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Original Research Article

Comparative study between laparoscopic common bile duct exploration and endoscopic retrograde cholangiopancreatography plus laparoscopic cholecystectomy for choledocholithiasis

Mohamed Mohsen Salem[1], Mohamed Emad Esmat[2], Ahmed Mohamed Abdelaziz Hassan[2]*, Yaser Amer[1], Hisham Abdelaziz[2], Mahmoud Rady[2]

[1]General Surgery Department, Al-Azhar University, Cairo, Egypt
[2]General Surgery Department, Theodor Bilhariz Research Institute, Giza, Egypt

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***Correspondence:**
Dr. Ahmed Mohamed Abdelaziz Hassan,
E-mail: ahmedelmaghney@yahoo.com

ABSTRACT

Background: Endoscopic retrograde cholangiopancreatography (ERCP) with consequent laparoscopic cholecystectomy (LC) has been the favored approach for the treatment of choledocholithiasis for a long time; however recently, laparoscopic common bile duct exploration (LCBDE) has been offered to patients with suspected choledocholithiasis. Objective and aim of this work was to compare the efficacy, safety, and the surgical outcomes of LCBDE with ERCP followed by LC and determine the most appropriate approach for patients with choledocholithiasis.
Methods: A prospective clinical study was carried out from March 2017 to September 2018. It included 50 patients with cholecysto-choledocholithiasis who were divided into two groups: group A (25 patients) included patients who underwent transcystic LCBDE and stone extraction with LC in one stage, and group B (25 patients) included patients who underwent ERCP followed by LC in two stages. The common bile duct (CBD) stone clearance rate, postoperative bile leakage, postoperative morbidity, mortality, overall hospital stay, and patient satisfaction were analyzed.
Results: LCBDE and ERCP+LC were similar in terms of clearance rate, operative time, postoperative complications, retained CBD stones, and postoperative length of stay, but there was a significant difference in number of procedures and patient satisfaction.
Conclusions: Although both approaches have equivalent success rates, LCBDE is better in terms of fewer procedures, and better satisfaction compared with ERCP + LC. Our study suggests that one-stage management is the treatment of choice for patients with cholecysto-choledocholithiasis.

Keywords: Bile duct stones, Endoscopic retrograde cholangiopancreatography, Laparoscopic common bile duct exploration, Laparoscopic cholecystectomy

INTRODUCTION

In general, 5% to 15% of patients experiencing cholecystectomy for cholelithiasis have corresponding bile duct stones, and a little rate of patients will develop CBD stones after cholecystectomy. Frequency of choledocholithiasis increments with age. Around 20% to 25% of patients more established than age 60 with symptomatic gallstones have stones in the CBD and in the gallbladder.[1] Subsequently, bile duct stones and their treatment constitute an imperative clinical issue. The essential objective in administration of

choledocholithiasis is to get complete clearance of the common duct and cholecystectomy, when shown.[2] Alternatives for management of common bile duct stones (CBDS) are expanding with advancement of new innovations for conclusion and treatment. Management of symptomatic or unexpectedly found choledocholithiasis is still dubious. There is no evident agreement on the best restorative approach (endoscopic versus surgical).[3]

Preoperative endoscopic retrograde cholangio-pancreatography (ERCP) and endoscopic sphincterotomy (ES) are safe and successful choices for evacuating CBDS as a rule, yet not withstanding when clinical, biochemical, and ultrasound criteria are utilized; just 10% to 60% of patients will have stones on ERCP. Accordingly, extremely numerous superfluous ERCP are being performed. Truth be told, one of the best preventive measures to diminish ERCP confusions is not to perform it on the off chance that it is superfluous.[4] Utilization of intraoperative ERCP has gradually expanded among different endoscopic gatherings, in light of the fact that the move of ERCP from the endoscopy unit to the operating room has a short learning curve (endoscopic gatherings with mastery in preoperative and postoperative ERCP) without the high specialized necessities required by laparoscopic administration of the bile duct.[5,6]

Laparoscopic common bile duct exploration (LCBDE) was presented more than 15 years back and different surgical gatherings have demonstrated that it has a high achievement rate and is similarly as productive and protected as preoperative or postoperative ERCP related with laparoscopic cholecystectomy (LC), in this way staying away from the need to play out extra methods.[7,8] After LCBDE, primary closure or T-tube drainage will be connected by the state of CBD and experience of surgeon. In 1991, Phillip initially announced the procedure of LCBDE and T-tube drainage in treatment of CBD calculi experienced amid laparoscopic cholecystectomy.[9] In recent years, there have been many articles published about the efficacy and safety of LCBDE compared with ERCP.[10,11]

This study aimed to compare the efficacy, safety, and the surgical outcomes of LCBDE with ERCP followed by LC and determine the most appropriate approach for patients with choledocholithiasis.

METHODS

This prospective clinical study was carried out in Theodor Bilharz Research Institute (TBRI) from March 2017 to September 2018. It included 50 patients with concomitant GB stones and CBD stones who were divided into two equal groups: group A (25 patients) underwent LTCBDE and LC in one stage, and group B (25 patients) underwent ERCP for CBD stone extraction followed by LC in two stages. The study was approved by the local Ethics Committee and conducted in accordance to the Helsinki II Declaration. An IRB form and written consent form was obtained from all patients after detailed explanation of the procedures and its possible complications. The main inclusion criteria were classic biliary-type pain, ultrasonographic demonstration of cholecystolithiasis, common bile duct diameter more than 6 mm (>5mm up to 50 years, then 5+1mm per decade) by ultrasonography or demonstration of CBD stones by USG or MRCP or EUS, intrahepatic duct dilation as determined by ultrasonography or CT scan, platelet count more than100 000 103/µL and prothrombin time less than 3 sec. of control. The main exclusion criteria were evidence of cholangitis and pancreatitis, evidence of cirrhosis, liver mass or abscess, neoplasm, suppurative or necrotizing cholecystitis, gallbladder empyema, or perforation.

All patients of our study were evaluated clinically before the operation and underwent standard laboratory investigations (complete blood count, prothrombin time, partial thromboplastin time, international normalized ratio, liver function tests, serum amylase, and lipase), as well as radiological study, including abdominal ultrasonography, MRCP and EUS that were performed for patients with suspected CBD stones (elevated bilirubin and liver enzymes or ultrasound suspicion of CBD stones).

The operative technique in Group (A)

Prophylactic broadspectrum intravenous antibiotic with third generation cephalosporin was given at the time of induction. Routine 4 port Reddick laparoscopic cholecystectomy was performed using open method for induction of pneumo-peritoneum. Insertion of the umbilical port by infra-umbilical incision using the Hasson technique to introduce 10 mm port was done, then introduction of Co_2 pneumoperitoneum maintaining the pressure at 12-15 mm-Hg. This was followed by insertion of another three ports, 10 mm epigastric port and two 5 mm ports one just lateral to rectus muscle at right midclavicular line opposite to fundus and the other port at right anterior axillary line at the level of the umbilicus.

After identification of cystic duct and artery was done, intra operative ultrasound was performed to check the integrity of the common bile duct. The laparoscopic ultrasound (LUS) probe was inserted through the umbilical or the epigastric port (Figure 1). A distal clip was applied to the duct near the gall bladder neck securing the infundibulo-cystic junction. A small incision in the cystic duct was performed near to the clip using laparoscopic micro-scissors and the duct milked using the blades of Maryland forceps to ensure clearance of cystic duct from stones. The cystic duct was dilated by the tip of Maryland, then cannulated using a front tipped, saline flushed, size 5 ureteric catheter introduced through a cholangioclamp then screened with a C-arm during the injection (Figure 2).

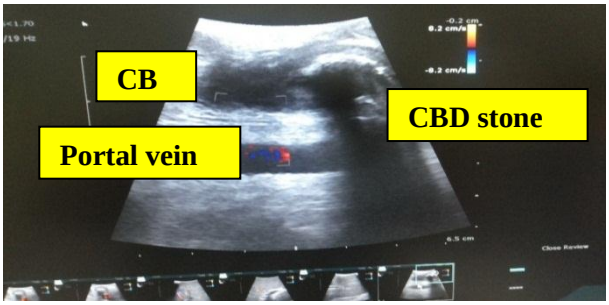

Figure 1: LUS showing CBD hyperechoic stone with posterior acoustic shadow.

Figure 2: IOC showing a filling defect in CBD.

After confirmation of choledocholithiasis was done and according to Table (1) we proceed to transcystic approach (Figure 3 and 4) or choledochotomy approach (Figure 5 and 6).

Table 1: The indications of various approaches of LCBDE.

Transcystic (tc) approach:	Choledochotomy approach:
A patent cystic duct	Dilated CBD more than 7–8 mm
A limited number of stones	Accessible porta hepatis.
Small stone size (less than cystic duct size)	
Stones located below CD – CBD junction	
Adequate biliary anatomy of the CD–CBD junction (the ideal case is a perpendicular angle of insertion of cd into the CBD)	

Transcystic approach (Figure 3 and 4)

The catheter was removed and a dilator [through the epigastric port] into the cystic duct and dilatation of the cystic duct was carried out. Instrumental stone extraction was performed using a three-wire soft Dormia basket under fluoroscopic guidance (safer for ensuring stone capture and avoiding instrumental CBD injury) or under visual cholangioscopic guidance (especially for small stones). The assessment of complete stone clearance is performed in by control cholangiography or by using the flexible choledochoscope.

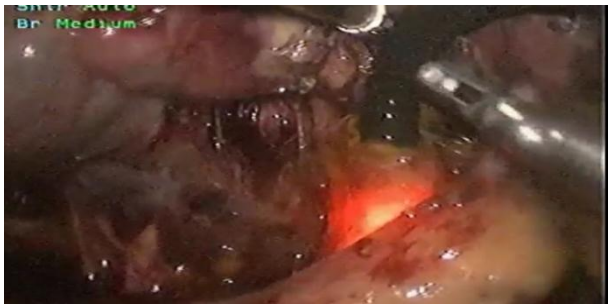

Figure 3: Visualization of the CBD using the choledochoscope.

Figure 4: Stone removal using the Dormia basket.

Choledochotomy approach

The anterior wall of the CBD was additionally dissected within the porta hepatis, by using blunt dissection (avoiding the use of electrocautery close to the CBD). A longitudinal incision was made into the CBD after having blown up the CBD with saline solution through the transcystic cholangiographic catheter. The size of the incision was dependent on the size of the largest CBD stones to be extracted from the CBD.

Instrumental stone extraction and stone clearance assessment were done as transcystic approach. Primary CBD closure was done when there is no doubt about the complete CBD vacuity. External biliary drainage was done by using T-tube exteriorized through the site of the most lateral trocar. Closure of the choledochotomy is performed by using interrupted sutures with PDS 4-0 stitches. At the end of the suturing, a water-tightness test is employed by blowing the CBD through the TC cholangiographic catheter, before clipping the CD or through the T-tube. Thereafter, cholecystectomy was completed by dissecting the GB from its bed using diathermy hook. Drain was inserted in the subhepatic region. The patient was discharged at postoperative 2-3 days. Control cholangiography was done at postoperative day 10 to exclude a residual CBD stones or a biliary leak.

Technique of endoscopic stone extraction

The procedure was performed with the patient under intravenous sedation. The ERCP procedure was performed with a side-viewing duodenoscope. Selective cannulation of the bile duct was achieved using a wire-guided sphincterotome and a hydrophilic guidewire. After guidewire assisted cannulation, a contrast dye was injected to confirm the presence of CBD stones. For extraction of the stones, a biliary sphincterotomy was performed using a combination current of cutting and coagulation. The stones were extracted with the help of a Dormia basket or an extraction balloon (Figure 5). A check cholangiogram was performed to confirm complete clearance of the bile duct. The patients were kept under observation for 6–8h after the procedure. The patients were given preprocedure, oral, broad-spectrum antibiotics from the day before the procedure to 5 days after it. After endoscopic extraction of the CBD stones, the patients underwent LC in another session.

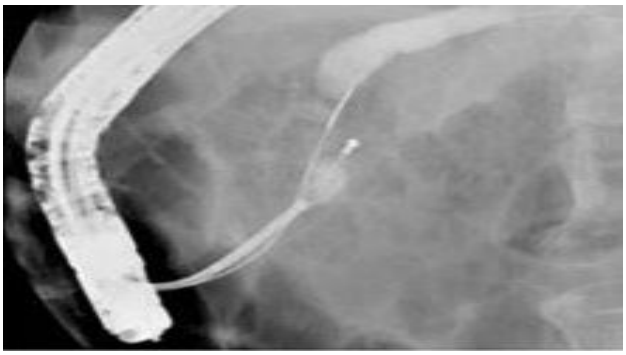

Figure 5: Radiographic view of basket stone extraction.

All of the patients were scheduled for postoperative follow-up at 1 week, 1, 6 months or at any time if symptoms developed. The presence of pain and its severity, condition of the wound, history of jaundice, and any other problems were noted. At 1- month follow-up, liver function tests and abdominal ultrasound were performed to assess the status of the CBD.

The surgical times, surgical success rates, postoperative complications, retained common bile duct stones, postoperative lengths of hospital stay, pain score and satisfaction score were denoted for all patients in group (A) and (B).

Statistical analysis

Collected data were tabulated. Quantitative data were expressed by the mean± standard deviation and qualitative data were expressed as number and percent (%). T-student test was used to compare numerical data and Chi- square test was used to compare qualitative data, and P value was considered to be significant if it was <0.05.

RESULTS

During the study period, March 2017 through Sep 2019, A total of 50 patients were randomized for the treatment of CBD stones. 25 patients were randomized to LCBDE+LC (group A) and 25 patients were randomized to ERCP+LC (group B).

This study was carried out on 50 patients, 9 males (30%) and 41 females (70%). Their ages ranged between 21 and 70 years with a mean age of 47.24 years in group (A), 44.76 years in group (B). The most common clinical presentations in patients of this study are shown in Table (2).

Table 2: Shows the clinical presentations of studied patients.

Complaint [n (%)]	Group A	Group B	P value
Right upper quadrant pain	21 (84%)	22 (88%)	Ns
Jaundice	8 (32%)	14 (56%)	0.15
Pruritus	5 (20%)	9 (36%)	0.34
Fever	2 (8%)	5 (20%)	0.41
Nausea and vomiting	7 (28%)	11 (44%)	0.37
Cholangitis	0	3 (12%)	0.23
Pancreatitis	0	2 (8%)	0.48

There was disturbance in liver functions in most of cases, elevated serum bilirubin level was detected in 30 patients (60.0%), elevated alkaline phosphatase and gamma glutamyl transeferase (GGT) levels in 35 patients (70.0%), elevated serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) in 35 patients (70.0%). The results of the imaging studies were shown in Table (3).

Intraoperative cholangiography was done routinely for all patients of both groups and it revealed stones in 24 patients in group (A) (96% sensitivity), and done for all patients in group (B) before cholecystectomy and it didn't reveal stones in any patient.

In Group (A), the procedures were completed in 21 cases (84%). four cases of 25 (16%) were converted to open CBD exploration and stone extraction followed by T-tube and drain insertion. The T-tube was removed after 10 days following T-tube cholangiography, and the drain was removed on the next day. The reasons for conversion were dense adhesions (two patients), impacted stone (one patient) (the choledochoscope wasn't available) and bleeding (one patient).

One patient in group A with a diagnosis of retained CBD stones was also considered as failure, This patient underwent LCBDE (choledochal approach + primary closure), She suffered from bile leak one week after

surgery, Abdominal ultrasound showed retained two CBD stones with no collections and she subsequently underwent successful ERCP and stone clearance. Thus, the actual success rate was 20 of 25 patients (80%).

Table 3: Results of imaging studies done for studied patients.

Imaging studies		Group A	Sensitivity	Group B	Sensitivity	P value
Ultrasound [n]	CCC	25/25	100%	25/25	100%	Ns
	Dilated CBD	19/25	76%	21/25	84%	0.72
	CBD stones	19/25	76%	21/25	84%	
MRCP [n]		12/13	92.3%	-	-	
EUS [n]		11/12	91.6%	14/15	93.3%	Ns
Max. size of CBD stones (mean±SD) (cm)		0.91±0.072	-	1.08±0.072	-	0.35
Single CBD stones [n]		9	-	11	-	0.77
Multiple CBD stones [n]		16	-	14	-	

In Group (B), ERCP was successful for 21 of 25 patients (84.0%). More than one attempt for complete clearance of the CBD was required for 3 patients (12%). This was followed by LC after six weeks. LC was completed for 19 of 21 patients (85.7%), and converted to open cholecystectomy in two cases (14.3%). The causes of conversion were bleeding (one case) and dense adhesions (one case). In the remaining 4 patients (16%), CBD stones could not be cleared by means of ERCP. The causes of ERCP failure were unsuccessful cannulation (one patient), inability to remove impacted CBD stones (one patient), impacted dormia basket (one patient).

Table 4: Operative data of the studied patients.

	Group A	Group B	P value
Number of procedures per patient (mean±SD)	1.040± 0.040	2.120± 0.0663	<0.0001
Success rate	20 (80%)	19 (76%)	0.52
Failure rate	5 (20%)	6 (24%)	
Operative time (mean±SD) (min)	199.2 ± 8.601	226.4 ± 14.59	0.11
Intraoperative cholangiogram	25 (96% sensitivity)		
Intraoperative ultrasound	15 (93% sensitivity)		
Choledochoscope	20 (95% sensitivity)		

All of them underwent LCBDE and stone extraction with cholecystectomy and duodenal perforation (one patient). This patient suffered from small posterior duodenal perforation sealed spontaneously without surgical intervention. After one week this patient underwent LCBDE (choledochal approach) and stone extraction with cholecystectomy and insertion of T-tube and drain. The actual success rate for group B was 19 of 25 patients (76%).

The overall success rate in both groups (80% in group A vs. 76% in group B; P=0.60). However, the average number of procedures per patient was significantly lower in group A than in group B (1.1 vs. 2.23; P<0.001).

Table 5: Postoperative follow up of the studied patients.

	Group A	Group B	P value
24 h pain score (mean±SD)	6.120 ± 0.240	6.440 ± 0.238	0.34
Hospital stay (mean±SD) (days)	4.440 ± 0.798	4.920 ± 0.772	0.66
Patient satisfaction score (mean±SD)	6.60 ± 0.408	5.20 ± 0.428	0.02

DISCUSSION

Bile duct stones are found in 7–20% of patients with symptomatic gallstones. The nearness of common bile duct stones essentially increases the morbidity, mortality, and expenses of patients with gallstones.[12]

The management of CBD stones has experienced different phases of advancement and development, and LCBDE is currently viewed as a better procedure compared with endoscopic extraction of stones, with comparable morbidity and mortality and a shorter hospital stay in fit patients.[13] The undeniable objective of treatment in choledocholithiasis is to accomplish ductal clearance with the least number of mediations, most minimal expense and least morbidity.[14] Conventional surgical treatment involves intraoperative choleangiography to identify the presence of bile duct calculi pursued by choledocholithotomy and T-tube placement. For a long time this strategy offered successful treatment and was related with a morbidity rate of 10– 15%, a death rate of <1% (in patients under 65 years) and a retained stone rate beneath 6%.[15]

Although ERCP is effective and safe, this management option has several disadvantages, including a large

number of normal ERCP's performed, up to 86% when ERCP is performed routinely for all patients and division of the choledochal sphincter in young adults, leading to loss of the normal physiologic barrier, with long term complications such as ampullary stenosis, duodenobiliary reflux, and recurrent stone formation.[16]

It was reported that one stage operations have some benefits, as compared to two stage operations. Morbidity after one-stage operations was only 7.5% (2 times lower). The reported results of LCBDE when compared to data obtained after the two-stage procedure, show at least identical, rather improved safety for the patient and partial reduction of costs.[17] Postponing laparoscopic cholecystectomy post ERCP makes it difficult to be performed due to the possibility of adhesions at the area of Calot triangle this is in additional risk of second time anaesthesia.[18]

Intraoperative cholangiography is an accurate method for detecting common bile duct stones and it helped us greatly in avoiding injury of the bile ducts. It was done for all patients of Group (A) before LCBDE and it revealed stones in 24 patients (95% sensitivity). Intraoperative ultrasonography was done for 15/25 patients of Group (A) before LCBDE and it revealed stones in 14 patients (93% sensitivity). These findings were similar to data collected from several studies which denoted that IOC (Intraoperative cholangiography) has a sensitivity of 98% and specificity of 94% to detection of CBD stones.[19]

The success rate for LCBDE in our study was 80%, which was comparable to that reported in the existing literatures (80–98.5%). Similar study carried out by Hong DF et al. denoted success rate of 80% 18.In other studies success rate of 80% to 95% were reported.[20-22]

Our study showed similar success rates for the single-stage and two-stage procedures (80 vs. 76%), but the single-stage procedure was better in terms of a less number of procedures and higher patient satisfaction compared with two-stage management. This is consistent with previous research reports.[23,24]

To date, little agreement has been reached on the rate of CBD stone clearance. One meta-analysis of eight RCTs showed that LCBDE+LC was associated with a higher rate of CBD stone clearance than pre-ERCP+LC (90.17% vs. 85.71%, respectively; recent meta-analysis.[25] However, a study conducted by Elgeidie et al showed that pre-ERCP+LC was associated with a higher success rate of CBD stone clearance.[26]

There was only one case suffered from retained common bile duct stones among patients belonged group A (4.5%). This was in contrary to 12% of studied patients in the study carried out by Stanley et al.[27] In the study by Ding et al, the authors reported that LCBDE+LC stones had a lower recurrence rate.[28]

In this study our favored technique for LCBDE was the transcholedochal approach and was done for nineteen patients while the transcystic approach was done for six patients as the transcystic approach needs specific cystic duct and stones characters as in Table 1. The postoperative course after successful transcystic clearance is similar to laparoscopic cholecystectomy alone. This was in agreement with the following studies.[8,29]

In this study we used the choledochoscope for twenty patients and it was helpful to confirm bile duct clearance and to visualize the proximal portion of the CBD with sensitivity (95%) In the other five cases choledochoscope was replaced (due to some technical problems in the choledochoscope) by fluoroscopic guidance and confirmatory IOC. This was in agreement with Phillips EH et al. who denoted nearly similar efficacy between choledochoscope and fluoroscopic guidance.[30] This was in contrary to Topal et al who reported that the use of a flexible choledochoscope is preferable to fluoroscopic guidance.[31]

In our study T-tube drainage was done for 10 cases while primary closure was done for 6 cases with no statistical difference between them. This is in agreement with recent studies which show that primary sutures have the same safety and effectiveness as T-tube drainage. This is still controversial. More detailed and higher-quality research on postoperative pancreatitis and bile leakage is necessary in the future.[32]

In our study ERCP was successful for 21 of 25patients (84.0%). More than one attempt for complete clearance of the CBD was required for 3 patients (12%). This was followed by LC after six weeks. LC was completed for 19 of 21 patients (85.7%), and converted to open cholecystectomy in two cases (14.3%). The actual success rate for group (B) was 19 of 25 patients (76%). However other studies denoted that the overall success rate of ERCP/S+LC in experienced hands is well established at about 95%. However, the minimum number of ERCP procedures necessary for competency has been suggested by Vitale et al. to be between 102 and 185 procedures to achieve a success rate of 85% to 90%.[33]

Our study reported that five patients in group B were converted from LC to open cholecystectomy following successful ERCP due to adhesions and uncontrollable bleeding. This is similar to Allen and Leeth and Donkervoort et al who reported greater difficulty and higher conversion rates with cholecystectomy after ERCP and the possibility of unpredictable adhesions.[34,35]

The mean operative time was shorter in group (A) than in group (B) in our study (199.2±8.6 vs. 226.4±14.5) with no significant difference (P=0.114). This was similar to previous studies that showed similar results.[36,37]

Our study showed no significant difference between group A and group B regarding postoperative complications (8% vs. 16%; P=0.66). The complication rates in the literature have not differed significantly between the two strategies. A meta-analysis found the morbidity rates to be 19% in the single-stage group and 15.2% in the two stage group, and the difference was not statistically significant.[38]

Our study showed no significant difference between group (A) and group (B) regarding hospital stay (4.44±0.79 vs. 4.92±0.77; P=0.66) and 24h pain score (6.12±0.24 vs. 6.44±0.23; P=0.34). This is in contrast to other studies which denoted shorter hospital stay in this group A than group B.[18,32,39]

CONCLUSION

Although both treatment methods have equivalent success rates, the one-stage management is better in terms of fewer procedures, and better overall satisfaction compared with the two-stage approach. In addition, the one-stage management also avoided the risks associated with ERCP and sphincterotomy and kept the sphincter of Oddi intact, and this was associated with a lower risk for late CBD stone formation.

Hence, the outcomes of this study suggest that the one-stage management is the treatment of choice for patients with concomitant GB and CBD stones, especially in younger patients who have longer period of risk for recurrence of CBD stones.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Pham TH, John G. Hunter Gallbladder and the Extrahepatic Biliary. In: Schwartz's Principles of Surgery, part II, Specific Considerations, Chapter 33, 10th edition. Charles FB, Dana KA, Timothy RB, et al, editors. McGraw-Hill Companies, Inc; 2015: 1310-40.
2. Mori T, Suzuki Y, Sugiyama M, Atomi Y. Choledocholithiasis. In: Bland KI, Büchler MW, Csendes A, et al, editors General Surgery. Principles and International Practice. Second Edition. London: Springer-Verlag London; 2009: 1061-1073.
3. Rábago LR, Chico I, Collado D, Olivares A, Ortega A, Quintanilla E, et al. Single-stage treatment with intraoperative ERCP: management of patients with possible choledocholithiasis and gallbladder in situ in a non-tertiary Spanish hospital. Surg Endosc. 2012;26:1028-34.
4. Ghazal AH, Sorour MA, El-Riwini M, El-Bahrawy H. Single-step treatment of gallbladder and bile duct stones: A combined endoscopic–laparoscopic technique. Int J Surg. 2009;7:338-46.
5. Chathadi KV, Chandrasekhara V, Acosta RD, Decker GA, Early DS, Eloubeidi MA, et al. ASGE Standards of Practice Committee, The role of ERCP in benign diseases of the biliary tract. Gastrointest Endosc. 2015;81(4):795-803.
6. Easler JJ, Sherman S. Endoscopic Retrograde Cholangio-pancreatography for the Management of Common Bile Duct Stones and Gallstone Pancreatitis. Gastrointest Endosc Clin N Am. 2015;25(4):657-75.
7. Darkahi B, Liljeholm H, Sandblom G. Laparoscopic Common Bile Duct Exploration: 9 Years Experience from a Single Center. Front Surg. 2016;3:23.
8. Aawsaj Y, Light D, Horgan L. Laparoscopic common bile duct exploration: 15-year experience in a district general hospital. Surg Endosc. 2016;30(6):2563-6.
9. Ha JP, Tang CN, Siu WT, Chau CH, Li MK. Primary closure versus T-tube drainage after laparoscopic choledochotomy for common bile duct stones. Hepatogastroenterol. 2004;51(60):1605-8.
10. Gupta N. Role of laparoscopic common bile duct exploration in the management of choledocholithiasis. World J Gastrointest Surg. 2016;8(5):376-81.
11. Qiu J, Yuan H, Chen S, Wu H. Laparoscopic common bile duct exploration in cirrhotic patients with choledocholithiasis. Surg Laparosc Endosc Percutan Tech. 2015;25(1):64-8.
12. Hungness ES, Soper NJ. Management of common bile duct stones. J Gastrointest Surg. 2006;10(4):612-9.
13. Vindal A, Chander J, Lal P, Mahendra B. Comparison between intraoperative cholangiography and choledochoscopy for ductal clearance in laparoscopic CBD exploration: a prospective randomized study. Surg Endosc. 2015;29:1030-8.
14. Zerey M, Haggerty S, Richardson W, Santos B, Fanelli R, Brunt LM, et al. Laparoscopic common bile duct exploration. Surg Endosc. 2018;32:2603.
15. Dolan JP, Diggs BS, Sheppard BC, Hunter JG. The National Mortality Burden and Significant Factors Associated with Open and Laparoscopic Cholecystectomy: 1997-2006. J Gastrointest Surg. 2009;13(12):2292-301.
16. Bansal VK, Misra MC, Rajan K, Kilambi R, Kumar S, Krishna A, et al. Single stage laparoscopic common bile duct exploration and cholecystectomy versus two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy for patients with concomitant gallbladder stones and common bile duct stones: a randomized controlled trial. Surg Endosc. 2014;28:875-85.
17. Kharbutli, Velanovich V. Management of preoperatively suspected choledocholithiasis: a

decision analysis, J Gastrointest Surg, 2008;12(11):1973-80.
18. Hong DF, Xin Y, Chen DW. Comparison of laparoscopic cholecystectomy combined with intraoperative endoscopic sphincterotomy and laparoscopic exploration of the common bile duct for cholecystocholedocholithiasis. Surg Endosc. 2006;20(3):424-7.
19. Griniatsos J, Karvounis E, Isla AM. Limitations of fluoroscopic intraoperative cholangiography in cases suggestive of choledocholithiasis, J Laparoendoscopic Advanced Surg Tech. 2005;15(3):312-7.
20. Mattila A, Luhtala J, Mrena J, Kautiainen H, Kellokumpu I. An audit of shortand long-term outcomes after laparoscopic removal of common bile duct stones in Finland. Surg Endosc. 2014;28:3451-7.
21. Chan DS, Jain PA, Khalifa A, Hughes R, Baker AL. Laparoscopic common bile duct exploration. Br J Surg. 2014;101:1448-52.
22. Zhang HW, Chen YJ, Wu CH, Li WD. Laparoscopic common bile duct exploration with primary closure for management of choledocholithiasis: a retrospective analysis and comparison with conventional T-tube drainage. Am Surg. 2014;80:178-81.
23. Zhu HY, Xu M, Shen HJ, Yang C, Li F, Li KW, Shi WJ, Ji F. A meta-analysis of single-stage versus two-stage management for concomitant gallstones and common bile duct stones. Clin Res Hepatol Gastroenterol. 2015;39(5):584–593.
24. Dasari BV, Tan CJ, Gurusamy KS, Martin DJ, Kirk G, McKie L, et al. Surgical versus endoscopic treatment of bile duct stones. Cochrane Database Syst Rev. 2013;12:Cd003327.
25. Pan L, Chen M, Ji L, Zheng L, Yan P, Fang J, et al. The safety and efficacy of laparoscopic common bile duct exploration combined with cholecystectomy for the management of cholecysto-choledocholithiasis: an up-to-date meta-analysis. Ann Surg. 2018;268(2):247-53.
26. ElGeidie A, Atif E, Naeem Y, ElEbidy G. Laparoscopic bile duct clearance without choledochoscopy. Surg Laparosc Endosc Percutan Tech. 2015;25(5):152-5.
27. Rogers SJ, Cello JP, Horn JK. Prospective Randomized Trial of LC_LCBDE vs ERCP/S_LC for Common Bile Duct Stone Disease. Archsurg. 2010;145:28-33.
28. Ding YM, Wang B, Wang WX, Wang P, Yan JS. New classification of the anatomic variations of cystic artery during laparoscopic cholecystectomy. World J Gastroenterol. 2007;13:5629-34.
29. Lee J, Yoon Y. Laparoscopic common bile duct exploration using V-Loc suture with insertion of endobiliary stent. Surg Endosc. 2016;30(6):2530-4.
30. Phillips EH, Toouli J, Pitt HA, Soper NJ. Treatment of common bile duct stones discovered during cholecystectomy. J Gastrointest Surg. 2008;12:624-8.
31. Topal B, Aerts R, Penninckx F. Laparoscopic common bile duct stone clearance with flexible choledochoscopy, Surg Endosc. 2007;21;2317-21.
32. Lyu Y, Cheng Y, Li T, Cheng B, Jin X. Laparoscopic common bile duct exploration plus cholecystectomy versus endoscopic retrograde cholangiopancreatography plus laparoscopic cholecystectomy for cholecystocholedocholithiasis: a meta-analysis. Surg Endosc. 2018.
33. Vitale GC, Zavaleta CM, Vitale DS, Binford JC, Tran TC and Larson GM. Training surgeons in endoscopic retrograde cholangiopancreatography. Surg Endosc. 2006;20(1):149-52.
34. Allen NL, Leeth RR, Finan KR, Tishler DS, Vickers SM, Wilcox CM, et al. Outcomes of cholecystectomy after endoscopic sphincterotomy for choledocholithiasis. J Gastrointest Surg. 2006;10:292-6.
35. Donkervoort SC, van Ruler O, Dijksman LM, van Geloven AA, Pierik EG. Identification of risk factors for an unfavorable laparoscopic cholecystectomy course after endoscopic retrograde cholangiography in the treatment of choledocholithiasis. Surg Endosc. 2010;24;798-804.
36. Noble H, Tranter S, Chesworth T, Norton S, Thompson MA. Randomized, clinical trial to compare endoscopic sphincterotomy and subsequent laparoscopic cholecystectomy with primary laparoscopic bile duct exploration during cholecystectomy in higher risk patients with choledocholithiasis. J Laparoendosc Adv Surg Tech A. 2009;19;713-20.
37. Martin DJ, Vernon DR. and Toouli J. Surgical versus endoscopic treatment of bile duct stones. Cochrane Database Syst Rev. 2006;2:CD003327.
38. Lu J, Cheng Y, Xiong XZ, Lin YX, Wu SJ, Cheng NS. Two-stage vs singlestage management for concomitant gallstones and common bile duct stones. World J Gastroenterol. 2012;18:3156-66.
39. Shojaiefard A, Esmaeilzadeh M, Ghafouri A, Mehrabi A. Various Techniques for the Surgical Treatment of Common Bile Duct Stones: A Meta Review. Gastroenterol Res Pract. 2009;840208:12.

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