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RESEARCH

Index admission vs elective laparoscopic common bile duct exploration: a district general hospital experience over 6 years

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Abstract

Background Laparoscopic common bile duct exploration (LCBDE) is relatively a new approach for clearing choledocholithiasis. The aim of this study is to assess the safety of this approach to clearing common bile duct (CBD) stones on an index admission including emergency setting.

Methods Retrospective data collection and analysis were carried out for 207 consecutive cases of LCBDE performed in Royal Cornwall Hospital over 6 years (2015–2020). Patients were divided into two groups (Index admission vs elective) then both groups compared.

Results A total of 207 cases of LCBDE were performed in our unit during the time period. One hundred twenty-two operations were performed on the index admission and 85 on a subsequent elective list. Mean operative time was 146 ± 64 min in the index admission group and 145 ± 65 min in the elective group ($p = 0.913$). Length of stay post-operatively was 3.3 ± 6.3 days in the index admission cases and 3.5 ± 4.6 days after elective cases.

Successful clearance was achieved at the end of the operation in 116 patients in the index admission group, clearance failed in one case and negative exploration in 5 patients. In the elective group 83 patients had a successful clearance at the end of the operation, and 2 patients has had a negative exploration.

Twelve patients (index admission group) and 8 patients of the elective cases required post-operative Endoscopic Retrograde Cholangiopancreatography (ERCP) to manage retained stones, recurrent stones and bile leak ($p = 0.921$). Three patients required re-operation for post-operative complications in each group.

Conclusion Common bile duct exploration in index admission is safe with high success rate if performed by well-trained surgeons with advanced laparoscopic skills.

Keywords Choledocholithiasis · Emergency surgery · Laparoscopic CBD exploration

Introduction

Choledocholithiasis is a common problem and can be found in around 20% of patients with symptomatic gallstones [1]. Patients with choledocholithiasis may present acutely with cholangitis, pancreatitis, obstructive jaundice or it can be an incidental finding in patients with cholecystitis or biliary pain. Up to 50% of choledocholithiasis may not demonstrate any clinical, chemical or radiological evidence pre-operatively [2]. In the literature there is evidence that up to 15% of patients who have pre-operative endoscopic clearance may still have common bile duct (CBD) stones at time of laparoscopic cholecystectomy (LC). Hence, it is recommended to perform intra-operative imaging even if ERCP was performed pre-operatively [3, 4].

Common bile duct stone management is a challenge and usually requires multimodal treatment and a multidisciplinary approach. It can include pre-operative, intra-operative or post-operative ERCP or concomitant LC and LCBDE.

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The best approach in managing concomitant gallbladder and CBD stones is still controversial especially in an emergency presentation with moderate or severe cholangitis.

Most of the evidence in the published literature studied heterogenous group of patients who had both elective and emergency LCBDE with very few comparing or studying the efficacy and safety of performing the procedure in the index admission.

In the last 10 years there are some studies in the literature comparing early vs late elective LCBDE for treating mild and moderate cholangitis [5, 6]. These showed that it is safe and efficient to perform the procedure in emergency settings; however, these studies do not present a strong recommendation or high quality of evidence.

Complications of CBD stones usually carry a significant morbidity and mortality if not treated promptly and in a timely manner.

The aim of this study is to assess the feasibility, safety and efficacy of performing LCBDE in the index admission including cases with Tokyo 2018 graded mild and moderate cholangitis (Tokyo guidelines 2018) [7].

Materials and methods

Data was collected retrospectively from all patients who had LC + LCBDE between January 2015 and December 2020 in our hospital. Patients were excluded if they had a previous cholecystectomy or their CBD was flushed under ultrasound or fluoroscopic guidance without use of a choledochoscope.

Pre-operative data including age, sex, American Society Of Anesthesiologists (ASA), pre-operative investigations (biochemical and radiological), pre-operative CBD diameter and indication for surgery were recorded. Intra-operative data included the CBD approach for exploration Trans-cystic (TC) vs Transductal (TD), duration of operation, conversion to open surgery, radiological modality used for intra-operative confirmation of CBD stones—Ultrasound (US) vs Intra-operative cholangiogram (IOC), size and number of stones, use of drains and T-tubes. The completeness of clearance at the end of the operation was recorded, and any evidence of retained or recurrent stones were documented, with post-operative length of stay, complications requiring intervention, CBD strictures and mortality.

The patients were allocated into two groups for analysis: those who had the operation performed on the index admission, and those who had the operation performed on an elective list. No ethical approval of institutional human research was required for this study.

Definitions

Index admission group—Any patient who had LC + LCBDE on the index admission regardless of the presentation of the patient.

Elective group—All patients who had elective LC + LCBDE or elective LC with incidental CBD stones found intra-operatively.

The diagnosis of acute cholangitis or cholecystitis was made according to Tokyo Guidelines 2018 [7]. Pancreatitis was defined according to Atlanta criteria [8].

Any common bile duct stone discovered within the first 6 months post-operatively was considered a retained stone and any stone discovered later than 6 months classified as a recurrent CBD stone.

A drain was placed for all trans-ductal cases, with the intention of removing the drain on the first post-operative day if there were no bile in the drain. No drain was used for the Trans-cystic cases.

Bile leaks were classified into either mild leak managed conservatively and stopped without intervention where the drain was present for more than 72 h post-operatively, equivalent to International Study Group of Liver Surgery (ISGLS) severity grade A [9], or significant leak requiring endoscopic or surgical intervention.

Surgical procedure

A standard four port laparoscopic cholecystectomy technique was used, with dissection of Calot's triangle being performed using critical view principals [10]. Following "milking back" of stones from the cystic duct into the gallbladder, the cystic duct was ligated with a surgical clip at the junction with the gallbladder. Intraoperative assessment of the CBD was performed using either a laparoscopic ultrasound technique (IOUS) [11] or conventional fluoroscopic technique.

If choledochal stones were found, the diameter of the common bile duct, the cystic duct and the largest stone were measured to guide the approach for bile duct exploration. For stones with a diameter less than the cystic duct, a trans-cystic (TC) duct approach was attempted. For stones exceeding the cystic duct diameter, a trans-ductal (TD) approach via a CBD choledochotomy was used, if the CBD diameter was 8 mm or more. However, surgeon preference and experience also factored into choosing the approach for the exploration.

For a TC approach, the cystic duct was opened with scissors and gentle dilatation of the cystic duct was performed with a Maryland dissector. A 3 mm choledochoscope (Karl Storz) was inserted into the cystic duct and

advanced proximally with saline irrigation into the CBD. Stones were extracted using a 1.9F or 2.4F Dormia basket (Zero tip™ Nitinol basket, Boston Scientific). Following successful extraction of stones, the CBD was examined choledochoscopically and by IOUS to confirm complete clearance.

For a TD approach, the anterior aspect of the CBD was cleared by blunt dissection. Both sides of the CBD were identified to ensure accurate positioning of a mid-ductal vertical choledochotomy made using a laparoscopic choledochotomy (Microfrance) knife. A 5 mm choledochoscope (Karl Storz) was inserted into the CBD via the choledochotomy and the CBD examined with saline irrigation. Stones were extracted using a combination of Dormia basket, forceps and/or irrigation. Following successful extraction, the extrahepatic biliary tree was examined choledochoscopically to confirm complete duct clearance. The choledochotomy was sutured closed using a continuous 4.0 Vicryl suture.

Following TD bile duct exploration, the cystic duct was clip ligated and divided, and the gallbladder excised. A non-suction 16F Robinson drain was placed sub-hepatically. The drain was removed 24 h post-operatively if no bile drained.

Statistical analysis

Statistical analysis was performed using Sigma plot (Systat Software Inc). Quantitative variables were presented as mean ± standard deviation. Qualitative variables were presented as absolute value and percentage. p value < 0.05 was considered statistically significant.

Results

Two hundred and seven patients had a LC + CBDE between January 2015 and December 2020. These were carried out electively in 85 patients (41%) and on the index admission in 122 patients.

The mean age was 66 years in the elective group and 58 years in the index admission group ($p < 0.001$), with more female patients in both groups 62% in elective vs 66% in index admission groups ($p = 0.003$). There were similar proportions of ASA > 2 and suspected CBD stones in both groups. There were significantly more pre-operative ERCPs in the elective group (41% vs 10%). There were no significant differences in pre-operative imaging modalities, or CBD diameter. Pre-operative LFTs were more abnormal in the index admission group (Table 1).

The indication for LCBDE in the index admission group was most commonly cholangitis, followed by jaundice and cholecystitis (Table 2).

The vast majority of cases were finished laparoscopically, with less than 6% converted to open in each group (Table 3). Transcystic approach was utilized less often in both groups (13% electively vs 23% index admission) and converted to transductal in 7% electively vs 12% in the index admission group, although these were not significantly different. The number of stones were similar in both groups, though larger in the elective group (9.4 mm vs 7.6 mm, $p = 0.002$). There was no difference in operative time between the groups.

There was a similar success rate both immediately and 6 months post-operatively (Table 4), with no difference

Table 1 Elective and index admission groups

	Elective ($n = 85$)	Index admission ($n = 122$)	p value
Age	66 (± 14.3) years	58 (± 17.8) years	$p < 0.001$
Sex, female	53 (62.4%)	81 (66.4%)	$p = 0.003$
ASA > 2	25 (29.4%)	25 (20.5%)	$p = 0.142$
Suspected (vs Incidental)	71 (83.5%)	97 (79.5%)	$p = 0.469$
Pre-op ERCP	35 (41.2%)	13 (10.7%)	$p < 0.001$
Pre-op Imaging			
MRCP	52 (60.5%)	66 (54.1%)	$p = 0.350$
US	70 (81.4%)	111 (91.0%)	$p = 0.066$
CT	20 (23.3%)	28 (23.0%)	$p = 0.924$
CBD diameter (mm)	10.3 (± 4.7)	9.9 (± 3.6)	$p = 0.489$
Pre-operative LFTS			
Bilirubin (units/mL)	24.6 (± 50.2)	53.7 (± 64.0)	$p < 0.001$
ALP (units/L)	233.2 (± 247.2)	279.0 (± 200.3)	$p = 0.143$
ALT (units/L)	108.6 (± 172.8)	256.0 (± 243.9)	$p < 0.001$

Data expressed as mean (± SD), absolute value and percentage or median (range)

ALT alanine transaminase, *ALP* alkaline phosphatase, *ASA* American Society of Anaesthesiologists, *CBD* common bile duct, *CT* computerized tomography, *ERCP* endoscopic retrograde cholangiopancreatography, *LFTs* liver function tests, *MRCP* magnetic resonance cholangiopancreatography, *SD* standard deviation, *US* ultrasound

Table 2 Indications for surgery in the Index Group

Indication for LCBDE in Index admission group	Total number = 122	%
CBD stones + biliary pain	16	13.1
CBD stones + jaundice	26	21.3
CBD stones + cholangitis	37	30.3
[a]Grade 1 Mild	22	59.5 of cholangitis cases
[a]Grade 2 Moderate	15	40.5
[a]Grade 3 Severe	0	0
CBD stones + pancreatitis	12	9.8
CBD stones + cholecystitis	21	17.2
Failed ERCP	10	8.2

Data expressed as mean (± SD) or absolute value and percentage

CBD common bile duct, *CT* computerized tomography, *ERCP* endoscopic retrograde cholangiopancreatography

[a]Cholangitis grading according to Toyko Criteria [8]

Table 3 Intra-operative data

	Elective (*n* = 85)	Index admission **(*n* = 122)**	***p* value**
Laparoscopic	80 (94.1%)	117 (95.9%)	$p = 0.559$
Conversion to open	5 (5.9%)	5 (4.1%)	$p = 0.559$
TC (vs TD)	11 (13.0%)	28 (23.0%)	$p = 0.071$
Converted TC to TD	6 (7.1%)	15 (12.3%)	$p = 0.222$
IOC	14 (16.5%)	11 (9.0%)	$p = 0.107$
IOUS	64 (75.3%)	103 (84.4%)	$p = 0.103$
Negative exploration	2 (2.4%)	5 (4.1%)	$p = 0.498$
Number of stones	2.6 (± 3.9)	2.4 (± 3.3)	$p = 0.691$
Size of largest stone (mm)	9.4 (± 4.8)	7.6 (± 3.4)	$p = 0.002$
T-tube insertion	0 (0%)	3 (2.5%)	$p = 0.148$
Operative time (min)	145 (± 65)	146 (± 64)	$p = 0.913$

Data expressed as mean (± SD) or absolute value and percentage

IOC intra operative cholangiogram, *IOUS* intra operative ultrasound, *TC* transcystic, *TD* transcholedochal

between post-operative length of stay. More patients who had a LCBDE on their index admission were discharged before the end of post-operative day 1 (56.6% vs 44.7%), though this did not reach significance ($p = 0.08$). There was no difference in complication rate, be it re-operation rate for complications, ERCP rate for bile leak, retained or recurrent stones, or readmission or mortality rates.

Discussion

Over the last 20 years the management of CBD stones has significantly changed with the introduction of laparoscopic CBD exploration and the subsequent developments and improvements in laparoscopic surgery and training. The literature confirms the increasing number of LCBDE cases performed per year [12, 13] with recent evidence that LCBDE has become the method of choice to clear the CBD in high volume centres [12].

ERCP and LCBDE are both recommended by the published guidelines in the management of CBD stones and have comparable efficacy and outcomes [14–16]. Evidence suggests that the single stage LC + LCBDE usually results in shorter hospital stay [17–19]. One metanalysis has demonstrated that single stage LCBDE has higher success rate than two-stage LC and post-operative ERCP approach [20].

All the published guidelines on CBD stones management including European Association of Endoscopic Surgery (EAES), British Society of Gastroenterology (BSG), The National Institute for Health and Care Excellence (NICE), Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), Tokyo Guidelines 2018 and the European Society of Gastrointestinal Endoscopy (ESGE) do not yet give any high-level evidence on the best approach to manage CBD stones in an emergency setting.

In our series we compared our index admission LCBDE cases to those performed electively, and subsequently the outcomes to the published literature. The index admission group includes patients that presented with biliary colic, cholecystitis, pancreatitis, cholangitis, jaundice and after failed endoscopic procedure. Thirty-seven patients (30%) had the operation to treat cholangitis, in which 15 had a Tokyo grade II cholangitis (moderate).

In the literature, two studies have compared early and elective laparoscopic choledocholithotomy for patients with mild or moderate acute cholangitis associated with choledocolithiasis. Early laparoscopic choledocholithotomy was safe, with no difference in the complication rate, but both studies were carried out in the same institution, had only a small number of cases with a high rate of exclusions and did not demonstrate the safety of single-stage laparoscopic choledocholithotomy in patients with moderate acute cholangitis [5, 6].

Duct clearance rates at the end of the operation in our series approached 100%; however, at 6 months this dropped to 95.1% in the index admission group and 95.2% in the elective group due to the discovery of retained stones. This is consistent with the rate reported in the literature ranging from 55 to 96.8% for ERCP and 75 to 100% for LCBDE [21, 22]. In comparison to our results in

Table 4 Post-operative data

	Elective ($n=85$)	Index admission ($n=122$)	p value
Clearance rate at the end of the operation	100%	99.2%	$p=0.409$
Clearance rate after 6 months post op	95.3%	95.1%	$p=0.947$
Post-op length of stay (days)	3.5 (±4.6)	3.3 (±6.3)	$p=0.803$
Percentage discharged ≤ 1 Day 1 post-op	38 (44.7%)	69 (56.6%)	$p=0.08$
Re-operation	**3 (3.5%)**	**3 (2.5%)**	$p=0.655$
Bile leak	1	3	$p=0.514$
Bleeding	1	0	$p=0.235$
Visceral injury	1	0	$p=0.235$
Stricture	0	2	$p=0.239$
Post-op ERCP	**8 (9.4%)**	**12 (9.8%)**	$p=0.921$
Retained stones[a]	4	5	$p=0.836$
Recurrent stones[b]	4	4	$p=0.604$
Bile leak	0	2	$p=0.239$
Mild bile leak[c]	6 (7.1%)	9 (7.4%)	$p=0.933$
TC	0	0	
TD	6	9	
Significant bile leak[d]	1 (1.1%)	5 (4%)	$p=0.220$
TC	1	0	$p=0.235$
TD	0	5	$p=0.06$
30-day readmission	7 (8.2%)	5 (4%)	$p=0.212$
30-day mortality	1 (1.1%)	0 (0%)	$p=0.235$

Data expressed as absolute value and percentage or mean (±SD)

CBD common bile duct, *CBDE* common bile duct exploration, *ERCP* endoscopic retrograde cholangiopancreatography, *SD* standard deviation

[a]Retained stones were diagnosed unexpectedly post-operatively either on a follow up imaging or ongoing LFTs abnormalities

[b]Recurrent stones were defined as a stone discovered more than 6 months from the date of the primary operation; these were discovered more than 2 years post-operatively

[c]Mild bile leak defined as bile leak managed conservatively and stopped without intervention where the drain was present for more than 72 h post-operatively. Equivalent to ISGLS Grade A

[d]Significant bile leak requiring endoscopic or surgical intervention; equivalent to ISGLS grade B and C

the emergency group (Heterogenous group of TC and TD), one study included homogenous 289 emergency Trans-cystic LCBDE with 93.8% success rate [12], and another published their lower success rate of 89% in emergency LCBDE [1].

Retained stones and recurrence of stones in the common bile duct are the most important indicator of the efficacy of the procedure. In this series, 5 patients (4%) were found to have retained stones within 6 months after index LCBDE and 4 patients (4.7%) after elective surgery with no significant statistical difference. This is comparable to previous publications with rates ranging 1–5% [23–25].

In this series, almost all the cases in the index group achieved successful clearance of the CBD at the end of the operation except in one case. Intra operative confirmation of clearance was achieved with choledochoscopy and or cholangiography or IOUS. Five patients were noted to have a negative exploration in this index admission group.

There was no significant difference in the duration of the operation between the two groups. In the index admission cases it was 146 ± 64 min, comparable to the elective group. In a small case series published recently, the duration of operation in the emergency LCBDE was 105 min [5] and 97 min in another publication [26], both with mixed cases of both TC and TD approach. In a series of emergency TC LCBDE duration of operation was 122 ± 63 min [12]. In another series of 62 patients who has had a TD emergency LCBDE, the mean operative time was 135 min [1].

Planning the operative approach is crucial to avoid longer operative time, reduce the conversion rate from TC to TD approach and/or reduce the time spent in clearing larger numbers of stones using the trans-cystic approach. There is evidence in the literature to consider the presence of 10 stones or more as a contraindication for the TC approach [27].

In our study, the rate of conversion to open surgery in the index admission and elective groups were 4% and 5.8% respectively with no statistical significance. The conversion rate in emergency group of LCBDE ranges from 0 to 4% in the literature [1, 5]. All the converted cases were in the first 3 years or the first half of the period this study covered. This trend has been previously noticed in another series, and it is usually an indicator of the importance of training and improving laparoscopic skills [26, 28].

Bile leak rates vary significantly between previously published papers due to variations in the definition of post-operative bile leak. In the index admission group in this study there were 5 cases (4%) of bile leak that required intervention; 2 were managed with post-operative ERCP and stenting (ISGLS grade B), and 3 cases returned to theatre for surgical washout (ISGLS grade C). Aawsaj et al. [1] reported a high rate of 13% bile leak requiring surgical or endoscopic management in their emergency LCBDE cases. Notably, they used a T-tube in 15% of their cases, with PDS sutures to repair the CBD, both of which the authors considered possible factors in the higher rate of bile leak. In another group of 81 patients undergoing emergency LCBDE but with primary closure of the choledochotomy the percentage of bile leak was much lower at 3.7% [26] which is comparable to our results. In another group the percentage was 6% without a clear definition of the bile leak [29].

It is also important to consider the number of the TC cases performed in any series as the rate of bile leak is much less in this approach even in emergency settings. The rate of bile leak was only 1% in a series of 289 emergency TC LCBDE from Argentina [12].

In our series we sub classified bile leak into major leak required intervention or minor leak recognized by delayed removal of the drains more than 3 days post-operative. This increases the total number of cases with any bile leak in the index admission group to 14 cases (11.5%).

Mean length of stay post-operatively was 3.3 ± 6.3 days in the index admission group and 3.5 ± 4.6 days after elective cases. More than half of the patients in the index admission group was discharged on day one post-operatively. This is similar to previously published literature in a heterogenous group of both elective and emergency cases with a median length of stay 3 days [30].

One patient in the index admission group developed stricture after TD approach; however, this patient was diagnosed with Mirrizi type 1 intra operatively and has since been lost to follow-up. In the literature to date there is no significant data on long-term complications and follow-up, and hence this complication is possibly underestimated. The rate of stricture after LCBDE is reported with a range of 0–0.8% [31–33].

Early in the twenty-first century there was strong evidence against using T-tubes with 11–15% risk of morbidity [34–36], and so we do not routinely use a T-tube in our practice, and we are very selective in the use of this approach. In this series, it was used in only 3 patients in the index admission group and none in the elective group. Those patients had already failed ERCP pre-operatively. One patient was found to have a stricture in addition to a stone, one failed the clearance at the end of the operation due to a large, impacted stone, and the third patient had a Mirrizi syndrome. Few studies have demonstrated that closure of the choledochotomy primarily in emergency setting is as safe as in elective operations [37, 38].

Re-operation was required in 3 cases in the index admission group (2.5%), and that was surprisingly less than the re-operation rate in the elective group (3.5%); however, this was not statistically significant. One possible reason for this is the complexity of some of the elective cases as 41.2% of them were performed after a failed ERCP.

This study has some limitations; first, it is a retrospective observational study. However, the data was collected for consecutive cases of LCBDE to minimize the effect of this and minimize the bias. The number of cases is not large, with only 121 patient in the index admission group; however, this number is similar or larger to previous publications comparing emergency and elective LCBDE. There was no regular follow-up for all the patients, and this may affect the results and the outcome. It represents a single centre experience rather than multi-centre study. Despite these limitations, this study presents a pragmatic assessment of the techniques for both elective and index admission cases. Randomized control multicentre studies are the way forward.

In conclusion, laparoscopic common bile duct exploration is becoming more popular in the UK as an alternative option to the classical endoscopic approach for the treatment of common bile duct stones. However, we still emphasize that none of those techniques is a replacement, but they complement each other. In our opinion, LCBDE is safe and effective option in index admissions including mild and moderate cholangitis given that the necessary expertise and instrumentation are available.

Authors' contributions IF Study conception and design, acquisition of data, drafting of manuscript, critical revision of manuscript. MA Study conception and design, acquisition of data, drafting of manuscript, critical revision of manuscript. HR Acquisition of data. LM Acquisition of data. REB Analysis and interpretation of data, critical revision of manuscript. MC Drafting of manuscript, critical revision of manuscript. JC Critical revision of manuscript. PP Critical revision of manuscript. AC Critical revision of manuscript.

Declarations

Conflict of interest The authors declare no competing interests.

References

1. Aawsaj Y, Brown J, Horgan L, Light D (2020) Emergency laparoscopic common bile duct exploration and analysis of risk factors for post-procedure leak: a seven years' experience. Laparosc Endosc Surg Sci 27(3):137–142
2. Berci G, Morgenstern L (1994) Laparoscopic management of common bile duct stones. A multi-institutional SAGES study. Society of American Gastrointestinal Endoscopic Surgeons. Surg Endosc 8(10):1168–74; discussion 74–5
3. Morino M, Baracchi F, Miglietta C, Furlan N, Ragona R, Garbarini A (2006) Preoperative endoscopic sphincterotomy versus laparoendoscopic rendezvous in patients with gallbladder and bile duct stones. Ann Surg 244(6):889–93; discussion 93–6
4. Rabago LR, Vicente C, Soler F, Delgado M, Moral I, Guerra I et al (2006) Two-stage treatment with preoperative endoscopic retrograde cholangiopancreatography (ERCP) compared with single-stage treatment with intraoperative ERCP for patients with symptomatic cholelithiasis with possible choledocholithiasis. Endoscopy 38(8):779–786
5. Zhu B, Wang Y, Gong K, Lu Y, Ren Y, Hou X et al (2014) Comparison of emergent versus elective laparoscopic common bile duct exploration for patients with or without nonsevere acute cholangitis complicated with common bile duct stones. J Surg Res 187(1):72–76
6. Zhu B, Li D, Ren Y, Li Y, Wang Y, Li K et al (2015) Early versus delayed laparoscopic common bile duct exploration for common bile duct stone-related nonsevere acute cholangitis. Sci Rep 5:11748
7. Kiriyama S, Kozaka K, Takada T, Strasberg SM, Pitt HA, Gabata T et al (2018) Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholangitis (with videos). J Hepatobiliary Pancreat Sci 25(1):17–30
8. Banks PA, Bollen TL, Dervenis C, Gooszen HG, Johnson CD, Sarr MG et al (2013) Classification of acute pancreatitis—2012: revision of the Atlanta classification and definitions by international consensus. Gut 62(1):102–111
9. Koch M, Garden OJ, Padbury R, Rahbari NN, Adam R, Capussotti L et al (2011) Bile leakage after hepatobiliary and pancreatic surgery: a definition and grading of severity by the International Study Group of Liver Surgery. Surgery 149(5):680–688
10. Strasberg SM, Hertl M, Soper NJ (1995) An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J Am Coll Surg 180(1):101–125
11. Tranter SE, Thompson MH (2003) A prospective single-blinded controlled study comparing laparoscopic ultrasound of the common bile duct with operative cholangiography. Surg Endosc 17(2):216–219
12. Czerwonko ME, Pekolj J, Uad P, Mazza O, Sanchez-Claria R, Arbues G et al (2019) Laparoscopic transcystic common bile duct exploration in the emergency is as effective and safe as in elective setting. J Gastrointest Surg 23(9):1848–1855
13. Al-Ardah M, Barnett RE, Morris S, Abdelrahman T, Nutt M, Boyce T et al (2021) Lessons learnt from the first 200 unselected consecutive cases of laparoscopic exploration of common bile duct stones at a district general hospital. Surg Endosc 35(11):6268–6277
14. Dasari BV, Tan CJ, Gurusamy KS, Martin DJ, Kirk G, McKie L, et al. (2013) Surgical versus endoscopic treatment of bile duct stones. Cochrane Database Syst Rev (9):CD003327
15. Kenny R, Richardson J, McGlone ER, Reddy M, Khan OA (2014) Laparoscopic common bile duct exploration versus pre or post-operative ERCP for common bile duct stones in patients undergoing cholecystectomy: is there any difference? Int J Surg 12(9):989–993
16. Alexakis N, Connor S (2012) Meta-analysis of one- vs. two-stage laparoscopic/endoscopic management of common bile duct stones. HPB (Oxford) 14(4):254–9
17. Bansal VK, Misra MC, Garg P, Prabhu M (2010) A prospective randomized trial comparing two-stage versus single-stage management of patients with gallstone disease and common bile duct stones. Surg Endosc 24(8):1986–1989
18. Koc B, Karahan S, Adas G, Tutal F, Guven H, Ozsoy A (2013) Comparison of laparoscopic common bile duct exploration and endoscopic retrograde cholangiopancreatography plus laparoscopic cholecystectomy for choledocholithiasis: a prospective randomized study. Am J Surg 206(4):457–463
19. Ding G, Cai W, Qin M (2014) Single-stage vs. two-stage management for concomitant gallstones and common bile duct stones: a prospective randomized trial with long-term follow-up. J Gastrointest Surg 18(5):947–51
20. Singh AN, Kilambi R (2018) Single-stage laparoscopic common bile duct exploration and cholecystectomy versus two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy for patients with gallbladder stones with common bile duct stones: systematic review and meta-analysis of randomized trials with trial sequential analysis. Surg Endosc 32(9):3763–3776
21. Zhu HY, Xu M, Shen HJ, Yang C, Li F, Li KW et al (2015) A meta-analysis of single-stage versus two-stage management for concomitant gallstones and common bile duct stones. Clin Res Hepatol Gastroenterol 39(5):584–593
22. Lu J, Cheng Y, Xiong XZ, Lin YX, Wu SJ, Cheng NS (2012) Two-stage vs single-stage management for concomitant gallstones and common bile duct stones. World J Gastroenterol 18(24):3156–3166
23. Pan L, Chen M, Ji L, Zheng L, Yan P, Fang J et al (2018) 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 268(2):247–253
24. Liu WS, Jiang Y, Zhang D, Shi LQ, Sun DL (2018) Laparoscopic common bile duct exploration is a safe and effective strategy for elderly patients. Surgical Innovation 25(5):465–469
25. Zheng C, Huang Y, Xie E, Xie D, Peng Y, Wang X (2017) Laparoscopic common bile duct exploration: a safe and definitive treatment for elderly patients. Surg Endosc 31(6):2541–2547
26. Alhamdani A, Mahmud S, Jameel M, Baker A (2008) Primary closure of choledochotomy after emergency laparoscopic common bile duct exploration. Surg Endosc 22(10):2190–2195
27. Lyass S, Phillips EH (2006) Laparoscopic transcystic duct common bile duct exploration. Surg Endosc 20(Suppl 2):S441–S445
28. Paganini AM, Lezoche E (1998) Follow-up of 161 unselected consecutive patients treated laparoscopically for common bile duct stones. Surg Endosc 12(1):23–29
29. Gurusamy KS, Samraj K (2007) Primary closure versus T-tube drainage after open common bile duct exploration. Cochrane Database Syst Rev (1):CD005640
30. Platt TE, Smith K, Sinha S, Nixon M, Srinivas G, Johnson N et al (2018) Laparoscopic common bile duct exploration; a preferential pathway for elderly patients. Ann Med Surg (Lond) 30:13–17
31. Campbell-Lloyd AJ, Martin DJ, Martin IJ (2008) Long-term outcomes after laparoscopic bile duct exploration: a 5-year follow up of 150 consecutive patients. ANZ J Surg 78(6):492–494
32. Giurgiu DI, Margulies DR, Carroll BJ, Gabbay J, Iida A, Takagi S, et al. (1999) Laparoscopic common bile duct exploration: long-term outcome. Arch Surg 134(8):839–43; discussion 43–4
33. Waage A, Stromberg C, Leijonmarck CE, Arvidsson D (2003) Long-term results from laparoscopic common bile duct exploration. Surg Endosc 17(8):1181–1185

34. Wei Q, Hu HJ, Cai XY, Li LB, Wang GY (2004) Biliary drainage after laparoscopic choledochotomy. World J Gastroenterol 10(21):3175–3178
35. Zhang LD, Bie P, Chen P, Wang SG, Ma KS, Dong JH (2004) Primary duct closure versus T-tube drainage following laparoscopic choledochotomy. Zhonghua Wai Ke Za Zhi 42(9):520–523
36. Gurusamy KS, Koti R, Davidson BR (2013) T-tube drainage versus primary closure after laparoscopic common bile duct exploration. Cochrane Database System Rev (6):CD005641
37. Pawa N, Tutton MG (2009) Primary common bile duct closure is safe following emergency and elective exploration. World J Surg 33(8):1779
38. Shojaiefard A, Esmaeilzadeh M, Ghafouri A, Mehrabi A (2009) Various techniques for the surgical treatment of common bile duct stones: a meta review. Gastroenterol Res Pract 2009:840208