Article

Discovery Medicine 2024; 36(187): 1715–1720
https://doi.org/10.24976/Discov.Med.202436187.157

Cystic Duct Exploration in Laparoscopic Cholecystectomy

Yingfeng Zhang[1], Kang Wang[1], Jiuping Li[1,*]

[1]Department of Hepatobiliary Surgery, Gaoyou People's Hospital, The Third Clinical Medical College of Yangzhou University, 225600 Gaoyou, Jiangsu, China

*Correspondence: lijiuping@126.com (Jiuping Li)

Published: 20 August 2024

Background: Bile duct injury (BDI) is a severe complication following cholecystectomy and is therefore a particularly concerning surgical predicament for hepatobiliary surgeons. Owing to very high medical compensation awarded to patients suffering from BDI, surgeons need to exercise caution during surgery to avoid BDI. Herein, we explored a novel method to identify cystic duct during laparoscopic cholecystectomy (LC), expanding the applicability of this surgical approach.

Methods: Patients receiving LC between April 2021 and October 2022 at the Gaoyou People's Hospital were included in this retrospective clinical study and divided into two groups according to whether the cystic duct was incised (one group with LC alone, while another with laparoscopic cholecystectomy and cystic duct exploration [LCCDE]). Clinical and baseline characteristics of patients were collected, and the preoperative and postoperative biochemical parameters were compared. The surgical outcomes of LCCDE were observed.

Results: A total of 114 patients had undergone LC, while 162 patients had received LCCDE as treatment. There were no significant differences in age, gender, common bile duct diameter, preoperative and postoperative biochemical parameters between the two groups. No significant difference in the mean operation time between the LC and LCCDE groups was noted ($p = 0.409$). In the LCCDE group, white secretions in the cystic duct were observed in 92 patients (56.8%).

Conclusions: The presence of intraoperative white secretions in the cystic duct may further confirm the presence of cystic duct, thereby enabling earlier detection of BDI. Importantly, LCCDE, as the new surgical method explored in this study, does not extend the operation time.

Keywords: bile duct injury; laparoscopic cholecystectomy; cystic duct exploration

Introduction

Since its inception, laparoscopic cholecystectomy (LC) has been in use for more than 30 years. Through the continuous advancements of endoscopic equipment, LC has persistently remained the first-choice approach to managing benign disease of the gallbladder. However, bile duct injury (BDI) is an unavoidable complication of LC for surgeons [1,2]. Owing to very high medical compensation awarded to patients suffering from BDI, surgeons need to exercise caution during surgery to avoid BDI [3]. The primary cause of BDI is the erroneous clipping of the common bile duct (CBD) due to incomplete definition of the gallbladder duct by surgeons. Hence, precisely defining the cystic duct is extremely critical during surgery.

Numerous methods are available to forestall the occurrence of intraoperative biliary tract injuries, including Strasberg's method, subtotal cholecystectomy, funnel technique (also known as gallbladder neck technique), retrograde LC, fluorescence cholangiography, and detection of anatomical landmarks such as Charlotte's lymph node and B-SAFE landmarks [4–8]. Intraoperative cholangiography (IOC) is a complex procedure that puts patients at risk of X-ray radiation exposure. It is typically used for patients with an acute cholecystitis history [9]. The incidence of BDI was reported to be around 0.15–0.3%, and despite a recent incidence decrease, BDI remains a completely inevitable complication [10,11]. Patients with BDI have shorter lifespan due to long-term decline in quality of life, work-related stress, and psychological burden [12,13].

Herein, we explored a novel method to identify cystic duct during LC, with the aim of expanding the applicability of this surgicgal approach. This novel approach permits early detection of BDI and thus timely management of the condition by specialized healthcare personnel.

Materials and Methods

Study Design

Patients receiving LC between April 2021 and October 2022 at the Gaoyou People's Hospital were included in this retrospective clinical study and divided into two groups according to whether the cystic duct had been incised: the LC group comprised patients having received

LC only, while the laparoscopic cholecystectomy and cystic duct exploration (LCCDE) group included patients having been treated with LCCDE. Prior to surgical treatment, all patients had been subjected to ultrasonography, magnetic resonance cholangiopancreatography (MRCP), assessment of biochemical markers, and other related tests. In this study, only patients with gallstones and cholecystitis were recruited. Patients suffering from Mirizzi syndrome and "frozen" gallbladder triangle due to inflammation or fibrosis, as well as those with a confirmed diagnosis of choledocholithiasis stones of CBD prior to surgery, were excluded from this study.

All operations were performed by the same experienced surgeon, and the data were collected from the hospital database. This study received approval from the Ethics Committee of Gaoyou Hospital (202301). Consent was obtained from all patients before surgery. The median follow-up time for both LC and LCCDE groups was 18 months.

Surgical Technique

LC was performed using the routine three-hole or four-hole method. Following exposure of the Calot's triangle, the gallbladder duct was separated to further identify its positional relationship with the common hepatic duct and the common bile duct. Next, from the Hartmann's pouch, an adequate length of the gallbladder duct was dissected. A titanium clip was placed on the gallbladder duct in the vicinity of the Hartmann's pouch, and the serosal layer of the cystic duct to be cut was coagulated with an electric hook (Fig. 1a). Scissors were used to create an opening of approximately one-third of the circumference of the cystic duct near Hartmann's pouch (Fig. 1b). Next, separating forceps were utilized to squeeze the cystic duct and to aid in the observation of the presence of white secretions (Fig. 1c–e), cystic duct stone, and bile (Fig. 1f). If required, the squeezing step was repeated several times to compress the hepatoduodenal ligament. If a persistent turbid bile outflow was noted, IOC was performed. Exploration of CBD was performed if IOC indicated the presence of stones in the CBD.

Precautions

Several precautionary measures should be undertaken while conducting the surgery:

(i) Before clamping the cystic duct near the Hartmann's pouch with titanium clips, attempts should be made to reduce the compression of the gallbladder, and gallbladder puncture and decompression should be performed if required.

(ii) Dissection of an adequately long gallbladder duct should be attempted to avoid the post-exploration retention of the short gallbladder duct, which will affect the follow-up operation.

(iii) Before cutting the cystic duct, squeezing the cystic duct using the separating forceps should be avoided.

Statistical Analysis

Categorical variables are presented as absolute numbers and percentages, while continuous variables are expressed as mean medians and standard deviations. Data analysis was performed using SPSS 26.0 (IBM, Armonk, NY, USA). As appropriate, categorical variables were analyzed using Fisher's exact test or Chi-square test. A *t*-test was used for inter-group comparison of continuous variables. Mann-Whitney U test were adopted for the comparison of nonparametric continuous variables. Standard statistical analyses were performed, and $p < 0.05$ were considered to be statistically significant.

Results

Baseline Characteristics

During the period between April 2021 and October 2022, a total of 298 patients had received LC for treatment. Of these 298 patients, 22 patients with a confirmed diagnosis of choledocholithiasis stones of the CBD prior to surgery were excluded. After excluding subjects that did not meet the inclusion criteria, 114 patients were assigned to the LC group, while 162 patients to the LCCDE group. Baseline information of the patients and relevant preoperative findings are detailed in Table 1. The results showed no differences in preoperative biochemical parameters, such as levels of total bilirubin (TBIL), direct bilirubin (DBIL), alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (γ-GT), and alkaline phosphatase (ALP). Moreover, both groups demonstrated no significant differences in age and gender ratio ($p = 0.337$ and $p = 0.118$, respectively). The CBD diameter, measured by MRCP, showed no significant variance between the LC and LCCDE groups ($p = 0.366$).

Postoperative Outcomes of the Two Groups

Patient outcomes are presented in Table 2. No significant difference in the mean operation time was noted between the LC and LCCDE groups ($p = 0.409$). Similarly, the groups showed no significant difference in postoperative biochemical parameters such as TBIL, DBIL, ALT, AST, γ-GT, and ALP levels. One patient in the LC group was found to have BDI after operation and was managed with biliary-enteric anastomosis. In the LC group, two patients experienced abdominal pain and abnormal liver function after operation, caused by CBD stones as revealed by further MRCP, and these patients were discharged after endoscopic retrograde cholangiopancreatography (ERCP) treatment. No deaths occurred in either group. There were no significant differences in postoperative complications between the two groups ($p > 0.05$).

Surgical Outcomes of LCCDE

The surgical outcomes of LCCDE are depicted in Table 3. In the LCCDE group, white secretions from the cystic

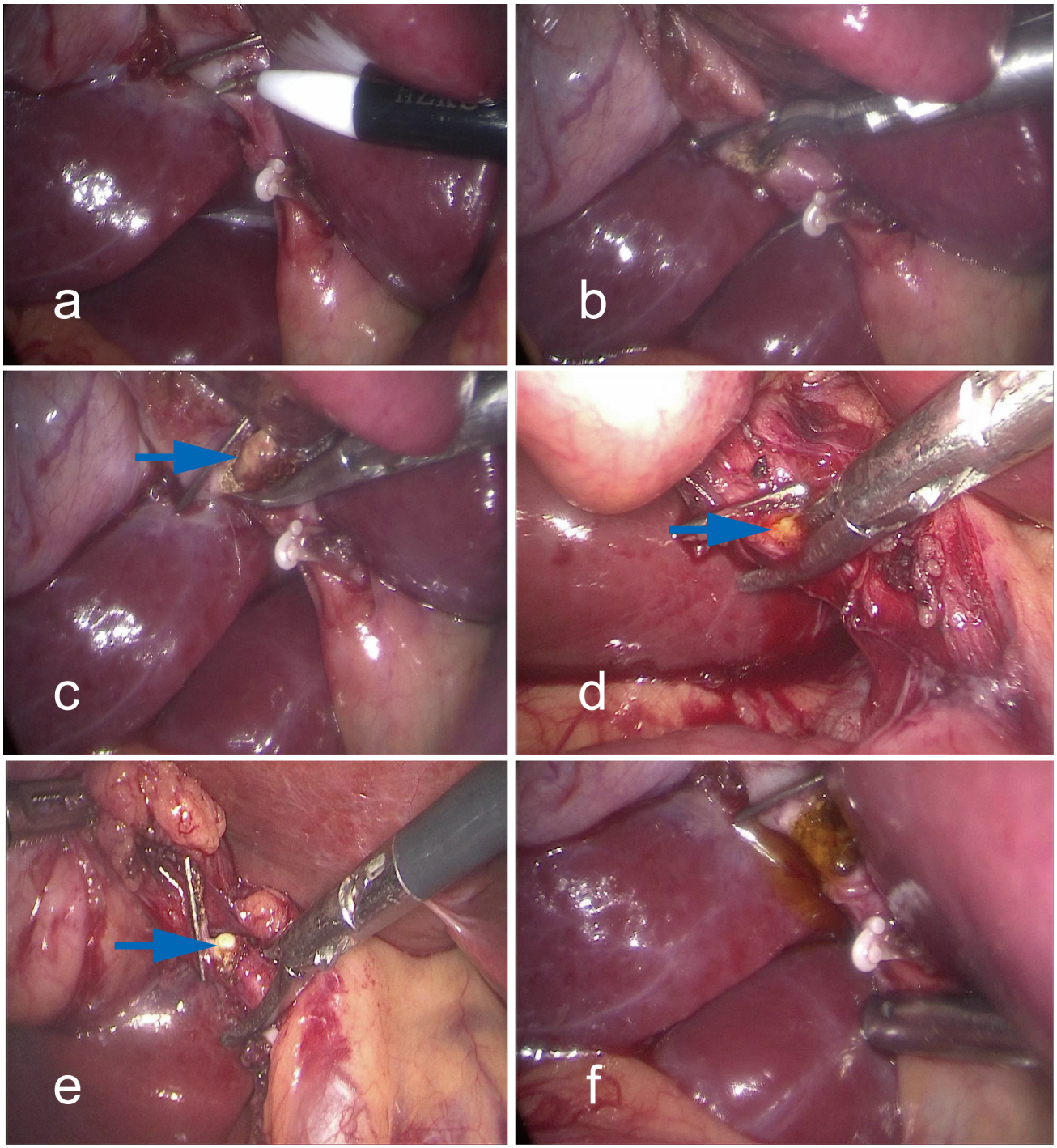

Fig. 1. Surgical technique of laparoscopic cholecystectomy and cystic duct exploration. (a) A titanium clip was placed on the gallbladder duct in the vicinity of Hartmann's pouch, and the serosal layer of the cystic duct to be cut was coagulated with an electric hook. (b) Scissors were used to make an opening of approximately one-third of the circumference of the cystic duct near Hartmann's pouch. (c–e) Separating forceps were employed to squeeze the cystic duct and to assist with the detection of white secretions. The blue arrow indicates white secretion from the cystic duct. (f) The squeezing step was repeated several times to compress the hepatoduodenal ligament, and the bile flowing out of the cystic duct.

duct were observed in 92 patients (56.8%). In three patients, the turbid bile flowed out of the cystic duct after incision, and clear bile was noted after removal of the cystic duct stone, a phenomenon we termed as non-persistent turbid bile. In four patients, incision resulted in persistent turbid bile outflow from the gallbladder duct, with accompanying CBD stones confirmed by IOC. Subsequently, CBD exploration was performed.

Table 1. Baseline information of the patients and relevant preoperative findings.

	LC group (n = 114)	LCCDE group (n = 162)	$\chi^2/t/Z$	*p*-value
Age (years) mean ± SD	54.2 ± 12.8	52.7 ± 12.8	0.962	0.337
Gender, n (%)			2.442	0.118
Male	50 (43.9)	56 (34.6)		
Female	64 (56.1)	106 (65.4)		
CBD diameter (mm)[a]	4.3 (3.6, 5.3)	4.6 (3.6, 6.3)	–0.904	0.366
Preoperative biochemical parameters				
TBIL (μmol/L)	18.0 (13.2, 25.6)	15.6 (13.4, 24.0)	–1.275	0.202
DBIL (μmol/L)	2.6 (1.8, 4.3)	2.3 (1.5, 3.7)	–1.868	0.062
ALT (IU/L)	25.0 (15.0, 33.0)	25.0 (16.8, 36.3)	–0.779	0.436
AST (IU/L)	25.0 (18.0, 28.0)	25.0 (18.0, 29.3)	–0.541	0.589
γ-GT (IU/L)	58.0 (40.5, 82.3)	68.0 (45.0, 85.3)	–1.476	0.140
ALP (IU/L)	72.5 (58.0, 92.5)	77.0 (56.0, 94.0)	–0.816	0.415

[a] Internal diameter of the common bile duct measured by MRCP.

Abbreviations: LC, laparoscopic cholecystectomy; LCCDE, laparoscopic cholecystectomy and cystic duct exploration; CBD, common bile duct; TBIL, total bilirubin; DBIL, direct bilirubin; ALT, alanine aminotransferase; AST, aspartate aminotransferase, γ-GT, gamma-glutamyl transferase; ALP, alkaline phosphatase; MRCP, magnetic resonance cholangiopancreatography.

Table 2. Postoperative patient outcomes of the two groups.

	LC group (n = 114)	LCCDE group (n = 162)	$\chi^2/t/Z$	*p*-value
Operation time (min)	47.1 ± 18.3	49.0 ± 18.5	–0.827	0.409
Postoperative biochemical parameters				
TBIL (μmol/L)	18.0 (15.0, 25.0)	16.2 (14.0, 25.0)	–0.945	0.344
DBIL (μmol/L)	2.0 (1.5, 2.8)	1.8 (1.4, 2.5)	–1.476	0.140
ALT (IU/L)	46.0 (25.0, 56.0)	41.0 (25.0, 57.3)	–0.697	0.486
AST (IU/L)	42.5 (25.0, 56.0)	41.5 (25.0, 54.0)	–0.682	0.495
γ-GT (IU/L)	75.0 (44.3, 84.0)	79.5 (48.0, 85.0)	–0.855	0.393
ALP (IU/L)	85.0 (71.8, 95.3)	85.0 (80.0, 96.0)	–1.350	0.177
BDI, n (%)	1 (0.9)	0	1.426	0.232
Postoperative CBD stones, n (%)	2 (1.8)	0	2.863	0.091
30-day mortality, n (%)	0	0	-	-
PCS, n (%)	1 (0.9)	0	1.426	0.232

Abbreviations: BDI, bile duct injury; PCS, post-cholecystectomy syndrome.

Table 3. Surgical outcomes of LCCDE.

Surgical outcome	n (%)
White secretion, n (%)	92 (56.8)
Bile outflow	
Clear bile, n (%)	155 (95.7)
Non-persistent turbid bile, n (%)	3 (1.9)
Persistent turbid bile, n (%)	4 (2.5)
Cystic duct stones, n (%)	3 (1.9)
CBD stone, n (%)	4 (2.5)

Discussion

The present study aimed to explore a new approach to identifying cystic duct while performing LC. White secretions in the cystic duct were detected in 56.8% of the patients in the LCCDE group. The mucosal surface of the cystic neck and the section of the gallbladder duct near the neck has numerous mucosal folds that form a spiral valve, commonly known as the spiral valves of Heister [14]. The main function of these valves is to regulate the entry and exit of bile, allowing the diluted liver bile to enter the gallbladder and the concentrated bile to pass out of the gallbladder, thus forming a passage for bile to enter and exit from the gallbladder. The dysregulated secretory function of the gallbladder and the Heister spiral valves in the gallbladder duct are probably the drivers of white secretions. Due to the blocking effect of the Heister spiral valves, the white secretions cannot be discharged instantly and completely into the CBD. Upon entering the CBD, the white secretions gain entry into the liver, triggering the production of a large amount of bile daily in the intestine. The white secretions are present only in the cystic duct and absent in the hepatic duct, and do not stay long in the CBD.

The new approach allows easy identification of the cystic duct upon detecting white secretions from it follow-

ing incision, enabling earlier pinpointing of the injured cystic duct or minimizing the number of procedures required for cystic duct confirmation. Absence of white secretion after incision may suggest that the duct is actually CBD. This guideline aids in the identification of either CBD or cystic duct, which is instrumental for early detection of BDI. Timely detection of BDI and accurate characterization of the injury type is critical to early referral and management. Nonetheless, few cases of BDI were reported to have been identified during cholecystectomy, and their occult symptoms additionally account for the diagnostic delay following surgery [15–17]. In this study, the volume of white secretions in the cystic duct during the operation varied across the patient cohort but was markedly different from the bile volume. The absence of white secretions in a portion of CBD may be related to the weakening of the Heister valve after dilation of the cystic duct, occlusion or inflammation of the cystic duct, cystic duct stones, distinctive anatomical and physiological factors of each patient, or the surgical procedure.

In this study, no significant differences were noted between the LC and LCCDE groups in terms of age, gender, preoperative diameter of the CBD, and preoperative and postoperative TBIL, ALT, AST, γ-GT, and ALP levels. This finding proved that LCCDE did not affect postoperative liver function recovery. Similarly, the operation duration of the LCCDE group did not differ significantly from that of the LC group implying that surgery on the cystic duct is not a complex procedure. Furthermore, the presence of white secretion in the cystic duct obviates the need for additional verification steps to confirm the identity of cystic duct.

The present study suggests implementing IOC after cystic duct incision if the outflow of persistent turbid bile indicates the presence of CBD stone. Besides, choledochotomy and choledochoscopy should be performed for the removal of CBD stones. In this study, a patient with the cystic duct stone showed nonpersistent turbid bile flowing out of the gallbladder duct following its exploration. Although MRCP is routinely deployed for the preoperative diagnosis of biliary system stones, detection of small stones in the CBD proves to be challenging, especially for stones with sediment [18,19]. Usually, residual CBD stones only occur in the case of unalleviated symptoms or exacerbated liver dysfunction, which delays the management of the disease; further treatment is required to eradicate the residual stones. A patient in this study exhibited persistent outflowing of turbid bile after CBD exploration. Preoperative MRCP was conducted on this patient but did not reveal signs of choledocholithiasis. However, CBD stones were detected by IOC, and choledochotomy was performed for stone extraction. IOC was performed in this case because this technique is generally used to determine whether the stones of the CBD are present during LC [20].

After cholecystectomy, certain patients may suffer from post-cholecystectomy syndrome (PCS), which encompasses symptoms such as abdominal pain, jaundice, and dyspepsia [21,22]. While the specific causes of PCS remain unclear, speculations abound that it may be related to residual cystic duct stones and infection after cholecystectomy [23]. Nevertheless, LCCDE stands out as a potential avenue for reducing the predisposition to PCS by maintaining the patency of cystic duct and ensuring the persistent flow of clear yellow bile from the cystic duct to reduce the occurrence of residual stones and infection in the duct; however, further research on this aspect is warranted.

The LCCDE procedure is similar to intraoperative transcystic cholangiography and does not increase the burden of postoperative complications following LC. Our preliminary results showed that LCCDE is superior to LC alone in terms of the rates of BDI, postoperative residual choledocholithiasis, PCS and other related complications, but this needs to be confirmed in further studies.

Several strengths of this study should be acknowledged. The white secretion inside the cystic duct, first detected during LC, can serve as an indicative marker for confirming cystic duct during surgery. Advanced intraoperative detection of BDI through LCCDE can avoid further serious injury and allow for timely treatment by specialized healthcare personnel as well as efficient communication with the patient's family so as to reduce the incidence of medical conflict between doctors and patients. Taken together, the integration of cystic duct exploration can improve the safety profile of LC, decrease the occurrence of BDI and earlier detection of BDI.

A prominent limitation of this study is the lack of findings concerning the white secretion components, as well as the limited elucidation of the production of its components and the mechanism of action of the white secretion.

Conclusions

In conclusion, the detection of white secretions in the cystic duct during LC serves as a reliable indicator for the identification of the cystic duct, thereby facilitating the early detection of BDI. This study also establishes the need to implement post-IOC CBD exploration if persistent turbid bile and CBD stones are detected. Upon diagnosis, CBD stones should be extracted with a choledochoscope after choledocholithotomy. Additionally, LCCDE, a new surgical method explored in this study, does not extend the operation time.

Abbreviations

BDI, bile duct injury; LC, laparoscopic cholecystectomy; CBD, common bile duct; LCCDE, LC and cystic duct exploration; IOC, intraoperative cholangiography; MRCP, magnetic resonance cholangiopancreatography; TBIL, total

bilirubin; DBIL, direct bilirubin; ALT, alanine aminotransferase; AST, aspartate aminotransferase; γ-GT, gamma-glutamyl transferase; ALP, alkaline phosphatase.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

YZ and JL collected, analyzed data and wrote the main manuscript text. YZ and KW contributed to the study concept and design. JL and KW prepared figures. All authors contributed significantly to editorial changes of important content. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

All methods were carried out in accordance with relevant guidelines and regulations. All patients signed informed consent before surgery. And this study received approval from the Ethics Committee of Gaoyou Hospital (202301).

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Keus F, de Jong JAF, Gooszen HG, van Laarhoven CJHM. Laparoscopic versus open cholecystectomy for patients with symptomatic cholecystolithiasis. The Cochrane Database of Systematic Reviews. 2006; CD006231.

[2] Coccolini F, Catena F, Pisano M, Gheza F, Fagiuoli S, Di Saverio S, *et al*. Open versus laparoscopic cholecystectomy in acute cholecystitis. Systematic review and meta-analysis. International Journal of Surgery. 2015; 18: 196–204.

[3] Gartland RM, Bloom JP, Fong ZV, DeRoo C, Dwyer K, Quinn G, *et al*. What Have We Learned From Malpractice Claims Involving the Surgical Management of Benign Biliary Disease?: A 128 Million Dollar Question. Annals of Surgery. 2019; 269: 785–791.

[4] Lammert F, Gurusamy K, Ko CW, Miquel JF, Méndez-Sánchez N, Portincasa P, *et al*. Gallstones. Nature Reviews. Disease Primers. 2016; 2: 16024.

[5] Cengiz Y, Lund M, Jänes A, Lundell L, Sandblom G, Israelsson L. Fundus first as the standard technique for laparoscopic cholecystectomy. Scientific Reports. 2019; 9: 18736.

[6] Elshaer M, Gravante G, Thomas K, Sorge R, Al-Hamali S, Ebdewi H. Subtotal cholecystectomy for "difficult gallbladders": systematic review and meta-analysis. JAMA Surgery. 2015; 150: 159–168.

[7] Portincasa P, Moschetta A, Palasciano G. Cholesterol gallstone disease. Lancet. 2006; 368: 230–239.

[8] Fujita N, Yasuda I, Endo I, Isayama H, Iwashita T, Ueki T, *et al*. Evidence-based clinical practice guidelines for cholelithiasis 2021. Journal of Gastroenterology. 2023; 58: 801–833.

[9] Törnqvist B, Strömberg C, Akre O, Enochsson L, Nilsson M. Selective intraoperative cholangiography and risk of bile duct injury during cholecystectomy. The British Journal of Surgery. 2015; 102: 952–958.

[10] European Association for the Study of the Liver (EASL). Electronic address: easloffice@easloffice.eu. EASL Clinical Practice Guidelines on the prevention, diagnosis and treatment of gallstones. Journal of Hepatology. 2016; 65: 146–181.

[11] Barrett M, Asbun HJ, Chien HL, Brunt LM, Telem DA. Bile duct injury and morbidity following cholecystectomy: a need for improvement. Surgical Endoscopy. 2018; 32: 1683–1688.

[12] Fong ZV, Pitt HA, Strasberg SM, Loehrer AP, Sicklick JK, Talamini MA, *et al*. Diminished Survival in Patients with Bile Leak and Ductal Injury: Management Strategy and Outcomes. Journal of the American College of Surgeons. 2018; 226: 568–576.e1.

[13] Booij KAC, de Reuver PR, van Dieren S, van Delden OM, Rauws EA, Busch OR, *et al*. Long-term Impact of Bile Duct Injury on Morbidity, Mortality, Quality of Life, and Work Related Limitations. Annals of Surgery. 2018; 268: 143–150.

[14] Zimmer V. Spiral valves of Heister as visualized by direct cystic ductoscopy. Gastrointestinal Endoscopy. 2018; 87: 1587–1589.

[15] Wang X, Yu WL, Fu XH, Zhu B, Zhao T, Zhang YJ. Early Versus Delayed Surgical Repair and Referral for Patients With Bile Duct Injury: A Systematic Review and Meta-analysis. Annals of Surgery. 2020; 271: 449–459.

[16] Schreuder AM, Nunez Vas BC, Booij KAC, van Dieren S, Besselink MG, Busch OR, *et al*. Optimal timing for surgical reconstruction of bile duct injury: meta-analysis. BJS Open. 2020; 4: 776–786.

[17] Perera MTPR, Silva MA, Hegab B, Muralidharan V, Bramhall SR, Mayer AD, *et al*. Specialist early and immediate repair of post-laparoscopic cholecystectomy bile duct injuries is associated with an improved long-term outcome. Annals of Surgery. 2011; 253: 553–560.

[18] Sirinek KR, Schwesinger WH. Has intraoperative cholangiography during laparoscopic cholecystectomy become obsolete in the era of preoperative endoscopic retrograde and magnetic resonance cholangiopancreatography? Journal of the American College of Surgeons. 2015; 220: 522–528.

[19] Luo Y, Yang T, Yu Q, Zhang Y. Laparoscopic Ultrasonography Versus Magnetic Resonance Cholangiopancreatography in Laparoscopic Surgery for Symptomatic Cholelithiasis and Suspected Common Bile Duct Stones. Journal of Gastrointestinal Surgery. 2019; 23: 1143–1147.

[20] Epelboym I, Winner M, Allendorf JD. MRCP is not a cost-effective strategy in the management of silent common bile duct stones. Journal of Gastrointestinal Surgery. 2013; 17: 863–871.

[21] Jaunoo SS, Mohandas S, Almond LM. Postcholecystectomy syndrome (PCS). International Journal of Surgery. 2010; 8: 15–17.

[22] de Jong JJ, Latenstein CSS, Boerma D, Hazebroek EJ, Hirsch D, Heikens JT, *et al*. Functional Dyspepsia and Irritable Bowel Syndrome are Highly Prevalent in Patients With Gallstones and Are Negatively Associated With Outcomes After Cholecystectomy: A Prospective, Multicenter, Observational Study (PERFECT - Trial). Annals of Surgery. 2022; 275: e766–e772.

[23] Judd S, Miller L, Antaki F. Symptomatic calculi in a remnant gallbladder: a rare cause of post-cholecystectomy syndrome and biliary pancreatitis. Endoscopy. 2014; 46: E67–E68.