



10 years of laparoscopic common bile duct exploration: A single tertiary institution experience

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ABSTRACT

Introduction: Laparoscopic common bile duct exploration (LCBDE-LC) or ERCP plus laparoscopic cholecystectomy (ERCP-LC) represent minimally invasive choledocholithiasis treatments. We hypothesized that LCBDE-LC has a shorter length of stay (LOS) and lower charges than ERCP-LC.

Methods: Charts were reviewed for all LCBDE-LC or ERCP-LC for choledocholithiasis from 2007 to 2017. Exclusions included cholangitis, concomitant procedures, or history of Roux-en-Y or biliary surgery. Groups were determined via intention-to-treat with LCBDE-LC or ERCP-LC.

Results: 281 subjects were identified; 157 met inclusion criteria. 89 (56%) were in the LCBDE-LC group. There were no differences in age, sex, or ASA. LOS was shorter for LCBDE-LC (3.1 vs 4.4 days, $p < 0.01$) although total anesthesia time was longer (292 vs 262 min, $p = 0.01$). There was no difference in total charges (\$44,412 vs \$51,353, $p = 0.08$). Thirty (33%) LCBDE-LC were aborted due to challenges passing the dilator or scope (33%) or clearing stones (30%). Two ERCP-LC cases required post-procedure LCBDE.

Conclusion: LCBDE-LC resulted in shorter LOS but had a high failure rate. Further research is needed to predict which cases suit each modality.

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Introduction

Common bile duct stones are a common challenge for general surgeons occurring in 3–15% of patients with symptomatic cholelithiasis.^{1–3} There are two minimally invasive methods by which surgeons treat common bile duct stones: 1) in one stage via a laparoscopic common bile duct exploration at the time of the laparoscopic cholecystectomy (LCBDE-LC), or 2) in two stages using endoscopic retrograde cholangiopancreatography with sphincterotomy (ERCP)—a procedure performed by gastroenterologists—either before or after a laparoscopic cholecystectomy (ERCP-LC).⁴ Although surgeon comfort with advanced laparoscopy has been steadily increasing, it remains unclear which method is the most cost-effective and associated with the best outcomes for patients. Further, general surgeons must be aware of alternatives as ERCP is not always readily available, particularly in rural areas, and carries with it the risk of bleeding, perforation, or pancreatitis in addition to the long-term sequelae of sphincter of Oddi disruption.^{5,6} While there are alternative minimally invasive methods of

treating common bile duct stones, such as intraoperative ERCP via the oropharynx or a gastrostomy, they are far less common as they involve coordinating two care teams.

Recent meta-analyses have found LCBDE-LC to be superior to pre-operative ERCP with laparoscopic cholecystectomy with regards to operative time, total length of stay, and common bile duct stone clearance rate, but there are mixed results regarding the frequency of perioperative complications.^{7–9} Our institution has previously developed a surgical education model for teaching laparoscopic common bile duct exploration wherein all faculty and surgical residents employ the same stepwise technique for laparoscopically addressing primary common bile duct stones.¹⁰ This study aimed to compare outcomes for ERCP-LC vs. LCBDE-LC in a pragmatic cohort of patients who presented to a tertiary institution with common bile duct stones.

Methods

This study retrospectively identified subjects via the institutional electronic medical record using ICD 9/10 codes for cholelithiasis (K80/574) in conjunction with CPT codes for common bile duct exploration (CPT 47564, 47610, 47612, 47620) or ERCP (CPT 43260–78) with laparoscopic cholecystectomy on the same

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admission between 2007 and 2017. Charts were manually reviewed and subjects were included if they were between ages 18–89 at the time of their operation. The indication for the procedure had to be known or suspected choledocholithiasis. Subjects were excluded for cholangitis, concomitant procedures, non-stone pathology, or a history of Roux-en-Y bypass or biliary surgery.

Subjects were grouped into the ERCP-LC or LCBDE-LC by the intended procedure. If a subject went to the operating room and a laparoscopic common bile duct exploration was attempted but was unsuccessful and followed by an ERCP, then that patient would be in the LCBDE-LC group. If, however, the operating surgeon had no intention of doing an LCBDE and planned a pre- or post-operative ERCP then the subject was placed in the ERCP-LC group. Total anesthesia time was obtained from the anesthesia record and was calculated using the anesthesia start and stop time rather than the procedure start and stop time as the procedure time was not consistently available early in the 10-year study period. In cases where the subject underwent both an ERCP and a common bile duct exploration the times were cumulative. Total hospital charges were obtained for the specific hospital encounter post-discharge from the institutional financial office.

Univariate analyses were performed with chi-square for all categorical variables, Student's t-test for parametric and Wilcoxon rank sum for non-parametric continuous variables, respectively. Variables with p-value ≤ 0.05 were considered significant. All statistical analyses were performed using STATA v15 (College Station, TX).

Results

281 subjects with pre-operative diagnoses of known or suspected choledocholithiasis were identified of which 157 met the inclusion criteria. 89 (56%) were in the LCBDE-LC group while 68 were in the ERCP-LC group. There were no differences in age, sex, ASA, or pre-procedure pancreatitis (Table 1). Patients preferentially sent for ERCP-LC had significantly higher liver function tests and frequency of jaundice.

Total and post-procedure length of stay was shorter for LCBDE-LC (4.45 vs. 5.8 days, $p = 0.02$ and 3.1 vs. 4.4 days, $p < 0.01$) although total anesthesia time was longer (292 vs. 262 min, $p = 0.01$, Fig. 1).

Table 1

Demographics and baseline characteristics of LCBDE-LC vs. ERCP-LC. * indicates Fisher's exact, *** $p < 0.05$. IQR= Interquartile Range. ASA = Anesthesia Society of America.

	LCBDE-LC		ERCP + LC		p-value
	N		N		
Median Age	89	48 (31–64)	68	36.5 (29–63)	0.19
Sex					
Male	37	42%	19	28%	0.08
Female	52	58%	49	72%	
Emergent Case					
No	13	15%	3	4%	0.06*
Yes	76	85%	65	96%	
Median AST (IQR)	88	157 (45.5–296)	68	281 (120–418)	<0.001***
Median ALT (IQR)	88	151 (45–360)	68	332 (154–621)	<0.001***
Median Alk Phos (IQR)	87	141 (94–209)	67	206 (132–347)	<0.001***
Median Tbili (IQR)	87	1.4 (0.7–2.6)	69	2.2 (1–5.3)	0.002***
Jaundice					
No	81	91%	50	74%	0.004***
Yes	8	9%	18	26%	
Pre-procedure Pancreatitis					
No	72	81%	48	71%	0.13
Yes	17	19%	20	29%	
ASA Group					
ASA 1-2	65	73%	50	76%	0.75
ASA 3-4	24	27%	16	24%	

There was no difference in total charges (\$44,412 vs \$51,353, $p = 0.08$), frequency of Clavien-Dindo grade 3 or greater complication (16% vs 6%, $p = 0.08$) or rate of conversion to open surgery (13% vs 10%, $p = 0.5$) (Table 2). There were no mortalities in either group.

Thirty (33%) LCBDE-LC were aborted due to inability to pass dilator or scope (33%), clear all stones (30%) or complete the cholangiogram (23%) (Table 3). Two ERCP-LC cases had retained stones that required LCBDE. Of the thirty LCBDE-LC that were not completed, twenty-nine (97%) went on to have a post-operative ERCP. Two (7%) of the aborted LCBDE-LC were converted from laparoscopic to open procedures. All of the Clavien-Dindo grade 3 or great complications within the LCBDE-LC group occurred in the aborted LCBDE-LC cases. Compared to those with a successful LCBDE-LC, aborted LCBDE-LC cases had a longer post-procedure length of stay (3.9 ± 2.5 days vs. 2.8 ± 2.3 days, $p = 0.006$), but there was no difference in the total length of stay (5.0 ± 2.7 days vs. 4.2 ± 2.5 days, $p = 0.13$). Total anesthesia time was higher for aborted LCBDE-LC was (333 ± 85 min vs. 273 ± 75 min, $p = 0.001$) for successful LCBDE-LC. Similarly, total charges were higher in the aborted group ($\$52,916 \pm \$23,626$ vs $\$40,232 \pm \$15,728$, $p = 0.002$).

Discussion

This study demonstrated that LCBDE-LC for choledocholithiasis resulted in a shorter total and post-procedure length of stay compared to ERCP-LC but had a high failure rate. As a result, there was a trend towards lower charges within the LCBDE-LC group but it did not reach statistical significance. Similarly, there was no difference in complication rates between the two modalities.

A shorter length of stay for LCBDE-LC has been seen elsewhere in the literature.^{11,12} However, in contrast to other studies, our review found a longer total anesthesia time and no significant difference in total charges between ERCP-LC and LCBDE-LC. There are numerous possible explanations for this finding, including a diverse pool of providers, residents, and operating room staff performing the LCBDE-LC. The total anesthesia time also includes cases where the LCBDE-LC was ultimately aborted and an ERCP was often required for a retained stone. With regards to charges, a 2010 randomized control trial of healthy persons with choledocholithiasis (ASA 1 or 2) similarly found a trend toward lower total charges in LCBDE-LC compared to ERCP but not a statistically significant difference.¹²

Previously published studies of LCBDE-LC report success rates of completion and stone clearance of 80–98.5%.^{13–15} Our sample had a 66% success rate with laparoscopic common bile duct exploration. In comparing successful LCBDE-LC to the aborted cases, the aborted cases were associated with more complications, longer anesthesia times, and total charges. While these findings likely reflect the increased complexity of the cases, further studies are warranted to examine whether particular clinical factors could have predicted LCBDE-LC failure in this population.

The retrospective, non-random nature of this study is the primary limitation to generalizing the results. As a result, the two groups—LCBDE-LC and ERCP-LC—had baseline differences in the presence of jaundice and elevated LFTs. Gender and whether the case was emergent or elective were nearly significant. Matching subjects to evaluate outcomes was considered, however, this would have severely limited the power of the study due to the small sample sizes and thus was not feasible for this cohort. ASA status, which was used as a proxy for the overall health status of the subjects, was not significantly different between the two populations. Therefore, while the baseline differences in the physiologic effects of choledocholithiasis may be different, it is unclear

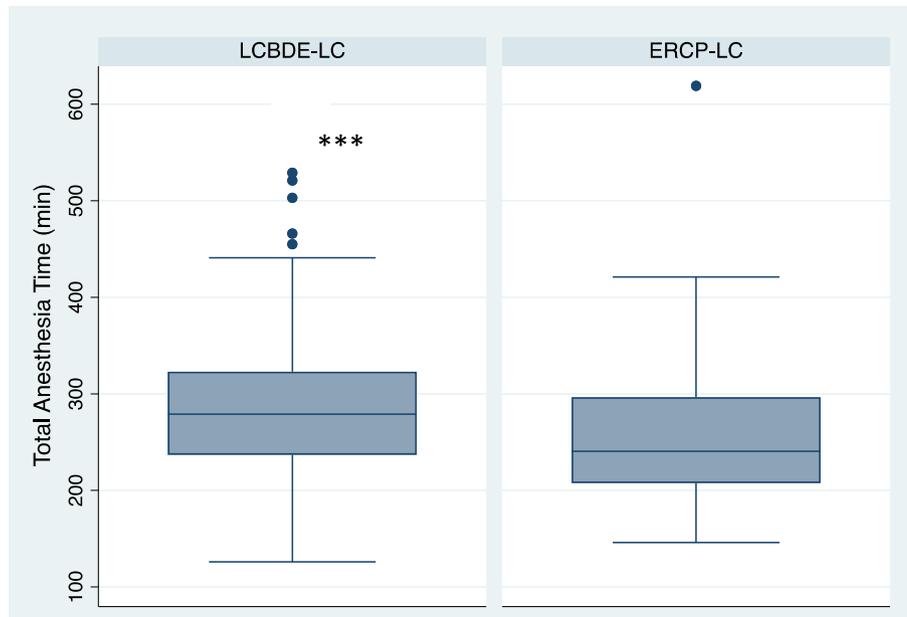


Fig. 1. Box plot of total anesthesia time for LCBDE-LC vs. ERCP-LC. *** $p = 0.01$.

Table 2

Outcomes in LCBDE-LC vs ERCP-LC subjects. * indicates Fisher's exact, *** $p < 0.05$.

	LCBDE-LC		ERCP + LC		p-value
	N	Mean (SD)	N	Mean (SD)	
Total LOS	89	4.45 (2.86)	68	5.8 (4.4)	0.02***
Post Primary Procedure LOS	89	3.13 (2.4)	68	4.37 (4.1)	0.003***
Total charges	88	44412 (19507)	68	51353 (32058)	0.07
Aborted Procedure					
No	59	66%	66	97%	<0.001***
Yes	30	34%	2	3%	
Conversion to Open					
No	77	87%	61	90%	0.54
Yes	12	13%	7	10%	
Any Complication					
No	73	82%	63	93%	0.061*
Yes	16	18%	5	7%	
Clavien Dindo ≥ 3					
No	75	84%	64	94%	0.08*
Yes	14	16%	4	6%	

Table 3

Reasons for unsuccessful LCBDE-LC.

Reasons for Unsuccessful LCBDE-LC	N (%)
Inability to pass dilator or scope	11 (34%)
Inability to clear all stones	9 (28%)
Inability to complete initial cholangiogram	7 (22%)
Other	5 (16%)

whether these differences affected the technical results of the two procedures after a clinical diagnosis of cholangitis was excluded.

With multiple surgeons performing the procedure over ten years, this study did not have the granularity to identify surgeon or patient characteristics that were associated with the failed LCBDE-LC attempts or longer operative times. While it is standard at this institution for all common bile duct explorations to include a senior or chief resident (in the fourth or fifth year of surgical residency) as well as an attending surgeon, there may have been variations in comfort performing a laparoscopic common bile duct exploration. The training and teaching of faculty and residents via a

standardized curriculum and simulation model was intended to control for practitioner knowledge and comfort, but prospective pre- and post-procedure evaluations of practitioner comfort and knowledge would be a valuable source of educational data going forward.

Finally, the lack of longitudinal and follow-up data limits the long-term outcome findings. From an institutional perspective, small changes were made to improve the efficiency of LCBDE-LC over the years. These changes include the creation of a formal LCBDE cart and standardizing the use of a choledochoscope rather than a ureteroscopy, but the timing of implementation was unclear and the number of cases was too small to draw generalized conclusions about the impact. Further, the role of the hospital as a tertiary level of care meant that many patients were transferred to the institution for management of their common bile duct stone. As a result, patient follow-up was limited and inconsistent as individuals were likely to follow up with their primary care providers or surgeons closer to home. Future studies aim to standardize patient follow-up to evaluate the clinical and patient-perceived impact of each procedure.

Despite these limitations, there is a benefit in comparing these two modalities as they are currently used in practice. It is important to note that there were two cases where ERCP could not clear the common bile duct stone and LCBDE-LC was needed. Further, there are geographic regions where ERCP is not readily available and LCBDE-LC may be a valuable tool to rural general surgeons.¹⁶ This study highlights some of the challenges that surgeons may encounter when performing a laparoscopic common bile duct exploration. Through this study, we have been able to identify potential areas for improvement and common failure points to improve our simulation model. Ultimately, further research is needed to predict which cases are likely to be successful as well as develop more advanced teaching models to address the most common pitfalls of LCBDE.

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