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Original Research Article

A comparison of surgical techniques in the management of patients with choledocholithiasis undergoing laparoscopic cholecystectomy: an Australian experience

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ABSTRACT

Background: Optimal management of patients with gallstones and concomitant choledocholithiasis has been a longstanding dilemma. Advancements in laparoscopic and endoscopic techniques have enabled multiple options for management. This study aims to compare the effectiveness of different procedures for choledocholithiasis in patients requiring laparoscopic cholecystectomy in the emergency setting of a large tertiary Australian hospital.
Methods: A retrospective review of patients requiring emergency laparoscopic cholecystectomy who were also treated for choledocholithiasis was conducted at Liverpool Hospital, New South Wales. Patients were allocated into three groups: pre-operative endoscopic retrograde cholangiopancreatography (ERCP) followed by laparoscopic cholecystectomy at index admission, or laparoscopic cholecystectomy with intraoperative biliary stent placement followed by interval ERCP and stent removal, or laparoscopic cholecystectomy with intraoperative bile duct exploration. The primary outcome assessed was bile duct clearance rate. The secondary outcomes included complication rates, number of procedures performed, total operative time, length of stay (LOS) and cost.
Results: A total of 96 patients were included. Primary outcome was no different between the three groups and there was no significant difference between post-operative complications. However, LOS was shorter in the laparoscopic cholecystectomy with intraoperative bile duct exploration by three days compared to the other two groups.
Conclusions: Laparoscopic cholecystectomy with intraoperative bile duct exploration has similar outcomes and complication rates to other techniques and may be associated with a shorter LOS and lower costs.

Keywords: Choledocholithiasis, ERCP, Laparoscopic common bile duct exploration, Biliary stent

INTRODUCTION

Gallstones are a common condition affecting many patients worldwide with an estimated prevalence of 25-30% in Australians over the age of 50.[1] Approximately 2% of patients with gallstones will become symptomatic annually, presenting with right upper quadrant or epigastric pain, nausea and/or vomiting.[2] The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) recommends patients with symptomatic gallstones be treated with laparoscopic cholecystectomy.[3] Concomitant choledocholithiasis occurs in 10-20% of patients, with a proportion requiring further surgical intervention for symptomatic relief and prevention of serious complications such as cholangitis, sepsis or pancreatitis.[4]

The management of bile duct stones (BDS) in the setting of a patient requiring a laparoscopic cholecystectomy (LC) is still debated with authors prescribing a single- or two-stage approach.[5,6] The current methods for a two-stage approach include an endoscopic retrograde

cholangiopancreatography (ERCP) followed by LC. This is often performed for patients with biliary sepsis, or a LC with biliary stent placement followed by an ERCP for patients with BDS detected on intraoperative cholangiogram (IOC). In Australia and the United States, ERCP appears to be the predominant treatment strategy for choledocholithiasis.[7,8] However, single-stage procedures such as LC with intraoperative bile duct exploration (LCBDE) have also been reported to have ductal clearance rates ranging from 75-96% and are an increasingly popular and effective treatment option for BDS.[9,10]

Nonetheless, the approach is dependent on anatomical considerations, location, number and size of bile duct stones, as well as equipment availability and surgeon skill set. This study critically reviews the clinical outcomes of different approaches in the management of BDS in patients requiring emergency LC in a facility that has relatively equal accessibility to each of these treatment options.

METHODS

A retrospective review was conducted at Liverpool Hospital, New South Wales, Australia from 2018-2020 for patients who presented with symptomatic cholelithiasis with concomitant CBD stones requiring laparoscopic cholecystectomy. Within our facility, patients undergoing emergency LC are supported by a system of readily available access to video choledochoscopy and transcystic stenting with surgeons comfortable in performing LCBDE and prompt access to ERCP. Data was collected from electronic medical data records including age, sex, clinical presentation, biochemical parameters, imaging, number of procedures and operating time.

Patient selection

The inclusion criteria were adult patients older than 18 years who underwent emergency LC with concomitant BDS. The exclusion criteria were patients younger than 18 years of age and/or open cholecystectomy.

BDS were determined either pre-operatively or intra-operatively. If determined pre-operatively, they were detected on ultrasound or computer tomography (CT) scan. Intraoperative cholangiogram (IOC) was performed routinely for all patients undergoing LC. If BDS were identified on IOC, an intraoperative decision by the senior surgeon was made to undergo LCBDE or transcystic insertion of a biliary stent.

Patients were assessed by a surgical trainee and surgeon upon which the operating surgeon determined who underwent specific management. Patients underwent one of the following management plans: group A: pre-operative ERCP followed by LC at index admission, group B: LC with intraoperative biliary stent placement followed by interval ERCP and stent removal, and group C: LC with intraoperative bile duct exploration.

Patients who are critically ill on admission with signs and symptoms of acute cholangitis or have a high bilirubin were referred for a pre-operative ERCP followed by definitive LC (group A). Furthermore, patients who underwent LC with intraoperative biliary stent placement (group B), underwent interval admission for subsequent ERCP and removal of the biliary stent approximately 6 weeks later. Patients who failed management under their respective groups and had further treatment i.e. ERCP or insertion of a stent were primarily analysed in their initial allocated group. For both two-stage procedures, pre-operative and post-operative ERCP, the shortlist created from the hospital's database was much larger and only the most recent 30 admissions were selected to provide comparable group sizes in all three treatment arms.

Outcome measures

The primary outcome assessed was bile duct clearance rate. The secondary outcomes included complication rates, number of procedures performed, total operative time, length of stay (LOS) and cost.

Statistical analyses

A statistical analysis using statistical package for the social sciences (SPSS) (version 27.0) was computed for continuous variables assessing the relationship between linear data and correlation based on a level of significance set at p value of 0.05. Continuous variables were expressed as mean, median, and standard deviation. Differences between proportions between surgical interventions derived from categorical data were analysed using Kruskal-Wallis H test with post hoc analysis and Fisher's exact test for continuous variables.

RESULTS

There was a total of 96 patients who presented with BDS in our study. The average age 55.0 years (±21.1) with a higher female proportion compared to males (61.3% versus 38.7%). Patients who underwent emergency surgery across the three groups included 31 patients in group A, 33 patients in group B and 32 patients in group C (Figure 1).

Patients who presented with BDS had an average bilirubin of 37.4 (µmol/l), gamma-glutamyl transferase (GGT) 382.4 (U/l), white cell count (WCC) 12.3 (x109/l), C-reactive protein (CRP) 49 (mg/l), amylase 201.5 (U/l), and lipase of 667.1 (U/l) (Table 1). The most common diagnosis on hospital presentation was cholecystitis (40.9%), followed by choledocholithiasis (21.5%), and cholangitis (16.1%). Patients who presented with cholecystitis were more likely to under LC + biliary stent + ERCP (60%), whereas those with choledocholithiasis were more likely to undergo LC and LCBDE (31.3%) (Figure 2). Thirty-one patients in the study group received pre-operative ERCP. Of those patients, thirteen had ascending cholangitis on presentation. A sub-group

analysis was performed for groups without cholangitis and this similarly showed no difference in bile duct clearance rate [F (2,76), p=0.811].

Successful clearance amongst all three intervention groups were similar ranging from 73.3-78.1% with no significant differences (Table 1). Group A had the highest number of patients (12/31) requiring further procedures to achieve ductal clearance. In comparison, group B (4/33) and group C (11/32) had lower proportions. All patients eventually achieved bile duct clearance with a maximum of 4 procedures performed (Table 2). Patients who required repeated procedures were either due to retained BD stones or an inability to cannulate the bile duct.

The average number of procedures was 2.1 (±0.8) with a total mean operative duration of 186.0 minutes (±76.1). The mean operative time was significantly shorter by 59 minutes for ERCP and LC (group A) compared to LC and LCBDE (group C) (159.2 versus 218.3, p=0.021). The post-operative complication rate was 31.2%. Post-operative complications were higher in the LC and biliary stent and ERCP group (36.7%) compared to 25.0% in the LC and LCBDE, albeit not statistically significant (p=0.615, Table 3). There was one mortality in the cohort. The average LOS was 8.8 days (±5.5) ranging from 2–29 days. The LC and LCBDE group had a significantly shorter LOS of approximately 3.0 days compared to both other groups (p=0.039).

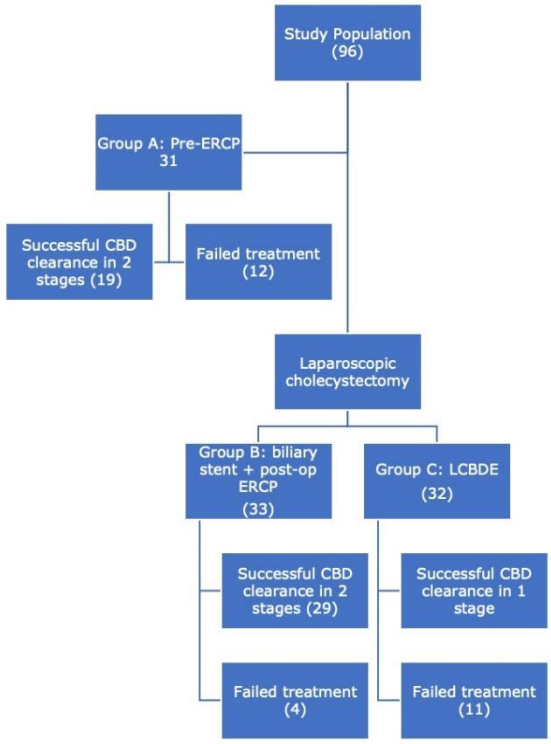

Figure 1: Flow chart of study population and patient distribution.

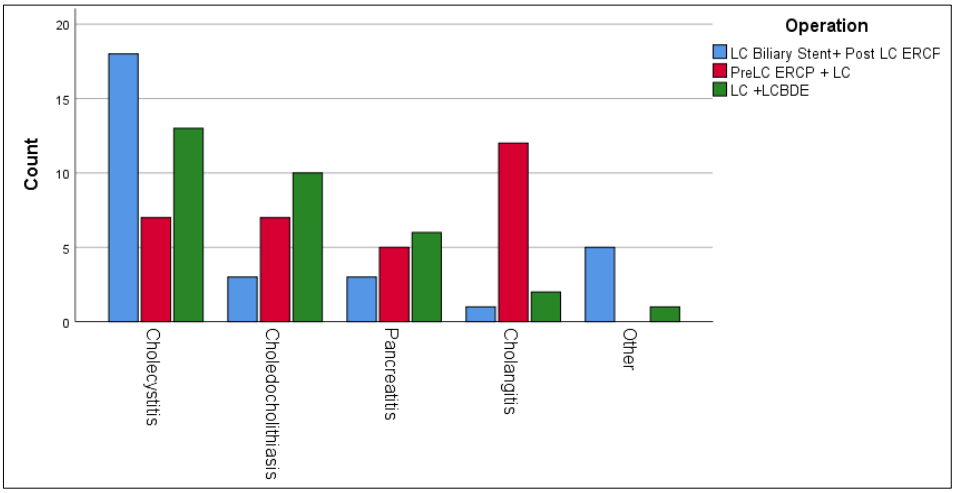

Figure 2: Clinical presentation and subsequent procedure.

Table 1: Comparison of clinical variables and outcomes, Kruskal-Wallis H test with post hoc analysis and Fisher's exact test.

Parameters	Pre LC ERCP + LC (group A)	LC + biliary stent + post LC ERCP (group B)	LC + LCBDE (group C)	P value	Pairwise compare-sons of groups
Demographics					
Age mean	64.3 (19.0)	52.6 (20.9)	48.3 (20.7)	0.009*	C versus B (0.009)*
Sex					
Male	17 (54.8)	10 (33.3)	8 (25.0)	0.023*	
Female	14 (45.2)	20 (66.7)	24 (75.0)		

Continued.

Parameters	Pre LC ERCP + LC (group A)	LC + biliary stent + post LC ERCP (group B)	LC + LCBDE (group C)	P value	Pairwise compare-sons of groups
Procedures					
1	-	-	21 (65.6)		
2	19 (61.3)	26 (86.7)	4 (12.5)		
3	9 (29.0)	3 (10.0)	5 (15.6)		
4	3 (9.7)	1 (3.3)	2 (6.3)		
More than two procedures	12 (38.7)	4 (13.3)	7 (21.9)	0.072	
Mean total procedures	2.5 (0.7)	2.2 (0.5)	1.6 (1.0)	0.001*	A versus B (0.005), C versus B (<0.001)
OT time (mins)	159.2 (60.1)	179.0 (46.3)	218.3 (99.3)	0.007*	B versus C (0.005)
Diagnosis on presentation					
Cholecystitis	7 (22.6)	18 (60)	13 (40.6)		
Choledocholithiasis	7 (22.6)	3 (10)	10 (31.3)		
Cholangitis	12 (38.7)	1 (3.3)	2 (6.3)		
Pancreatitis	5 (16.1)	3 (10)	6 (18.8)		
Other	0 (0.0)	5 (16.7)	1 (3.1)		
Biochemical parameters and investigations					
Temperature >37.5	9 (29.0)	2 (6.7)	3 (9.4)	0.036*	
Bilirubin	48.9 (51.0)	27.6 (26.6)	35.5 (34.3)	0.099	
GGT	465.4 (378.4)	286.7 (411.7)	391.8 (456.5)	0.030*	A versus B (0.009)
Amylase	192.1 (292.9)	78.6 (143.9)	391.8 (456.5)	0.008*	A versus C (0.004), A versus B (0.018)
Lipase	752.0 (2083.9)	605.1 (2201.5)	641.7 (1647.1)	0.431	
WCC	14.2 (13.3)	11.8 (6.4)	10.9 (4.2)	0.478	
CRP	75.9 (98.2)	46.7 (96.5)	22.8 (30.8)	0.015*	A versus B (0.008), B versus C (0.020)
Imaging					
Ultrasound	10 (32.3)	17 (56.7)	20 (62.5)	0.044*	
CT	19 (61.3)	10 (33.3)	9 (28.1)	0.018*	
No imaging	5 (16.1)	5 (16.7)	6 (18.8)	-	
Treatment and outcomes					
Successful outcome	24 (77.4)	22 (73.3)	25 (78.1)	0.909	
Post op complications	10 (32.3)	11 (36.7)	8 (25.0)	0.615	
Medical					
Surgical					
LoS					C versus A (0.031), C versus B (0.017)
Mean (SD)	9.8 (5.7)	9.9 (6.4)	6.8 (3.8)	0.031*	
Mortality	1 (3.2)	-	-	0.656	

Table 2: A frequency table of attempts to ductal clearance.

Parameters	Group A	Group B	Group C
Failed once	9	3	4
Failed twice	3	1	5
Failed three times			2
Total	12	4	11

Group A: Pre-operative ERCP and interval LC, Group B: LC + intraoperative biliary stent + post operative ERCP, Group C: LC + LCBDE

Table 3: Post operative complications as per Clavien–Dindo classification for each group.

Parameters	Group A	Group B	Group C	Clavien-Dindo classification
Retained BD stone	3	3	4	3b
Failed ERCP	1	1	4	
Post ERCP pancreatitis	1	4		1
Wound infection/surgical collection		1		2
Bile leak		1		3b
Other	2-bacteraemia, 1-AKI, 1-APO, 1-sickle cell crisis	1-Hypoxia		1, 2
Total	10	11	8	

Group A: Pre-operative ERCP and interval LC, group B: LC + intraoperative biliary stent + post-operative ERCP, group C: LC + LCBDE

DISCUSSION

In our study, the rate of bile duct clearance was not significantly different amongst the three surgical techniques. A successful bile duct clearance was obtained in 77%, 78% and 73% for group A, B and C respectively (Table 1). The literature reports that LCBDE has clearance rates of up to 97%, however in comparison, our centre showed overall lower bile duct clearance rates.[11-14] This is likely due to the fact that our centre has a lower utilization of the LCBDE technique and that success rates depend on a steep learning curve with established skill sets. In the emergency scenario, consultants may not have been readily available to perform or supervise trainees who undertook the LCBDE technique, further contributing to a lower duct clearance rate.

In terms of secondary outcome measures, the pre-operative ERCP group required more procedures overall to achieve ductal clearance. Although this was statistically significant in comparison to group B and C treatment approaches (p=0.001), this was likely secondary to inherent selection bias given a larger proportion of the patients in group A presented with cholangitis (13 out of 31) compared to in group B and C. Patients in group A likely had larger or more stones that were more difficult to remove. Our experience showed that patients with cholangitis more commonly underwent ERCP and concurrent intravenous antibiotic therapy prior to interval cholecystectomy.[15,16] Despite the increased number of procedures required in group A, the complication rates were similar in all three study groups with no statistical difference in severe (Clavien-Dindo IIIb-V) complications (p=0.615, Table 3). In our study, we had relatively high morbidity rates for all three of our treatment groups (32%, 37% and 25% respectively) comparative to the literature.[12,14,17] This can be attributed by the inclusion of both expected and unexpected bile duct stones as a complication compared to the literature, where studies only reported unexpected bile duct stones as a complication or the rate of retained stones.[18-20]

We found that the LCBDE group had a significantly shorter LOS by 3.0 days compared to the other interventions (p=0.031, Table 1). The shorter inpatient hospital stay associated with the LCBDE group in comparison to two-stage procedures has been reported by other studies.[12,18,21] A meta-analysis of 11 trials with a total of 1513 patients demonstrated an shorter overall hospital stay for LCBDE compared to the pre-operative ERCP group (4.9±1.6 vesus 6.5±3.4; p=0.05).[22] Across major metropolitan Australian hospitals in 2011-2012, estimated preliminary costs for admission for cholecystectomy without complications or co-morbidities was $7400.[23] However, this sum does not factor the additional costs of surgical intervention required for the management of choledocholithiasis. An RCT conducted at an American teaching hospital demonstrated significantly less costs for LCBDE than ERCP + LC, $4820 versus $6139 USD respectively.[14] Another retrospective cohort study in Finland, demonstrated that single-stage management resulted in mean total difference of €1000 compared to multi-stage management.[19] Although our study did not calculate the cost per procedure, it showed a favourably shorter LOS for LCBDE which implies reduced hospital accommodation costs and therefore overall expense. Accomplishing bile duct treatment during a single hospital visit is favourable compared to the other techniques, which would require at least two hospital admissions and consequently at least two anaesthetics. However, this does not factor operative time, equipment, and expertise, all of which are important variables that drive costs for particular interventions.

In our centre, we identified variations in operative time between groups, with LCBDE yielding a significantly longer time compared to group A and B respectively (218.3 versus 159.2 versus 179 minutes; p=0.007). However, a meta-analysis of eight RCTs reported a significantly lower mean operative time of 119.5 minutes with LCBDE versus 129 minutes with pre-operative ERCP + LC.20 In several studies, there was some disparity regarding whether single or two-stage management results in shorter operating times.[14,19,24]

However in our centre, for ERCP + LC, a consultant is more likely to be performing the procedure, whereas a LCBDE is more likely to be performed by a trainee or fellow. The variation in operative time may be partially attributed to the training opportunities provided to trainees

during the less frequently performed LCBDE. Our preference is for transcystic LCBDE (if clinically suitable) with a 3.5 mm flexible video choledochoscope.

There are some limitations to the study notably the retrospective nature, selection bias and small sample size. Our study population was relatively small and is reflective of the multiple treatment modalities available to clinicians faced with patients with emergency biliary presentations and concomitant choledocholithiasis. In order to achieve significant population size, and to minimize the influence of bias and clinical heterogeneity, larger prospective multicentre studies would be necessary.

CONCLUSION

Laparoscopic cholecystectomy with intraoperative bile duct exploration has similar bile duct clearance and complication rates to other surgical techniques. It is a safe and effective treatment option for choledocholithiasis and is associated with a reduced length of stay.

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