ORIGINAL RESEARCH

Comparison of Laparoscopic Common Bile Duct Exploration and Endoscopic Retrograde Cholangiopancreatography in the Treatment of Bile Duct Stones and Analysis of Risk Factors for Postoperative Acute Pancreatitis

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ABSTRACT

Objective • To compare the clinical efficacy and safety of laparoscopic common bile duct exploration and endoscopic retrograde cholangiopancreatography in the treatment of bile duct stones, and to analyze the related factors influencing postoperative acute pancreatitis.

Methods • From March 2017 to June 2021, we recruited patients with bile duct stones to our study: 175 patients undergoing endoscopic retrograde cholangiopancreatography and 147 patients undergoing laparoscopic common bile duct exploration. The operative time, intraoperative blood loss, conversion to laparotomy, postoperative exhaust time, hospitalization time, liver function before and after the operation, and the incidence of adverse events were compared. Logistic regression analysis was used to analyze the related factors influencing postoperative acute pancreatitis.

Results • All patients were operated on successfully, with no conversion to laparotomy. Operative time, postoperative exhaust time, and hospitalization time were shorter, intraoperative blood loss was lower, and aspartate aminotransferase and alanine aminotransferase were higher in the endoscopic retrograde cholangiopancreatography group compared with the laparoscopic common bile duct exploration group ($P < .05$). The endoscopic retrograde cholangiopancreatography group had a higher incidence of adverse events than the laparoscopic common bile duct exploration group ($P < .05$). After logistic regression analysis, white blood cell concentration, operative time, intraoperative blood loss, previous history of pancreatic disease, and endoscopic retrograde cholangiopancreatography operation all independently influenced the occurrence of acute pancreatitis.

Conclusion • Laparoscopic common bile duct exploration is our first choice for patients with bile duct stones who have no history of abdominal surgery, cardiac or pulmonary valve insufficiency, bile duct stenosis, and poor duodenal papilla function, as it can reduce the occurrence of postoperative complications and shorten rehabilitation. Further investigation of the factors that independently caused postoperative acute pancreatitis after stone removal is warranted. (*Altern Ther Health Med.* 2023;29(6):358-363).

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INTRODUCTION

Bile duct stones (BDSs), which can form in the intrahepatic and extrahepatic bile ducts in response to cholestasis or biliary tract infection, are a common cause of biliary disease in China, and patients usually require surgical treatment to remove them.[1] Epigastric pain is the major symptom, accompanied by fever and jaundice in some cases. At present, the etiology of BDSs is still unclear; the known predisposing factors include biliary stricture, biliary obstruction, segmental bile duct dilatation, foreign bodies in the bile duct, and malnutrition.[2] BDSs can cause liver damage, biliary pancreatitis, biliary abscess, biliary cirrhosis, systemic infection, and even cholangiocarcinoma, posing a serious threat to patients' health.[3] A recent increase in the incidence of gallstones in China mirrors a significant increase in the incidence of extrahepatic BDSs secondary to gallstones moving into the bile duct.[4] Therefore, a more effective clinical treatment is needed to effectively remove stones, reduce complications, and improve patient prognosis.[5]

Because of the ongoing development of minimally invasive technology in China, traditional surgery is being gradually replaced by minimally invasive surgery, a procedure with less trauma and faster postoperative recovery.[6] Laparoscopic common bile duct exploration (LCBDE) is a minimally invasive operation of the biliary tract used for BDS treatment; it involves placing a choledochoscope into

the bile duct for exploration and stone removal, and it has fewer side effects, surgical injuries, and complications, and less pain than biliary ductotomy for lithotripsy.[7] Endoscopic retrograde cholangiopancreatography (ERCP) is another commonly used and minimally invasive BDS treatment method that is often used to diagnose and treat BDSs in the same operation.[8] To better clarify the therapeutic effect of LCBDE and ERCP on patients with BDSs, we analyzed the merits and shortcomings of the 2 procedures in the treatment of BDSs, and we explored the related factors influencing postoperative acute pancreatitis (POAP), so as to provide an effective reference and guidance for future clinical treatment plans.

MATERIALS AND METHODS

General data

We recruited 322 patients with BDSs who visited Yongkang First People's Hospital between March 2017 and June 2021, of which 175 patients who received ERCP were regarded as the ERCP group, and 147 patients who received LCBDE were regarded as the LCBDE group. The study was approved by the ethics committee of Yongkang First People's Hospital (approval No. YKYX-2022-94).

Eligibility criteria

Those patients diagnosed with BDSs by clinicians at Yongkang First People's Hospital, who met the treatment indications of LCBDE and ERCP,[9,10] and who had intact medical records and provided informed consent were included in our study. Pregnant women, or those with an iodine contrast agent allergy, anesthesia contraindication, coagulation dysfunction, severe cardiopulmonary disease, infectious diseases, malignant tumors, or mental disorders were excluded.

Surgical methods

The same senior surgical team performed all operations at Yongkang First People's Hospital. Patients in the LCBDE group first underwent laparoscopic cholecystectomy. After tracheal intubation under general anesthesia, a 1 cm trocar was used to puncture above the navel, and pneumoperitoneum was established with a pressure of 8 to 12 mm Hg. Using the 4-hole method, other cannulas were placed at the xiphoid process (1 cm deep), right subclavian midline (0.5 cm deep), and right front axilla (0.5 cm deep) to explore the abdominal cavity. Then, the gallbladder triangle was cut open to separate the gallbladder artery. The gallbladder artery was clamped with a ligature clamp and an automatic ligature clamp (Weck Hem-o-lok, Teleflex) and was divided using electrocoagulation. LCBDE was then performed: the bile duct was exposed, a 1- to 2-cm cut was made in the anterior wall, and a choledochoscope was placed for observation. After stone removal, a T-tube or bile duct suture was placed in an area of the bile duct where there was no stone residue. The gallbladder was then removed from the gallbladder bed, and the incision was closed after confirming that there was no active bleeding and bile leakage.

Patients in the ERCP group had their bile collected from the duodenal papilla by duodenoscopy under general anesthesia, and retrograde cholangiopancreatography was performed after injecting meglumine diatrizoate. Choledocholithiasis and the location, size, and number of stones were confirmed by cholangiopancreatography and preoperative ERCP; the incision location and size were determined by the results of the cholangiopancreatography and preoperative ERCP and the shape of the nipple. The stones were then removed with the use of a microscope. Larger stones were removed after mechanical lithotripsy. Laparoscopic cholecystectomy was performed after ERCP, using the same method as for the LCBDE group.

Observation indexes

The relevant surgical indicators of operative time, intraoperative blood loss, conversion to laparotomy, and postoperative exhaust time were recorded; liver function was assessed; and fasting venous blood was collected preoperatively and 3 days postoperatively to examine liver function indexes such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), and total bilirubin concentrations. adverse events that occurred in the 2 groups postoperatively until discharge were recorded. The related factors influencing POAP were explored.

Statistical methods

SPSS 23.0 was used for statistical analysis. Independent sample and paired *t* tests were used to compare measurement data represented by mean (SD). The chi-square test was used to compare count data represented by n (%). Logistic regression was used to analyze influencing factors related to POAP. $P < .05$ indicated the presence of statistically significant differences.

RESULTS

Comparison of clinical baseline data

We compared the baseline data of the 2 groups of patients (Table 1). The 2 groups of patients included in this study were comparable ($P > .05$).

Comparison of liver function

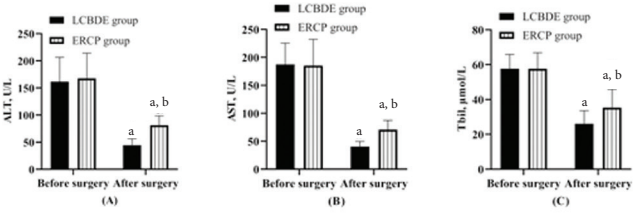
The potential for damage to patients' liver function from bile duct surgery is an important issue that deserves clinical attention. Therefore, we compared the liver function of the 2 groups before and after surgery. There were no significant differences in the preoperative ALT, AST, and total bilirubin concentrations between the ERCP and LCBDE groups ($P > .05$). ALT, AST and total bilirubin concentrations were lower postoperatively compared with their preoperative concentrations within each group ($P < .05$). Postoperatively, the ALT concentration of the LCBDE group of 44.46 (11.85) U/L was lower than that of the ERCP group ($P < .05$, Figure 1A), and the AST concentration of the LCBDE group of 40.35 (9.36) U/L was lower than that of the ERCP group ($P < .05$, Figure 1B). The total bilirubin of the LCBDE group of 35.39 (10.43) μmol/L was also lower than that of the ERCP group postoperatively ($P < .05$, Figure 1C).

Table 1. Comparison of Clinical Baseline Data

	LCBDE group (n = 147)	ERCP group (n = 175)	*t* or χ^2	*P* value
Age, mean (SD), y	63.1 (15.8)	62.2 (19.3)	0.5	.64
Stones, mean (SD), n	2.29 (1.40)	2.18 (1.29)	0.8	.46
White blood cells, mean (SD), 10^9/L	9.12 (5.45)	9.34 (5.31)	0.4	.72
Hemoglobin, mean (SD), g/L	123.18 (17.10)	128.00 (20.05)	1.9	.06
Platelets, mean (SD), 10^9/L	200.75 (81.72)	196.61 (66.15)	0.5	.62
Gender			0.9	.34
Male	62	83		
Female	85	92		
Smoking			1.4	.24
Yes	35	52		
No	112	123		
Drinking			NA	.95
Yes	29	34		
No	118	141		
History of pancreatic disease			0.7	0.42
Yes	25	36		
No	122	139		

Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; LCBDE, laparoscopic common bile duct exploration.

Figure 1. Comparison of Liver Function**.** A, Comparison of ALT before and after surgery [Before surgery LCBDE group: 161.86 (44.68) and before surgery ERCP group: 167.79 (46.52). After surgery LCBDE group: 44.46 (11.85), after surgery ERCP group: 81.39 (17.32)]. B, Comparison of AST before and after surgery [Before surgery LCBDE group: 187.61 (37.94) and before surgery ERCP group: 185.53 (46.77). After surgery LCBDE group: 40.35 (9.36), after surgery ERCP group: 70.85 (16.38)]. C, Comparison of total bilirubin before and after surgery [Before surgery LCBDE group: 57.64 (8.18) and before surgery ERCP group: 57.62 (9.21). After surgery LCBDE group: 26.09 (7.50), after surgery ERCP group: 35.39 (10.43)].



[a]*P* < .05, vs before surgery
[b]*P* < .05, vs LCBDE group

Abbreviations: ALT, alanine aminotransferase; AST, aspartate aminotransferase; Tbil, total bilirubin.

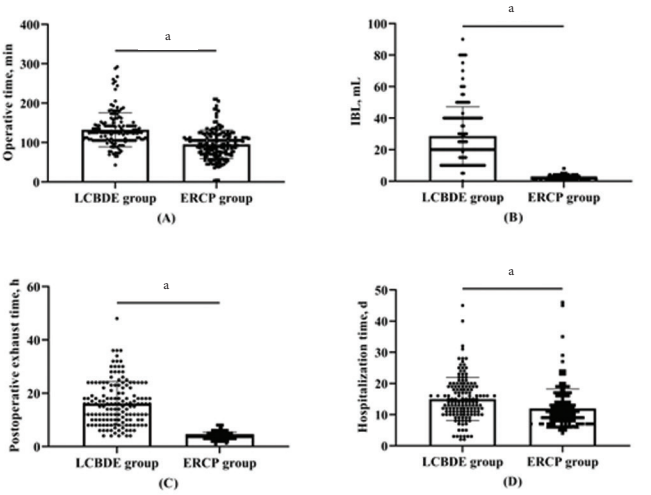
Comparison of operation conditions

The success rate of the operations in both groups was 100%, with no conversion to laparotomy. The intergroup comparison showed a longer operative time for the LCBDE group of 132.99 (42.90) minutes compared with the ERCP group of 95.90 (35.98) minutes (*P* < .05, Figure 2A). The intraoperative blood loss of the LCBDE group was 28.68 (18.67) mL, higher than that of the ERCP group (*P* < .05, Figure 2B). The postoperative exhaust time of the LCBDE group was 16.44 (8.32) hours, which was significantly longer when compared with the ERCP group of 4.07 (1.28) hours (*P* < .05, Figure 2C). The hospitalization time of the LCBDE group was 15.07 (6.91) days, which was longer than that of the ERCP group (*P* < .05, Figure 2D). Comparison of these operation conditions between the 2 groups suggests higher surgical safety and shorter postoperative recovery time with ERCP than with LCBDE.

Comparison of adverse events

Neither group had postoperative incision infection. In the LCBDE group, 1 patient (7.48%) had POAP, 16 patients (10.88%) had cholangitis, and 7 patients (4.76%) had bleeding. In the ERCP group, 26 patients (14.86%) had POAP, 22 patients (12.57%) had cholangitis, 8 patients (4.57%) had hyperamylasemia, and 4 patients (2.29%) had bleeding. The incidence of postoperative complications was lower in the LCBDE group than in the ERCP group (*P* < .05, Table 2).

Figure 2. Comparison of Operation Conditions. A, Comparison of operative time [LCBDE group: 132.39 (43.24) and ERCP group: 95.56 (36.06)]. B, Comparison of intraoperative blood loss (IBL) [LCBDE group: 28.61 (18.56) and ERCP group: 2.37 (1.16)]. C, Comparison of postoperative exhaust time [LCBDE group: 16.16 (8.19) and ERCP group: 406 (1.29)]. D, Comparison of hospitalization time [LCBDE group: 15.02 (6.90) and ERCP group: 11.99 (6.23)].



[a]*P* < .05

Table 2. Comparison of adverse events

	POAP, mean (SD), n	Cholangitis, mean (SD), n	Bleeding, mean (SD), n	Hyperamylasemia, mean (SD), n	ARs, %
LCBDE group (n = 147)	11 (7.48)	16 (10.88)	7 (4.76)	0 (0.0)	23.13
ERCP group (n = 175)	26 (14.86)	22 (12.57)	4 (2.29)	8 (4.57)	34.29
χ^2	NA	NA	NA	NA	4.8
P value	NA	NA	NA	NA	.028

Abbreviations: AR, adverse reaction; ERCP, endoscopic retrograde cholangiopancreatography; LCBDE, laparoscopic common bile duct exploration; NA, not applicable; POAP, postoperative acute pancreatitis.

Table 3. Univariate Analysis of Postoperative Acute Pancreatitis

	Patients without POAP (n = 285)	Patients with POAP (n = 37)	*t* or χ^2	*P* value
Age, mean (SD), y	61.0 (17.6)	75.0 (13.8)	4.7	<.001
Stones, mean (SD), n	2.22 (1.33)	2.30 (1.45)	0.3	.73
White blood cells, mean (SD), 10^9/L	8.28 (4.31)	16.64 (6.82)	10.2	<.001
Hemoglobin, mean (SD), g/L	125.71 (19.32)	126.57 (15.40)	0.3	.80
Platelets, mean (SD), 10^9/L	198.30 (76.14)	199.97 (50.13)	0.1	.90
OT, mean (SD), min	112.01 (41.17)	119.19 (57.93)	0.9	.34
IBL, mean (SD), mL	14.39 (17.67)	14.32 (8.48)	0.1	.98
Postoperative exhaust time, mean (SD), h	8.48 (10.10)	9.37 (7.96)	0.5	.61
Gender			0.4	.51
Male	126	18		
Female	159	18		
Smoking			0.2	.62
Yes	76	11		
No	209	25		
Drinking			0.2	.68
Yes	55	8		
No	230	28		
Surgical method			5.3	.02
LCBDE/ERCP	136	11		
ERCP	149	26		
History of pancreatic disease			46.7	<.001
Yes	39	22	NA	NA
No	246	14		

Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; IBL, intraoperative blood loss; LCBDE, laparoscopic common bile duct exploration; NA, not applicable; OT, operative time; POAP, postoperative acute pancreatitis.

Table 4. Multivariate Analysis of Postoperative Acute Pancreatitis

Factor	*b*	SE	Wald χ^2	*P* value	OR	95% CI
Age	1.106	0.787	2.0	>.05	3.04	2.14-7.54
White blood cell concentration	1.443	0.0341	22.7	<.05	4.24	1.54-6.54
History of pancreatic disease	1.214	0.341	14.5	<.05	3.34	1.84-6.11
Surgical method	1.209	0.224	28.8	<.05	1.97	0.87-3.67

Abbreviations: ERCP, endoscopic retrograde cholangiopancreatography; LCBDE, laparoscopic common bile duct exploration; OR, odds ratio.

Univariate analysis of POAP

Next, we compared data from patients with and without POAP. There was no significant difference in hemoglobin concentration, platelet concentration, operative time, intraoperative blood loss, liver function test results, gender composition, number of smokers and drinkers, and number of stones between POAP and non-POAP patients ($P > .05$), indicating that the above factors did not individually influence the occurrence of POAP. However, age, white blood cell concentration, previous history of pancreatic disease, and number of patients undergoing ERCP were significantly higher in patients with POAP compared with non-POAP patients ($P < .05$, Table 3), suggesting these individual factors can affect the occurrence of POAP.

Multivariate analysis of POAP

Subsequent to our univariate analysis of POAP, we assigned the factors of age (data are continuous variables; raw data was used for analysis), white blood cell concentration (data are continuous variables; raw data was used for analysis), previous history of pancreatic disease (No was assigned a value of 0 and Yes was assigned a value of 1), and number of patients under going ERCP (LCBDE was assigned a value of 0 and ERCP was assigned a value of 1) (which were higher in patients with POAP compared with non-POAP patients) as covariates and made multiple logistic regression analyses with POAP or non-POAP as the dependent variable. Age was not an independent factor that affected POAP ($P > .05$), but white blood cell concentration, previous history of pancreatic disease, and the ERCP operation were independent factors that affected POAP ($P < .05$, Table 4).

DISCUSSION

BDS disease is one of the most common types of stone disease at present and has a very high incidence worldwide.[11] Currently, the specific pathogenesis of BDSs has not been completely clarified. Clinical factors such as biliary tract infection, intestinal obstruction, parasites, and malnutrition may cause BDSs. Progression of BDS disease may cause liver function damage, cirrhosis, systemic infection, and even cholangiocarcinoma.[12] Therefore, timely and effective treatment for BDSs is important to ensure the safety of patients' lives. Stone removal is currently the most direct and effective way to treat BDSs in the clinic, with well documented effects.[13] However, patients have high expectations for the therapeutic effect of stone removal surgery, and the improvement of surgical techniques is an ongoing area of development. Therefore, finding the best and safest surgical

method of stone removal has become the focus of current clinical research. LCBDE and ERCP, 2 of the most commonly used surgical procedures for BDSs, are rarely compared. Therefore, this study has important reference significance for future clinical selection of BDS surgery. In addition, POAP, one of the most common complications after BDS surgery, seriously affects the recovery of patients.[14] Hence, a focus of modern clinical treatment is the avoidance of POAP. Our analysis of the related factors of POAP also inform the future treatment of BDSs.

In this study, we found no differences in pre- and postoperative liver function between the LCBDE and ERCP groups, indicating that the 2 procedures did little damage to liver function and could be used to treat cholelithiasis.

We also compared surgical indicators and found lower operative time and less intraoperative blood loss in the ERCP group compared with the LCBDE group, indicating that ERCP contributed to less damage to patients. Thus, ERCP could offer a faster recovery time of patients' bodily functions after surgery. For example, LCBDE surgery is more complicated, and the gastrointestinal function of patients undergoing ERCP surgery is only lightly affected by anesthesia. In addition, intestinal inflation during ERCP can stimulate gastrointestinal activity and accelerate postoperative intestinal exhaust time. However, when comparing the postoperative complications, we found a lower complication rate in the LCBDE group than in the ERCP group, indicating that LCBDE has higher safety for BDS treatment. It is well known that patients with BDSs have unfavorable postoperative recovery and complications because of the need for cholecystectomy during stone removal.[15] Therefore, a safer operation can provide more effective assurance for patients' postoperative rehabilitation. ERCP requires papilla sphincterotomy, which inevitably destroys the integrity and function of the sphincter, causing reflux.[16] In addition, increased incidence of recurrent cholangitis, POAP, choledocholithiasis, and even biliary malignancy over time.[17] Moreover, Tsapaki et al reported that the stone extraction success rate by ERCP is greatly reduced for stones larger than 2 cm and for a large number of stones because of the limitation of the incision length.[18]

We believe that it is precisely because of these limitations that the postoperative conditions of the patients in the ERCP group were not as ideal as those in the LCBDE group. For LCBDE, cholecystectomy and bile duct exploration can be performed simultaneously under conventional operating room conditions, which protects the function of the duodenal papilla sphincter, prevents retrograde infection, and and reduces the likelihood that stones could be left behind.[19] However, LCBDE is more difficult to implement than ERCP due to its requirements for more specialized training and endoscopic equipment.[20]

LCBDE has limitations, such as prolonged operative time for elderly patients with declining cardiopulmonary function, especially those with a history of upper abdominal surgery, which increases the operative risk.[21] Moreover, LCBDE generally requires indwelling of the T-tube, so the possibility of bile infection and the pain of the removal of the T-tube are greater, and there is a risk of bile leakage.[22] Therefore, we believe that LCBDE should be the first choice for patients with BDS with no history of abdominal surgery.

Our subsequent analysis of the causes of POAP after lithotomy led us to conclude that white blood cell concentration, previous history of pancreatic disease, and the ERCP operation were potential independent influencing factors, consistent with previous research.[23] Thus, ERCP may be more harmful to patients. Therefore, a focus for the future clinical treatment of patients with BDS will be to pay attention to the patient's condition and to choose the best surgical plan so as to reduce the possibility of POAP and improve the quality of rehabilitation.

There are some limitations to our study. Because of the short study period, we were unable to evaluate the long-term prognosis of patients with BDS for the 2 surgical procedures. We also need to compare more BDS treatments to further understand the advantages and address the disadvantages of LCBDE and ERCP.

CONCLUSIONS

LCBDE is our first choice for patients with BDS who have no history of abdominal surgery, cardiac and pulmonary valve insufficiency, bile duct stenosis, and poor duodenal papilla function; LCBDE can reduce the occurrence of postoperative complications and shorten the rehabilitation cycle in those patients. White blood cell concentration, previous history of pancreatic disease, and ERCP all independently cause POAP after stone removal, which needs clinical attention.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ETHICS APPROVAL

The study was approved by the ethics committee of Yongkang First People's Hospital (approval No. YKYX-2022-94).

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