperative adhesions compared with open surgery. Additionally, the authors of this study minimized the dissection around the CBD during the initial LCBDE. This approach allows for the opportunity to perform re-do LCBDE with minimal differences in operative time compared with the initial LCBDE.

LCBDE carries the risk of biliary complications such as bile leakage or bile duct stricture. Recent studies have reported bile leakage of 1.1%–3.8%, and biliary stricture of 0%–1.1% following LCBDE [18,19]. In this study, neither bile leakage nor biliary stricture occurred in the re-do LCBDE group. The authors believe that by dissecting only the anterior surface of the CBD without fully dissecting and isolating the entire CBD, which can prevent injury to the 3 and 9 o'clock arteries when performing a choledochotomy, and by suturing the choledochotomy site with absorbable sutures (usually PDS 5-0) without placing a drain tube unless absolutely necessary, they minimized fibrosis of the CBD after the initial LCBDE. This approach made it possible to perform re-do LCBDE without surgical difficulty and minimized complications such as bile leakage or bile duct stricture. Conversely, one case of biliary stenosis occurred in the initial LCBDE group, likely due to concurrent biliary leakage, which led to inflammation and adhesion formation.

CBD stone recurrence after treatment is relatively common, and its prediction and treatment are clinical issues. Our previous study identified risk factors such as old age, dilated CBD diameter, and combined type 1 periampullary diverticulum [12] to be more common in the re-do LCBDE group than in the initial LCBDE group. Maybe due to the impact of these risk factors; the recurrence rate was higher in the re-do group compared to the initial group (13.2% *vs.* 50%, $P < 0.001$). In addition, it has been reported that the cumulative recurrence rate of ERCP increased in recurrent cases [20], however, additional research is needed to determine whether the cumulative recurrence rate increases when LCBDE is repeated.

This study has several limitations. First, as a retrospective study, there is a possibility of selection bias in sample recruitment, and the small sample size may limit the representation of all re-do LCBDE cases. Second, the long duration of patient recruitment resulted in changes in surgical techniques over time. Specifically, the change from bile duct closure using a stent or T-tube insertion to primary closure may have increased the heterogeneity in surgical outcomes. Additional investigations involving a larger sample size with homogeneous characteristics are required to clarify the role of re-do LCBDE in the treatment of recurrent CBD stones.

In conclusion, this study demonstrated that, compared to initial LCBDE and endoscopic or radiologic treatment, re-do LCBDE for recurrent CBD stones is a treatment option worth considering in selected patients.

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Conflict of Interest

Ju Ik Moon, serving as an Editorial Board member of *Annals of Surgical Treatment and Research*, did not participate in the review process of this article. No other potential conflicts of interest pertinent to this article were reported.

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Methodology: SEL, DSY, WJC
Writing – Original Draft: IHL, SJL
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