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ORIGINAL RESEARCH

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Investigating the efficacy of endoscopic retrograde cholangiopancreatography combined with laparoscopic cholecystectomy in treating male choledocholithiasis

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Abstract

This study aimed to assess the efficacy of endoscopic retrograde cholangiopancreatography (ERCP) combined with laparoscopic cholecystectomy in the management of male choledocholithiasis. A retrospective analysis was performed on the clinical data of 100 male patients diagnosed with choledocholithiasis and treated at our hospital between May 2020 and May 2022. The patients were categorized into either an experimental group (n = 50) or a control group (n = 50) based on their respective treatment modalities. The control group underwent laparoscopic cholecystectomy coupled with exploration and stone extraction from the common bile duct, while the experimental group underwent ERCP in conjunction with laparoscopic cholecystectomy. The results showed that the efficacy of these treatment approaches was compared in terms of their impact on choledocholithiasis. The stone clearance rate was significantly higher in the experimental group compared to the control group ($p < 0.05$), with no significant difference observed in the six-month recurrence rate ($p > 0.05$). However, the one-year recurrence rate was significantly lower in the experimental group ($p < 0.05$). Furthermore, the experimental group experienced reduced intraoperative bleeding, shorter hospital stays, and decreased operative duration compared to the control group ($p < 0.05$). Time to resume oral intake, passage of flatus, recovery of bowel sounds, and mobilization were all significantly shorter for the experimental group ($p < 0.05$). Notably, there was no significant difference in the incidence of postoperative complications between the two groups ($p > 0.05$). ERCP combined with laparoscopic cholecystectomy demonstrates efficacy in reducing postoperative stone recurrence, diminishing complications and patient trauma, alleviating pain, and facilitating continuous patient recovery following treatment for choledocholithiasis.

Keywords

Endoscopic retrograde cholangiopancreatography; Choledocholithiasis; Laparoscopic cholecystectomy

1. Introduction

Choledocholithiasis, a prevalent disorder of the digestive system, is predominantly observed in middle-aged and elderly populations [1]. It is classified into primary and secondary types, constituting approximately 10%–15% of biliary diseases [2]. Choledocholithiasis encompasses stones originating from both the gallbladder and the bile duct system, with their formation influenced by various factors such as lifestyle, diet, geographical location, anatomical variations in the bile duct, and metabolic processes. Notably, pigment stones, prevalent in regions like China and Southeast Asia, are classified as primary choledocholithiasis, whereas those originating outside the common bile duct are termed secondary choledocholithiasis [3, 4]. Clinically, choledocholithiasis typically manifests as fever, jaundice, and right upper abdominal colic pain. Left untreated, it may progress to severe complications such as acute suppurative cholangitis and biliary pancreatitis, posing significant risks to patient survival. Previously, open surgery was the standard treatment, albeit associated with considerable trauma and higher risks, particularly in older patients [5]. However, advancements in medical technology have popularized minimally invasive methods, namely laparoscopic and endoscopic approaches, due to their reduced invasiveness and quicker recovery times [6]. These methods have demonstrated superior outcomes in the treatment of choledocholithiasis [7]. Given that males constitute a significant proportion of those affected and exhibit distinct physiological structure compared to females, leading to variations in the incidence rates of choledocholithiasis [8], it is imperative for men, particularly those with predisposing factors like obesity, to be vigilant about early treatment and related information [9]. Therefore,

this study focuses on male patients with choledocholithiasis to compare the efficacy and safety of endoscopic retrograde cholangiopancreatography (ERCP) combined with laparoscopic surgery versus laparoscopic cholecystectomy (LC) in treating male choledocholithiasis, aiming to provide insights for clinical treatment.

2. Materials and methods

2.1 General information

A retrospective analysis was conducted on clinical data obtained from 100 male patients diagnosed with choledocholithiasis and treated at the Fifth Affiliated Hospital of Sun Yat-sen University between May 2020 and May 2022. Patients were assigned to either the experimental or control group based on treatment type, with 50 participants in each group (Fig. 1). Data comparability between the groups was confirmed ($p > 0.05$) (Table 1).

The inclusion criteria for participant selection were as follows: (1) Diagnosis of choledocholithiasis confirmed by preoperative magnetic resonance cholangiopancreatography (MRCP); (2) Age ≥18 years; (3) Availability of complete clinical data and high cooperation from the patient; (4) Provision of signed informed consent regarding the condition. Conversely, the exclusion criteria were defined as follows: (1) Presence of abnormal cardiopulmonary function, liver, or kidney function; (2) Coagulation disorders or systemic infectious diseases; (3) Severe underlying conditions rendering the patient unfit for surgery; (4) Consciousness disorders or psychiatric abnormalities.

2.2 Treatments

For the control group, LC combined with lithotomy for common bile duct exploration (LCBDE) was performed. The patient was positioned in a head-up and foot-down supine stance with a 20–30-degree leftward head tilt. An arcuate

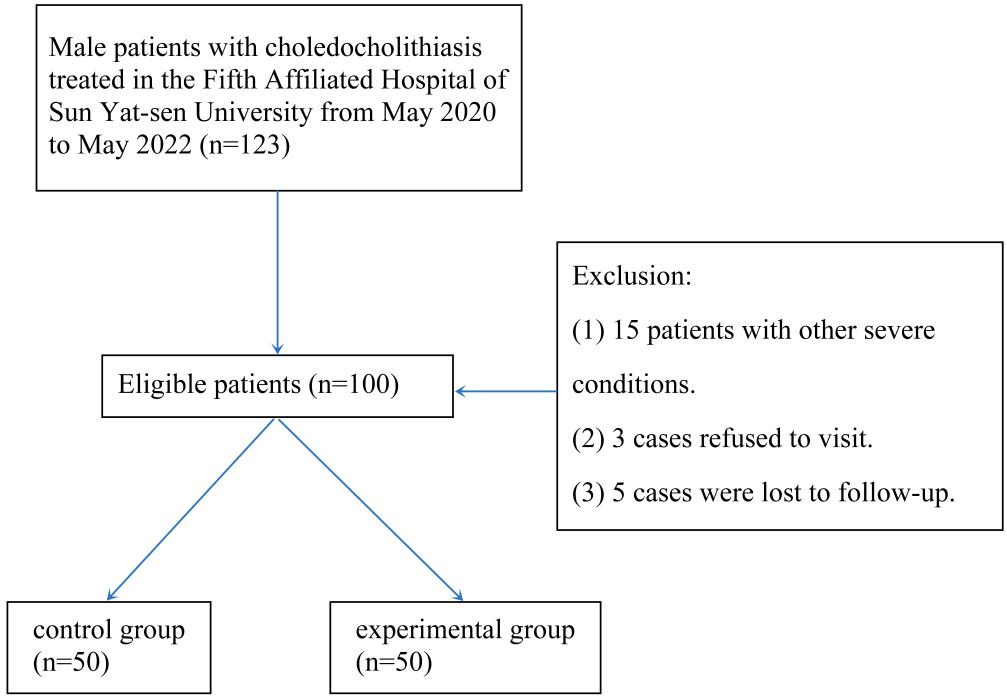

FIGURE 1. Flow chart of the include patients.

TABLE 1. Comparison of general information between two groups ($\bar{x} \pm s$).

Variables	Experimental group (n = 50)	Control group (n = 50)	t/χ^2	p
Age (yr)	43.26 ± 8.29	44.61 ± 8.96	0.782	0.436
Disease course (mon)	4.30 ± 1.52	4.45 ± 1.22	0.544	0.588
BMI (kg/m^2)	19.63 ± 2.58	20.04 ± 1.96	0.895	0.373
Maximum diameter of gall stones (cm)	0.57 ± 0.23	0.53 ± 0.17	0.989	0.325
Number of gall stones (pieces)	2.70 ± 0.61	2.64 ± 0.52	0.529	0.598
Diabetes	11	13	0.219	0.640
Hypertension	7	9	0.298	0.585
Coronary disease	7	8	0.078	0.780

BMI: Body Mass Index.

incision was made below the umbilicus to establish pneumoperitoneum, maintaining intra-abdominal pressure at 10–14 mmHg. Through this entry point, a 10 mm trocar and a laparoscope were introduced for internal visualization. The primary inspection port was set up 2–3 cm below and 1 cm right of the umbilicus, while the main operative port was placed below and right of the xiphoid process. Additional ports were positioned under the right midclavicular line on the costal margin and 2 cm below the right anterior axillary line to facilitate the insertion of atraumatic graspers. We dissected the cystic triangle and revealed the anterior wall of the common bile duct-duodenal segment, cystic duct, lower segment of the hepatic duct, and cystic artery. The cystic duct and artery were identified, ligated using clip appliers and cut. The distal side of the cystic artery was coagulated and severed with an electrosurgical hook before gallbladder removal. In cases of unclear anatomical configurations or severe adhesions, retrograde dissection was performed at the gallbladder neck to expose essential structures for ligation and severance. Then, we completely exposed the common bile duct-duodenal segment's anterior wall and assessed for potential dilation. A choledochotomy was performed longitudinally based on the stone's size, typically 5–10 mm, through which stones were extracted using a choledochoscope. If the cystic duct exceeded 5 mm in diameter, allowing for a smaller stone passage, we attempted direct extraction. After reducing the size of large or impacted stones using a retrieval basket, extracorporeal shock wave lithotripsy was considered as a potential treatment option. In cases where small stones were lodged at the end of the common bile duct, they were gently pushed into the duodenum. Prior to deciding on drainage, multiple observations were conducted to ensure no residual stones remained. The decision regarding biliary stent placement was based on the condition and diameter of the common bile duct. For diameters exceeding 10 mm, primary repair suturing was preferred. However, for diameters ranging between 8–10 mm, the choice varied depending on the expertise of the surgical team. Ducts with diameters less than 8 mm warranted the placement of a T-tube. Additionally, narrow or poorly draining ducts also necessitated the insertion of a T-tube. To ensure proper external fixation, a drainage tube was inserted through Winslow's foramen alongside the T-tube. Gallbladders and stones were removed using a specimen bag introduced through the main operation port, and any dropped stones during surgery were retrieved using forceps. Postoperative management included antibiotic therapy.

For the experimental group, ERCP combined with LC was performed. Under general anesthesia, the patient was positioned supine, and the surgical area was sterilized and draped. A duodenoscope was introduced orally to access the descending part of the duodenum and locate the duodenal papilla. Selective cannulation into the bile duct was followed by the injection of a contrast agent for X-ray imaging, facilitating the assessment of stone size, location and number. Once optimally positioned, a sphincterotomy was performed at the papilla to allow for the insertion of a stone retrieval basket. Stones were then extracted through the papillary opening under X-ray guidance. In cases where direct extraction proved challenging, mechanical lithotripsy or other techniques were employed to remove the stones. Three days post-initial treatment, patients were evaluated for potential adverse reactions, including abdominal distension, pain, fever, and acute pancreatitis. In the absence of complications, LC was performed *via* either a 4-port or 3-port approach. The procedure involved making an incision below the umbilicus for Veress needle insertion and establishing pneumoperitoneum with carbon dioxide to prevent stone migration. The cystic duct was clamped, and the gallbladder fundus was manipulated to adequately expose the Calot's triangle. Following cholecystectomy, a decision on whether to place a drain in the gallbladder bed was made based on the extent of operative bleeding. Postoperative management included routine tube removal and advising the patient to abstain from eating and drinking for 2 hours. Vital signs were monitored, supportive care was provided, and antibiotic therapy was administered as per protocol.

Both patient groups received postoperative treatments aimed at liver protection, hemostasis, fluid replenishment, anti-infection, and acid suppression. Pain management was individualized based on the discomfort at the incision site. Regular assessments of liver and kidney functions, as well as blood tests, were conducted, with medication adjustments made as necessary. Patients were scheduled for follow-up visits at 3, 6 and 12 months post-discharge. These visits included abdominal ultrasound, magnetic resonance imaging (MRI) with MRCP, and liver function tests to monitor recovery and detect any potential complications.

2.3 Observation indicators

To assess clinical efficacy, the patients underwent abdominal computer tomography (CT), ultrasound, and T-tube cholangiography to assess stone clearance rates 7 days after the surgery. Subsequent follow-up assessments were conducted at six months and one year postoperatively, utilizing CT and ultrasound to detect any signs of recurrence. Criteria for recurrence included confirmation of new choledocholithiasis *via* ERCP, ultrasonography, or MRCP, with an interval of more than six months between initial stone removal and recurrence. Surgery-related metrics, such as postoperative bleeding volume, hospital stay duration, and operation time, were recorded. Additionally, parameters regarding postoperative recovery, including the time to start eating, first flatus, bowel sounds recovery, and time to mobilization from bed, were closely monitored. Postoperative complications, such as abdominal pain, vomiting, and persistent elevation of blood and urine amylase levels, were also documented.

2.4 Statistical methods

Data analysis was conducted using SPSS 22.0 (IBM, Armonk, NY, USA) statistical software. Quantitative data were described using means ($\pm$standard deviation (SD)) and compared using *t*-tests, while qualitative data were described using percentages (%) and compared using χ^2 tests. $p < 0.05$ was considered statistically significant.

3. Results

3.1 Clinical efficacy

In the experimental group, the stone clearance rate was significantly higher compared to the control group ($p < 0.05$), while there was no significant difference in recurrence rates after six months ($p > 0.05$). However, the one-year recurrence rate was significantly lower in the experimental group compared to the control group ($p < 0.05$). The detailed statistical results are presented in Table 2.

3.2 Surgery-related indicators

In comparison to the control group, the experimental group demonstrated significantly lower measures in bleeding volume, hospital stay, and surgery time ($p < 0.05$) (Table 3).

3.3 Postoperative recovery

In the experimental group, the time to initiation of oral intake, time to first passage of flatus, time for bowel sounds recovery, and time to ambulation were notably shorter compared to the control group ($p < 0.05$) (Table 4).

3.4 Postoperative complications

In regards to postoperative complications, we found that the incidence rate of complications was not significantly different between the two groups ($p > 0.05$) (Table 5).

4. Discussion

Common bile duct stones (CBD stones) represent a prevalent acute condition in hepatobiliary surgery, characterized by multifactorial origins such as bile duct stricture, biliary parasitic infections, bacterial infections, and elevated cholesterol levels in bile [10, 11]. Typical manifestations include upper abdominal pain, chills, fever, and jaundice (Charcot's triad), often necessitating surgical intervention in severe cases [12]. The primary approach to management is surgical, aiming to effectively eliminate stones, relieve biliary obstruction, and restore bile flow [13]. Treatment modalities encompass traditional open surgery, endoscopic sphincterotomy, ERCP, and endoscopic papillary balloon dilation. With the progression of minimally invasive medical technologies, these minimally invasive procedures have increasingly supplanted conventional surgeries as the foremost treatment modalities for CBD stones [14].

TABLE 2. Comparison of therapeutic effects between two groups of patients (n (%)).

Group	N	Gallstone net extraction	Recurrence within six months after surgery	Recurrence within 1 year after surgery
Experimental group	50	49 (98.00)	0	1 (2.00)
Control group	50	42 (84.00)	4 (8.00)	9 (18.00)
χ^2	-	4.396	2.344	7.111
p	-	0.036	0.126	0.008

TABLE 3. Comparison of clinical indicators between two groups of patients ($\bar{x} \pm s$).

Group	N	Blood loss (mL)	Operative time (min)	Hospital stay (d)
Experimental group	50	23.64 ± 5.70	78.62 ± 14.52	5.31 ± 2.37
Control group	50	31.07 ± 6.84	110.35 ± 15.04	8.76 ± 2.32
t		5.901	10.732	7.356
p		<0.001	<0.001	<0.001

TABLE 4. Comparison of clinical indicators in the two groups ($\bar{x} \pm s$).

Group	N	Time to start eating	Time to first flatus	Time for bowel sound recovery	Time to ambulation
Experimental group	50	1.50 ± 0.32	1.68 ± 0.32	3.38 ± 1.12	1.39 ± 0.37
Control group	50	2.95 ± 0.85	2.38 ± 0.54	5.25 ± 1.64	2.65 ± 0.62
t		11.289	7.886	6.658	12.34
p		<0.001	<0.001	<0.001	<0.001

TABLE 5. Comparison of postoperative complications (n (%)).

Group	N	Bile leakage	Pancreatitis	Gastrointestinal bleeding	Elevated urine amylase	Total
Experimental group	50	1 (2.00)	0	1 (2.00)	1 (2.00)	3 (6.00)
Control group	50	2 (4.00)	1 (2.00)	2 (4.00)	4 (8.00)	9 (18.00)
χ^2						3.409
p						0.065

LC involves making only a few small incisions in the abdomen, facilitating the removal of CBD stones with the assistance of a laparoscope. This approach minimizes physical trauma and results in less conspicuous postoperative scars, addressing patients' aesthetic concerns [15]. However, long-term studies have highlighted heightened risks associated with LC, such as inadvertent injury to adjacent blood vessels and substantial intraoperative bleeding, particularly in cases of severe edema at Calot's triangle or challenges in fully exposing surrounding structures. These factors also augment the technical proficiency required by the operator and may increase the likelihood of postoperative bile duct injury [16].

ERCP is performed using natural orifices, obviates the need for general anesthesia and has broad applicability. Research indicates that ERCP effectively alleviates biliary obstruction, minimizes trauma, and significantly improves patient quality of life [17, 18]. The results of our study demonstrate a higher stone clearance rate in the experimental group compared to the control group. Although there was no significant difference in recurrence rates after six months, the one-year recurrence rate was lower in the experimental group, highlighting the effectiveness of ERCP in enhancing stone removal success rates and positively influencing postoperative outcomes. Moreover, ERCP allows for precise visualization of biliary conditions, establishing it as the clinical standard for diagnosing pancreaticobiliary diseases and notably reducing the risk of postoperative residual stones [19]. Studies conducted by Yalmeh Mehdi *et al.* [20] reported a postoperative residual stone rate of 20.5%, while research by Li Tao *et al.* [21] indicated a rate of 0.6%. In our study, the postoperative residual stone rate was 2%. Factors such as intestinal infections, hypercholesterolemia, diabetes, and prior cholecystectomy contribute to an increased risk of stone recurrence.

Compared to laparoscopic common bile duct exploration (LCBDE), ERCP offers clearer visualization of bile duct stones in terms of number, size and location, thereby reducing surgical risks. Additionally, postoperative nasobiliary imaging further decreases the likelihood of overlooking stones in the liver and papillary region, thus augmenting the stone clearance rate and reducing the recurrence rate [22]. Consequently, the one-year recurrence rate of stones in the control group exceeded that in the experimental group post-operation.

The experimental group demonstrated reduced bleeding, shorter hospital stays, and decreased operation times compared to the control group. This improvement is attributed to the combined approach of endoscopic sphincterotomy (EST) and ERCP, involving access to the bile duct *via* the duodenum and removal of stones through the papillary sphincter based on their characteristics, effectively alleviating obstruction. Endoscopy minimizes trauma from large incisions, significantly diminishes bleeding, and enhances the visibility of the surgical field with the assistance of an endoscope. This enhances surgical precision, reduces damage to surrounding tissues, and shortens operation times. Consequently, the procedure induces less trauma, facilitates swift and convenient stone removal, and expedites patient recovery. The experimental group also had shorter durations for initiating oral intake, passing gas, return of bowel sounds, and ambulation compared to the control group ($p < 0.05$). These findings suggest that combining ERCP with LC can expedite patient recovery.

ERCP, known for causing minimal trauma and enabling rapid postoperative recovery, is notably beneficial. Utilizing a duodenoscope, EST facilitates biliary tract drainage *via* bile duct puncture through the duodenum, thereby preventing bile stasis, ensuring biliary patency, averting infections, and addressing the fundamental issue of obstructions. This approach not only facilitates stone removal but also promotes quicker recovery. Regarding complications, there was no significant difference in complication rates between the two groups, establishing both ERCP and LC as safe surgical options for treating CBD stones. The impact of ERCP on the structure and function of the Oddi's sphincter is minimal, significantly reducing the risk of postoperative complications such as pancreatitis and gastrointestinal bleeding, while also decreasing the likelihood of bile leaks [23]. However, the small sample size of this study limits a comprehensive understanding of other postoperative indicators and may introduce bias into the results. Future research should increase sample sizes and involve multicenter studies to enhance result accuracy.

5. Conclusions

In conclusion, the combination of ERCP with LC was found to be an effective approach to enhancing surgical outcomes for patients with CBD stones. It not only reduces the recurrence rate but also ensures safety, thus rendering it a commendable choice for widespread clinical application.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

AUTHOR CONTRIBUTIONS

YZH—designed the study and carried them out; prepared the manuscript for publication and reviewed the draft of the manuscript. YZH, XLC, HL, MZG, WZ and XFL—supervised the data collection, analyzed the data, interpreted the data. All authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of the Fifth Affiliated Hospital Sun Yat-sen University (Approval no. KJ2023-299-01). Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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