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ORIGINAL ARTICLE

Retrospective Study

Clinical efficacy of laparoscopic cholecystectomy combined with endoscopic papillary balloon dilation in treatment of gallbladder stones with common bile duct stones: A retrospective study

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Abstract

BACKGROUND

The incidence of cholelithiasis has been on the rise in recent years, but the choice of procedure is controversial.

AIM

To investigate the efficacy of laparoscopic cholecystectomy (LC) combined with endoscopic papillary balloon dilation (EPBD) in patients with gallbladder stones (GS) with common bile duct stones (CBDS).

METHODS

The clinical data of 102 patients with GS combined with CBDS were selected for retrospective analysis and divided into either an LC + EPBD group (n = 50) or an LC + endoscopic sphincterotomy (EST) group (n = 52) according to surgical methods. Surgery-related indexes, postoperative recovery, postoperative complications, and expression levels of inflammatory response indexes were compared between the two groups.

RESULTS

Total surgical time, stone free rate, rate of conversion to laparotomy, and successful stone extraction rate did not differ significantly between the LC + EPBD group and LC + EST group. Intraoperative hemorrhage, time to ambulation, and length of hospitalization in the LC + EPBD group were lower than those of the LC + EST group (P < 0.05). The rate of total complications of the two groups was 9.80% and 17.65%, respectively, and the difference was not statistically significant. No serious complications occurred in either group. At 48 h postoperatively, the expression levels of interleukin-6, tumor necrosis factor-α, high-sensitivity C-reactive protein, and procalcitonin were lower in the LC + EPBD group than in

the LC + EST group ($P < 0.05$). At 3 d postoperatively, the expression levels of aspartate transaminase, alanine transaminase, and total bilirubin were lower in the LC + EPBD group than in the LC + EST group ($P < 0.05$).

CONCLUSION

LC combined with EPBD and LC combined with EST are both effective procedures for the treatment of GS with CBDS, in which LC combined with EPBD is beneficial to shorten the patient's hospitalization time, reduce the magnitude of elevated inflammatory response indexes, and promote postoperative recovery.

Key Words: Gallbladder stone; Common bile duct stone; Endoscopic papillary balloon dilation; Laparoscopic cholecystectomy; Endoscopic sphincterotomy

Core Tip: The study investigated the efficacy of laparoscopic cholecystectomy (LC) combined with endoscopic papillary balloon dilation (EPBD) and LC combined with endoscopic sphincterotomy (EST) in the treatment of gallbladder stones with common bile duct stones. The results demonstrated a significant reduction in intraoperative bleeding and postoperative recovery time in the LC + EPBD group compared to the LC + EST group. Additionally, there was a notable improvement in inflammatory indexes and liver function. Therefore, LC combined with EPBD may be beneficial to the hospitalization time and inflammatory response of such patients.

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INTRODUCTION

In recent years, there has been a notable increase in the incidence of cholelithiasis. Notably, the prevalence of gallbladder stones (GS) combined with common bile duct stones (CBDS) reaches as high as 20%[1]. The pathogenesis of GS combined with CBDS is multifactorial, involving genetic predisposition and dietary habits, and it is a common disease in clinical surgery. If not treated in time, it can lead to serious complications such as biliary obstruction, posing a life-threatening risk to the patient[2]. GS combined with CBDS is an important clinical problem. In symptomatic patients, the primary goal is to achieve complete stone removal and perform cholecystectomy, while for asymptomatic patients, there remains a lack of standardized treatment options[3]. Studies have found that approximately 25% of patients with GS experience symptoms and/or complications, with a 1%-2% incidence of serious complications. The primary etiology of complications lies in the migratory nature of stones, with common manifestations including biliary pain, pancreatitis, bile duct obstruction, and cholangitis. These complications are typically precipitated by stone migration[4].

The selection of a safer and more effective treatment method for patients with GS combined with CBDS is of paramount importance at present. In general, laparoscopic cholecystectomy (LC) is considered as the preferred method for treating benign gallbladder diseases because of its advantages of short operation time, minimal trauma, and rapid postoperative recovery[5]. In addition, LC combined with endoscopic papillary balloon dilation (EPBD) and LC combined with endoscopic sphincterotomy (EST) have been widely used to treat GS combined with CBDS[6]. The application of EPBD has been reported to result in a decreased occurrence of recurrent cholecystitis, cholangitis, and bile duct stones when compared to EST[7]. A randomized controlled trial showed that the incidence of postoperative pancreatitis after EPBD was 16.7%, which was significantly higher than that of EST surgery[8]. However, another study indicated that the incidence of pancreatitis could be reduced by prolonging the duration of EPBD balloon dilatation[9]. This implies that there remains a degree of debate concerning the selection between these two methodologies. Therefore, this retrospective clinical study aimed to compare the efficacy of LC combined with EPBD *vs* LC combined with EST for treating GS combined with CBDS in 102 patients in the Gastroenterology Department of our hospital.

MATERIALS AND METHODS

General information

The clinical data of 102 patients with GS combined with CBDS in the Department of Gastroenterology of the Third Affiliated Hospital of Qiqihar Medical University Hospital from December 2018 to December 2023 were selected for a retrospective study, and they were divided into either an EPBD + LC group ($n = 50$) or an EST + LC group ($n = 52$) according to the surgical methods.

The inclusion criteria were: (1) Patients meeting the diagnostic criteria for GS and CBDS in the 7th edition of Surgery; (2) Patients with a diagnosis of the condition confirmed by computed tomography, magnetic resonance imaging, and other imaging examinations before surgery; (3) Patients with a diameter of the common bile duct ≥ 0.8 cm, and the maximum diameter of CBDS < 2.0 cm; (4) Patients aged 42-75 years old; (5) Patients providing written informed consent; and (6) Patients with no contraindications to surgery or anesthesia.

The exclusion criteria were: (1) Patients with a prior history of upper abdominal surgery; (2) Patients diagnosed with neoplasms affecting the gallbladder or biliary system; (3) Patients with acute septic cholangitis or acute pancreatitis; and (4) Patients with incomplete clinical data. The study was approved by the Ethics Committee of the Third Affiliated Hospital of Qiqihar Medical University (No. 2023LW-3) and all participants provided written informed consent. The study was conducted in accordance with the Declaration of Helsinki.

Treatment methods

Before the treatment of choledocholithiasis, patients were required to undergo a routine preoperative evaluation to assess their cardiovascular and respiratory fitness. Additionally, they must adhere to a fasting period of 6 h prior to surgery. The LC + EPBD group was treated as follows. First, the patient was given lidocaine local anesthesia to anesthetize the pharynx. Then, operating endoscopically, a guidewire was placed at the opening of the papilla and a dilatation balloon was placed in the position of the guidewire. The balloon dilation was observed and, following confirmation of proper dilation, the guidewire and balloon catheter were withdrawn from the body. Next, the stones were removed from the common bile duct using a reticular basket to ensure that they were completely removed and the duct was clear. A nasobiliary tube was placed for drainage after the procedure and an LC was scheduled at a later time.

The LC + EST group was treated as follows. The patient was positioned in the left lateral decubitus position and received general anesthesia. A duodenoscope was then inserted through the oral cavity, followed by a precise incision made in the papillary sphincter using a high-frequency electric knife. Next, stones were removed from the common bile duct using a reticular basket for stone extraction, and a nasobiliary tube was placed for drainage. Food and water were fasted for 24 h postoperatively, and LC was performed after the patient's condition was stabilized.

Observation indicators

Observational indicators included patients' general information, surgical success rate, surgery-related indexes, post-surgical recovery, and complications (before discharge). Inflammatory indexes [interleukin-6 (IL-6), IL-10, tumor necrosis factor-α (TNF-α), high-sensitivity C-reactive protein (hs-CRP), and procalcitonin (PCT)], hepatic function indexes [aspartate transaminase (AST), alanine transaminase (ALT), and total bilirubin (TBIL)], surgery-related indexes (stone free rate, total operation time, intraoperative hemorrhage, rate of conversion to laparotomy, *etc.*), postoperative recovery [visual analogue scale (VAS) score at 6 h postoperatively, time to postoperative exhaust, time to ambulation, length of hospitalization, *etc.*], and complications (hemorrhage, cholecystitis, acute pancreatitis, *etc.*) were also recorded.

Surgical success rate was judged by the following criteria. "Significantly effective" referred to the complete resolution of clinical symptoms, total elimination of stones, and restoration of normal gastrointestinal function within 24 h post-surgery without any complications. "Effective" meant achieving clinical symptom improvement, complete stone removal, and restoration of normal gastrointestinal function within 7 d after surgery without any infections or complications. "Ineffective" meant not meeting the criteria for symptoms, stones, and gastrointestinal function mentioned above. The surgical success rate was calculated as (significantly effective + effective) cases/total cases × 100%.

Evaluation of therapeutic effects

The efficacy for a duration of 14 d was assessed based on the criteria outlined in the Surgery of Hepatobiliary Oncology: Significantly effective: Ultrasonography revealed a significant reduction in the thickness and size of the gallbladder wall, approaching normal levels. No recurrence has been observed for three consecutive months; effective: Although the volume of the gallbladder wall and lower gallbladder was not within normal range, it exhibited obvious thinning and shrinkage, leading to significant alleviation of clinical symptoms; ineffective: Absence of any alteration in the volume of the gallbladder wall and lower gallbladder, coupled with a lack of reduction or even exacerbation of clinical symptoms.

Statistical analysis

SPSS 22.0 software was used for statistical analyses. Measurement data are expressed as the mean ± SD, and comparisons between groups were conducted using a *t*-test. Count data are presented as *n* (%), and comparisons between groups were performed using a χ^2 test. A *P* value of less than 0.05 was considered statistically significant.

RESULTS

General information of patients

The comparison of age, gender, body mass index, size of bile duct stones, diameter of common bile duct, and number of bile duct stones between the two groups of patients did not reveal any statistically significant differences ($P > 0.05$) (Table 1).

Surgical success rate

There was no significant difference in the success rates between the two groups ($P > 0.05$) (Table 2).

Table 1 General data of the two patient groups

Variable	LC + EPBD group (*n* = 50)	LC + EST group (*n* = 52)	t/χ^2	*P* value
Age (year)	57.22 ± 8.03	58.19 ± 8.74	-0.584	0.560
Gender (male/female)	25/24	24/28	0.151	0.698
BMI	22.35 ± 3.21	23.15 ± 3.91	-1.127	0.263
Size of bile duct stones (mm)	8.18 ± 2.19	8.56 ± 2.57	-0.797	0.427
Diameter of the common bile duct (mm)	11.84 ± 1.40	12.12 ± 1.59	-0.925	0.357
Number of bile duct stones (*n*)	3.02 ± 1.22	2.77 ± 1.17	1.062	0.291

LC: Laparoscopic cholecystectomy; EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation; BMI: Body mass index.

Table 2 Comparison of surgical success rates between the two groups, *n* (%)

Item	LC + EPBD group (*n* = 50)	LC + EST group (*n* = 52)	χ^2	*P* value
Significantly effective	38 (76.00)	37 (71.20)	0.527	0.768
Effective	9 (18.00)	10 (19.20)		
Ineffective	3 (6.00)	5 (9.60)		
Surgical success rate	47 (94.00)	44 (90.40)		

LC: Laparoscopic cholecystectomy; EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation.

Surgery-related indicators

Total operation time, rate of conversion to laparotomy, stone removal rate, and success rate of stone extraction did not differ significantly between the two groups ($P > 0.05$). Intraoperative hemorrhage, time to ambulation, and length of hospitalization were significantly lower in the LC + EPBD group than in the LC + EST group ($P < 0.05$) (Table 3).

Comparison of postoperative recovery between the two groups

Comparison of VAS score at 6 h postoperatively and time to postoperative exhaust between the two groups showed no statistically significant difference ($P > 0.05$). The time to ambulation and hospitalization time of patients in the LC + EPBD group were significantly shorter than those of the LC + EST group ($P < 0.05$) (Table 4).

Comparison of complications after surgery in the two groups

The overall incidence of complications in the LC + EPBD and LC + EST groups was 7.84% and 9.80%, respectively. All the complications resolved after conservative treatment. Although the number of cases of pancreatitis in the LC + EPBD group was more than that of the LC + EST group, and the number of cases with cholangitis and abdominal infection was significantly less than that of the LC + EST group ($P > 0.05$) (Table 5).

Expression of inflammatory response indicators

Before surgery, IL-6, IL-10, TNF-α, hs-CRP, and PCT were not significantly different between the two groups ($P > 0.05$). At 48 h after surgery, IL-6, TNF-α, hs-CRP, and PCT in the LC + EPBD group were significantly lower than those of the LC + EST group ($P < 0.05$) (Table 6).

Comparison of preoperative and postoperative liver function indexes between the two groups

The expression levels of AST, ALT, and TBIL were not significantly different between the two groups before operation ($P > 0.05$). At 3 d after surgery, AST, ALT, and TBIL in both groups were lower than preoperative values, and AST, ALT, and TBIL in the LC + EPBD group were significantly lower than those of the LC + EST group ($P < 0.05$) (Table 7).

DISCUSSION

Cholelithiasis, a common biliary tract disease both domestically and internationally, can be categorized into cholesterol stones, pigment calculus, and combination calculus based on their composition. It is often caused by bile stasis, bacterial infections, and other factors leading to the formation of single or multiple stone obstructions in any part of the biliary tract system. Consequently, symptoms such as abdominal pain, nausea and vomiting, and jaundice may occur[10].

Table 3 Surgery-related indicators in the two groups

Item	LC + EPBD group (*n* = 50)	LC + EST group (*n* = 52)	t/χ^2	*P* value
Total operation time (min)	94.16 ± 14.32	92.37 ± 12.85	0.667	0.507
Intraoperative hemorrhage (mL)	32.98 ± 8.95	37.48 ± 8.85	-2.554	0.012
Rate of conversion to laparotomy, *n* (%)	0	0	/	/
Success rate of stone extraction, *n* (%)	48 (96.00)	49 (94.20)		1.000
Stone removal rate, *n* (%)	48 (96.00)	50 (96.20)		1.000

LC: Laparoscopic cholecystectomy; EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation.

Table 4 Comparison of postoperative recovery between the two groups

Item	LC + EPBD group (*n* = 50)	LC + EST group (*n* = 52)	*t*	*P* value
VAS score	3.06 ± 0.74	3.21 ± 0.87	-0.945	0.347
Time to postoperative exhaust (d)	1.34 ± 0.63	1.42 ± 0.67	-0.648	0.519
Time to ambulation (d)	1.32 ± 0.62	1.82 ± 0.51	-4.502	< 0.001
Hospitalization time (d)	11.52 ± 1.76	11.98 ± 1.48	-1.433	0.155

LC: Laparoscopic cholecystectomy; EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation; VAS: Visual analogue scale.

Table 5 Comparison of complications after surgery in the two groups, *n* (%)

Item	LC + EPBD group (*n* = 50)	LC + EST group (*n* = 52)	χ^2	*P* value
Pancreatitis	3 (6.00)	2 (3.80)		0.675
Cholangitis	1 (2.00)	2 (3.80)		1.000
Abdominal infection	0	1 (1.90)		1.000
Death	0	0		/
Perforation	0	0		/
Overall complications	4 (8.00)	5 (9.60)		1.000

LC: Laparoscopic cholecystectomy; EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation.

Historically, surgical interventions such as open exploratory cholecystectomy and choledochotomy for stone extraction have been the primary treatments for GS combined with CBDS. The advancement of minimally invasive endoscopic techniques has led to the development of various surgical procedures for treating GS combined with CBDS, although there is still some controversy regarding the optimal treatment method. Studies have confirmed that LC is a safe and effective procedure for treating GS, observing gallbladder structures and adhesions under laparoscopic guidance, reducing perioperative stress reactions, and promoting rapid postoperative physical recovery[11]. The combination of LC with EST and EPBD represents two distinct approaches for the treatment of GS combined with CBDS, offering the advantages of reduced invasiveness, diminished pain, accelerated recovery, and shortened hospitalization duration[12]. According to the national and international literature, the combination of LC with EPBD and EST has demonstrated significant clinical benefits in the treatment of GS combined with CBDS[13,14]. The efficacy of EST in the treatment of GS combined with CBDS is widely acknowledged, although it carries potential risks including hemorrhage, perforation, and permanent impairment of sphincter function[15,16]. To mitigate these complications, the EPBD technique was introduced for the management of GS combined with CBDS. This technique involves utilizing a biliary dilatation balloon to enlarge the biliary orifice without incising the papillary sphincter, as initially reported by Ishii *et al*[17].

The incidence of bleeding and perforation during EPBD was reported to be extremely low, particularly in the presence of coagulation disorders or anatomical alterations. Additionally, the efficacy of stone removal was found to be comparable to that achieved with EST[18]. The findings of this study demonstrated that the combination of LC and EPBD exhibited advantages in terms of intraoperative hemorrhage, time to ambulation, and length of hospitalization. These results suggest that LC combined with EPBD may effectively reduce intraoperative hemorrhage and promote patient recovery. This could be attributed to the avoidance of papillary sphincter incision by EPBD, which preserves the integrity

Table 6 Expression of inflammatory response indicators in the two groups

Indicator	LC + EPBD group (*n* = 50)	LC + EST group (*n* = 52)	*t*	*P* value
IL-6 (pg/mL)				
Preoperative	12.96 ± 2.83	13.21 ± 3.25	0.426	0.671
48 h postoperatively	20.43 ± 3.02	24.84 ± 3.51	6.783	< 0.001
IL-10 (pg/mL)				
Preoperative	17.35 ± 3.94	16.21 ± 4.06	1.439	0.153
48 h postoperatively	13.43 ± 2.25	13.26 ± 2.47	0.347	0.729
TNF-α (pg/mL)				
Preoperative	18.35 ± 4.32	18.92 ± 4.75	0.624	0.534
48 h postoperatively	36.36 ± 8.35	46.22 ± 8.95	5.744	< 0.001
hs-CRP (mg/L)				
Preoperative	4.43 ± 1.38	4.78 ± 1.67	1.177	0.242
48 h postoperatively	15.07 ± 3.04	18.75 ± 5.16	4.361	< 0.001
PCT (ng/mL)				
Preoperative	0.35 ± 0.14	0.32 ± 0.16	1.039	0.301
48 h postoperatively	1.42 ± 0.47	1.51 ± 0.38	1.069	0.290

LC: Laparoscopic cholecystectomy; EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation; IL: Interleukin; TNF: Tumor necrosis factor; hs-CRP: High-sensitivity C-reactive protein; PCT: Procalcitonin.

Table 7 Comparison of liver function indicators in the two groups

Indicator	LC + EPBD group (*n* = 50)	LC + EST group (*n* = 52)	*t*	*P* value
AST (U/L)				
Preoperative	54.72 ± 4.36	55.24 ± 5.55	0.525	0.600
3 d postoperatively	30.56 ± 5.64	41.91 ± 6.03	9.804	< 0.001
ALT (U/L)				
Preoperative	72.84 ± 6.92	71.43 ± 7.58	0.973	0.333
3 d postoperatively	47.94 ± 7.37	59.35 ± 7.58	7.699	< 0.001
TBIL (umol/L)				
Preoperative	52.14 ± 6.42	54.22 ± 7.15	1.537	0.127
3 d postoperatively	24.14 ± 6.45	27.22 ± 7.05	2.293	0.024

LC: Laparoscopic cholecystectomy; EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation; AST: Aspartate transaminase; ALT: Alanine transaminase; TBIL: Total bilirubin.

of biliary-intestinal union and maintains its physiological function. In addition, the incidence of postoperative complications was lower in both groups, which proved that both LC combined EPBD and LC combined EST have high safety and could effectively avoid excessive injury to the body. Although the incidence of pancreatitis was higher in the LC + EPBD group compared to the LC + EST group, the difference did not reach statistical significance. Some researchers suggest that pancreatitis may be attributed to sphincter dilatation leading to intramucosal hemorrhage, edema, and subsequent obstruction of the pancreatic duct[19]. Meanwhile, several studies have demonstrated a negative correlation between the duration of EPBD and the risk of pancreatitis. Additionally, it has been observed that balloon dilatation for ≤ 1 min increases the likelihood of pancreatitis in patients with CBDS. However, prolonging the duration to at least > 3 min effectively reduces the incidence of pancreatitis[20]. Therefore, EPBD may be a safe and effective alternative to EST for the treatment of GS combined with CBDS.

In addition, patients often have different stress responses during surgery, which may suppress the immune response and heighten inflammation levels, increasing the risk of postoperative complications. The control of inflammation is a crucial determinant for disease prognosis and recovery[21]. IL-6, TNF-α, hs-CRP, and PCT are all common indicators of

inflammatory response in the body, and are associated with the risk of gallstone disease. Among them, IL-6 is an important pro-inflammatory factor, which is produced by a variety of immune cells stimulated by various factors to participate in the body's inflammatory and immune responses[22]. Studies have shown that IL-6 overexpression in the biliary epithelium causes inflammatory cell infiltration and increases the thickness of the gallbladder wall, thus inducing gallstones[23]. IL-6 also induces the liver to release the non-specific acute phase protein CRP, which is normally expressed at low levels, but when an acute inflammatory response is initiated, CRP rises dramatically, exerting an anti-inflammatory effect and reducing excessive tissue damage[24]. TNF-α production is often significantly increased during trauma, inflammation, and infection. Wan *et al*[25] confirmed that it was elevated after GS combined with CBDS, which may reflect the body's stress to inflammation and trauma.

PCT, serving as a biomarker for assessing inflammatory response, typically remains at a basal level. However, during the period of inflammation, its expression level becomes elevated, reflecting the severity of inflammation within the body [26]. The severity of acute cholecystitis is positively correlated with PCT, making it a valuable laboratory indicator for assessing the severity of this complication in gallstone patients[27]. In this study, both groups exhibited high levels of IL-6, TNF-α, hs-CRP, and PCT after surgery. However, the elevation of IL-6, TNF-α, hs-CRP, and PCT was comparatively lower in the LC + EPBD group than in the LC + EST group. This difference can be attributed to the fact that in the LC + EPBD group, repeated lithotripsy is avoided during surgery, thereby mitigating biliary tract injury and reducing traumatic operations such as resection and other stress reactions.

The liver function indexes, including ALT, AST, and TBIL, can serve as indicators of hepatocellular injury severity. In patients with GS combined with CBDS, significantly elevated levels of serum AST, ALT, and TBIL were observed. This finding may be attributed to the impact of artificial pneumoperitoneum during surgery on hepatic tissue hemodynamics and subsequent reduction in blood flow through the hepatic artery and portal vein leading to impaired liver function [28]. In addition, a meta-analysis found that CBDS was the most common etiology for significantly elevated ALT levels (> 500 IU/L), and that approximately one-third of patients with CBDS would present with ALT or AST > 500 IU/L[29]. The elevation of TBIL levels in certain pathological conditions may augment and predispose to the development of gallstones [30]. In this study, the preoperative liver function indexes of the patients were consistent with previous findings. The LC + EPBD group demonstrated a significant reduction in AST, ALT, and TBIL levels, indicating that this approach effectively improved liver function. This could be attributed to the fact that LC combined with EPBD obviated the need for incising the papillary sphincter, thereby mitigating local damage and reducing inflammatory factor release, ultimately safeguarding liver function.

This study, however, still has certain limitations, such as small sample size, which may somewhat restrict the generalizability of the findings. The limited duration of the study precluded a comprehensive evaluation of long-term outcomes and complication rates. Furthermore, potential confounding factors that were not adequately controlled for in the study, such as inter-individual variations among patients and uncertainty surrounding complications, may have influenced the objectivity of the findings. The current study necessitates further expansion of the sample size and longer follow-up periods in order to comprehensively evaluate the actual efficacy and safety of this surgical procedure.

CONCLUSION

In summary, both LC combined with EPBD and LC combined with EST are effective for the treatment of GS with CBDS. In the present study, LC combined with EPBD achieved better clinical benefits, and was conducive to shortening the hospitalization time, reducing inflammatory stress response, and improving the liver function. However, there were some limitations, which must be validated in the future by using large samples and other research methods. In addition, according to literature reports[31], traditional Chinese medicine such as Da Chaihu Tang, anti-inflammatory and bile-relieving Tang, and Xiao Chaihu Tang play a crucial role in the treatment of GS combined with CBDS. These medications have been shown to significantly reduce cholesterol and bile acid levels, expedite the body's recovery, and effectively decrease stone recurrence rates. Therefore, the the synergistic treatment program of Chinese and Western medicines can be used to improve patients' postoperative recovery and reduce the occurrence of complications.

FOOTNOTES

Author contributions: Liu HD and Jin S contributed to the conception and design of this study, collection and assembly of the data, and data analysis and interpretation; Liu HD participated in the administrative support; Liu HD, Zhang Q, Xu WS, and Jin S were involved in the provision of study materials or patients of this study; and all authors wrote the manuscript and approved the final manuscript.

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