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Win or lose, nighttime transcystic laparoscopic common bile duct exploration is a win

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ABSTRACT

Objectives Although controversial, recent data suggest nighttime versus daytime laparoscopic cholecystectomy (LC) have comparable outcomes. Laparoscopic common bile duct exploration (LCBDE) for choledocholithiasis decreases length of stay (LOS) as compared with LC with endoscopic retrograde cholangiopancreatography (ERCP) but increases case complexity/time. The influence of time of day on LCBDE outcomes has not been evaluated. Our aim was to examine outcomes and LOS for nighttime (PM) compared with daytime LC+LCBDE (DAY).

Methods Consecutive patients who underwent LCBDE were reviewed. Demographics, operative duration, success of LCBDE, time to postoperative ERCP (if required), LOS, and complications were compared. PM procedures were defined as beginning 19:00–07:00 hours.

Results Between 2018 and 2022, sixty patients underwent LCBDE (PM 42%). Groups had equivalent age/sex and preoperative liver function tests (LFTs). LCBDE success was 69% PM versus 71% DAY (p=0.78). Operative duration did not differ (2.8 IQR: 2.2–3.3 hours vs. 2.8 IQR: 2.3–3.2 hours, p=0.9). LOS was compared, and PM LOS was shorter (p=0.03). Time to ERCP after a failed LCBDE at night was compared with daytime (13.8 IQR: 10.6–29.5 hours vs. 19.9 IQR: 18.7–54.4 hours, p=0.07). LOS for *failed* PM LCBDE requiring ERCP was similar to *successful* DAY LCBDE (p=0.29). One complication (transient hyperbilirubinemia) was reported in the DAY group, none in PM.

Conclusion PM LCBDE cases are equivalent in safety and success rate to DAY cases but have reduced LOS. Widespread adoption of acute care surgery-driven management of choledocholithiasis via LCBDE during cholecystectomy may decrease LOS, especially in PM cases.

Level of evidence Level IV.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The utilization of laparoscopic common bile duct explorations at the time of laparoscopic cholecystectomy has been shown to reduce costs and hospital length of stay for the treatment of patients with choledocholithiasis. While simple laparoscopic cholecystectomy has been shown to be performed safe and effectively at night, the performance of nighttime laparoscopic common bile duct exploration on length of stay has not been evaluated.

WHAT THIS STUDY ADDS

⇒ In an acute care surgery-driven model, the performance of nighttime laparoscopic common bile duct exploration at the time of laparoscopic cholecystectomy reduces length of stay compared with those performed in the daytime.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This could potentially lead to reduced cost and resource utilization by streamlining the care for patients with choledocholithiasis or other benign biliary disease.

INTRODUCTION

An established acute care surgery (ACS) model is associated with improved emergency general surgery (EGS) outcomes.[1] This is exemplified in benign biliary disease, in which the ACS model has been shown to significantly reduce hospital length of stay (LOS), improve access to timely surgical care, and decrease rates of complications.[2 3] Despite this, there remains controversy regarding the utilization of out-of-hours or nighttime laparoscopic cholecystectomy (LC).[4–9]

Critics of nighttime LC cite increased complication rates, increased rates of retained stones, and increased conversion to open surgery as reasons to perform cholecystectomy during daytime hours.[5 6 9] On the other hand, proponents of nighttime LC have demonstrated that it is equally safe to daytime procedures with the added benefit of reduced hospital LOS and costs to the healthcare system.[4 5 7 8 10]

Common bile duct exploration at the time of LC has been increasingly performed by the ACS surgeon and is a natural extension of surgeons treating the entire spectrum of the disease. Several studies have shown the efficacy of LC with laparoscopic common bile duct exploration (LC+LCBDE) reporting equivalent rates of biliary stone clearance compared with LC followed by postoperative endoscopic retrograde cholangiopancreatography (ERCP).[11–15] Furthermore, recent data suggest that duration of hospital stay and overall costs are reduced when LC+LCBDE is performed.[15]

With the beneficial role of nighttime LC coming into focus, the efficacy of off-hours LC+LCBDE exploration must also be examined. The overall lack of data on LCBDE irrespective of the time of day is likely due to the declining utilization of LCBDE given the additional time and perceived complexity that LCBDE adds to the operation.[16] Despite this, there is a renewed interest among ACS surgeons in treating these additional dimensions of benign biliary disease.[15 17 18] To make LCBDE relevant to

an ACS practice, we must understand whether nighttime LC+LCBDE can be effectively integrated into a service that operates around the clock. Our aim was to evaluate key outcomes in patients who underwent nighttime LC+LCBDE compared with daytime LC+LCBDE in a tertiary referral center with an established ACS practice model. We hypothesize that nighttime LC+LCBDE is safe and, compared with daytime LC+LCBDE, had a shorter length of hospital stay.

METHODS

This is a retrospective cohort study of a prospectively collected database. Data were collected in consecutive patients undergoing LC+LCBDE on our EGS service between December 2018 and February 2022 at Atrium Health Wake Forest Baptist Hospital, a tertiary referral center affiliated with Wake Forest School of Medicine.

Adult EGS patients who underwent LC+LCBDE were tracked in a prospectively maintained database. Demographic data collected included age, sex, body mass index (BMI), laboratory values, time of procedure (day vs. night), success or failure of LC+LCBDE, duration of operation, length of hospital stay, and time to ERCP if failed LC+LCBDE. Nighttime procedures were defined as those that occurred between 19:00 and 07:00 hours. This timing corresponded to handoff and coverage by the nighttime ACS provider. Cases were classified daytime or nighttime based on the time at which the operation began. During daytime hours, our ACS service includes a faculty surgeon, an ACS fellow, several general surgery residents (levels PGY 1–3), and advanced practice providers covering our EGS service. At night, the service includes a faculty surgeon, and a cohort of several general surgery residents (levels PGY 1–5) taking in-house call who cover both EGS and trauma. A backup attending is available during both daytime and nighttime if emergency procedures or trauma activations occur simultaneously. The determination of performing intraoperative cholangiogram and subsequent LCBDE was surgeon specific. All faculty and fellows covering EGS during the day and/or night perform LCBDE and its use was not limited to specific surgeons. During the same time period, patients who received a preoperative ERCP followed by LC were also identified for comparison. Patients who underwent LC+LCBDE on a non-ACS service were not included in this analysis. Patient data were reviewed to determine complications or readmissions within 30 days of surgery. Complications were defined as those that required readmission or intervention, including surgical site infections.

The technique for common bile duct exploration is standardized within our ACS model. A transcystic catheter-based approach, as has previously been described by this group, was employed.[17 18] In brief, after confirmation of common bile duct stone via intraoperative cholangiography (IOC), a cystic duct ductotomy is made and a 0.035″ floppy guidewire is inserted into the cystic duct, traversing the common bile duct, and ending in the duodenum. Antegrade balloon sphincteroplasty is then performed at the ampulla of Vater to facilitate common bile duct clearance.[17 18] Clearance was confirmed with use of IOC. If failure of LC+LCBDE to clear the common bile duct occurred, the LC was completed and patients were referred for postoperative ERCP.

IBM SPSS Statistics V.27 (IBM, Armonk, NY) and GraphPad Prism V.9.3.1 (GraphPad Software Inc., La Jolla, CA) were used for statistical analysis. All tests were two tailed with significance set at $p<0.05$. The Mann-Whitney test was used for continuous variables. The χ^2 test was used for categorical variables. Given the small number of patients included in the study, a power analysis was not performed.

Table 1 Demographic characteristics of all patients who underwent LC+LCBDE and ERCP followed by LC (ERCP+LC)

Variable	LC+LCBDE	ERCP+LC	P value
Age (years)	51 (27–66)	58 (32–75)	0.11
Female	62%	64%	0.84
BMI (kg/m^2)	31 (27–37)	30 (27–36)	0.6
AST (IU/L)	119 (54–236)	59 (32–88)	<0.01
ALT (IU/L)	130 (64–311)	139 (84–262)	0.87
Alk Phos (U/L)	133 (91–171)	132 (95–158)	0.98
T Bili (mg/dL)	1.5 (0.9–2.7)	1.2 (0.8–1.9)	0.33
Preoperative diagnosis (%)			<0.01
Cholecystitis	45	2	
Choledocholithiasis	30	68	
Preoperative symptomatic cholelithiasis	7	2	
Gallstone pancreatitis	15	28	
Other diagnosis	3	0	
Duration of operation (hours)	2.8 (2.3–3.3)	2.0 (1.5–2.4)	<0.01
Length of stay (hours)	48 (33–72)	86 (70–110)	<0.01
Nighttime surgery	42%	N/A	N/A
Successful bile duct exploration	70%	N/A	N/A

Data presented as median and IQR.
Alk Phos, alkaline phosphatase; ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; ERCP, endoscopic retrograde cholangiopancreatography; LC+LCBDE, laparoscopic cholecystectomy with laparoscopic common bile duct exploration; T Bili, total bilirubin.

RESULTS

There were 60 patients who underwent LC+LCBDE on our EGS service between December 2018 and February 2022. During the same time period, 47 patients who received preoperative ERCP followed by LC were also identified. Demographic characteristics of the patients are shown in table 1. Significant differences are shown in table 1 and were present for preoperative diagnosis (LC+LCBDE vs. ERCP+LC, $p<0.01$), duration of operation (LC+LCBDE (2.8 IQR: 2.3–3.3 hours) vs. ERCP+LC (2.0 IQR: 1.5–2.4 hours), $p<0.01$), and total length of hospital stay (48 IQR: 33–72 hours vs. 86 IQR: 70–110 hours, $p<0.01$). The rate of successful bile duct clearance during LC+LCBDE was 70%.

Of the 60 patients, 25 (42%) underwent a nighttime LC+LCBDE. Table 2 illustrates the demographic characteristics of patients who underwent daytime versus nighttime LC+LCBDE. The primary difference between groups was BMI, with a greater BMI in the group that underwent nighttime LC+LCBDE (29 IQR: 26–36 vs. 34 IQR: 29–38, $p=0.03$). Other parameters such as age, preoperative laboratory values, and preoperative diagnosis were no different between the groups (table 2). The success rate for LC+LCBDE was the same whether the procedure was performed during daytime or nighttime (71% vs. 68%, $p=0.78$). The hospital LOS between patients who underwent daytime versus nighttime LC+LCBDE was significantly shorter for nighttime procedures (59 IQR: 38–96 hours vs. 44 IQR: 28–59 hours, $p=0.03$).

There were a total of 18 patients (30%) who failed duct clearance during LC+LCBDE, with eight of those failures occurring at night. For these nighttime LCBDE failures, time to postoperative ERCP (13.8 IQR: 10.6–29.5 hours) was compared with time to postoperative ERCP after failed LC+LCBDE during the day (19.9 IQR: 18.7–54.4 hours, $p=0.07$). There was a shorter LOS in patients who had a failed nighttime LC+LCBDE compared

Table 2 Comparison of LC+LCBDE during the daytime and nighttime

Variable	Daytime LC+LCBDE	Nighttime LC+LCBDE	P value
Age (years)	55 (31–70)	45 (25–63)	0.21
Female	63%	60%	>0.99
BMI (kg/m²)	29 (26–36)	34 (29–38)	0.03
AST (IU/L)	89 (36–205)	191 (60–328)	0.09
ALT (IU/L)	113 (38–212)	282 (80–503)	0.03
Alk Phos (U/L)	123 (90–167)	149 (95–210)	0.32
T Bili (mg/dL)	1.4 (0.9–2.4)	1.7 (0.9–3.6)	0.14
Preoperative diagnosis (%)			0.11
Cholecystitis	49	40	
Choledocholithiasis	29	32	
Preoperative symptomatic cholelithiasis	6	8	
Gallstone pancreatitis	14	4	
Other diagnosis	2	0	
Duration of operation (hours)	2.8 (2.2–3.3)	2.8 (2.3–3.2)	0.88
Length of stay (hours)	59 (38–96)	44 (28–59)	0.03
Successful bile duct exploration	71%	68%	0.78

Rates of successful clearance of the bile duct were the same between groups. Length of stay was significantly shorter for LC+LCBDE performed at night. Data presented as median and IQR.
Alk Phos, alkaline phosphatase; ALT, alanine transaminase; AST, aspartate transaminase; BMI, body mass index; LC+LCBDE, laparoscopic cholecystectomy with laparoscopic common bile duct exploration; T Bili, total bilirubin.

with failed daytime LC+LCBDE (59 IQR: 48.6–71.6 hours vs. 85.7 IQR: 56.1–113.1 hours, p=0.05).

Finally, the LOS for a successful daytime LC+LCBDE was similar to a patient who had a failed LC+LCBDE and required postoperative ERCP (43.9 IQR: 31.8–74.4 hours vs. 59 IQR: 48.6–71.6 hours, p=0.29).

Complication rates were minimal. There was only one complication (transient hyperbilirubinemia) reported in the daytime LC+LCBDE group, none in the nighttime LC+LCBDE group. Three patients were readmitted (one in nighttime group, two in daytime group). Readmission was for exacerbation of underlying chronic medical comorbidities and not complications of surgery.

DISCUSSION

In our study, LC+LCBDE shortens the LOS compared with ERCP followed by LC. In patients undergoing LC+LCBDE, there was a 70% success rate of common bile duct clearance. The rate of successful clearance was the same during the daytime (71%) or nighttime (69%). Further, those who failed nighttime clearance of the common bile duct and underwent postoperative ERCP had LOS comparable to patients who had a successful clearance of the common bile duct with LC+LCBDE during the daytime.

During the last several years there have been multiple studies evaluating the risks and benefits of nighttime LC. Critics of nighttime cholecystectomy report modest differences in complications.[5 6 9] At one high-volume center, Phatak *et al* showed on multivariate analysis that nighttime LC was associated with increased risk of complications. This risk was most pronounced in elderly patients but in younger adults appeared to be equivalent.[6] Merati-Kashani *et al* also identified nighttime procedures were associated with an increased risk of complications while mortality was not different. However, this was partially attributed to the significantly higher American Society of Anesthesiologists (ASA) scores in the nighttime cohort of patients.[5] On the other hand, proponents of nighttime LC cite equivalent outcomes as well as decreased LOS and subsequent healthcare costs in patients who undergo nighttime LC.[4 7 8 10] A single-center study by Siada *et al* showed shorter LOS for patients who underwent nighttime cholecystectomy compared with daytime, while reducing costs.[7] Similarly, one of the largest studies to date evaluating nighttime versus daytime LC at a tertiary care facility with a robust ACS-driven model showed significantly reduced LOS with no difference in complications between day and night.[8] Further, a recent meta-analysis evaluating outcomes after LC showed apparent equipoise to timing of procedure. This study evaluated out-of-hours (which included weekends and nights) to normal daytime procedures. This study showed there were no differences between operations performed out of hours or during normal hours for rates of bile leak, bile duct injury, postoperative complications, conversion to open procedures, operative duration, readmission rates, mortality, and postoperative LOS.[10]

While some surgeons are still uncomfortable with the routine use of LCBDE,[18 19] performing bile duct exploration at the time of LC has been shown to be safe with reduced costs and hospital LOS.[11 14 15 20–22] Our data confirm previous studies showing a significantly shorter LOS for those who underwent LC+LCBDE versus ERCP followed by LC. However, this has not been specifically evaluated for nighttime LC+LCBDE. While the use of common bile duct exploration for treatment of choledocholithiasis has become less common,[16] more recent studies, especially in the area of increased utilization of an ACS-driven model for EGS, advocate for bile duct exploration at the time of LC.[11 14 15 20–22] Our study reveals that success rates of LC+LCBDE are high (about 70%) and equal regardless if they are performed during the day or the night. This is performed with a minimal complication profile. Further, the demographic characteristics between the daytime and nighttime groups were largely the same indicating that patient selection by provider did not influence daytime versus nighttime success (table 2). These data would suggest that an 'OR first' pathway, even for nighttime LC+LCBDE, should be used, thus reducing LOS. A pathway that allows referrals to the ACS surgeons directly from the emergency department and aggressive utilization of transcystic LCBDE may further reduce LOS.

While cost was not able to be directly analyzed in our study, we did note a significant decrease in LOS in those who underwent nighttime LC+LCBDE. Further, patients who had an initial failed LC+LCBDE at night had shorter LOS compared with failed daytime LC+LCBDE. Similarly, failed nighttime LC+LCBDE had an LOS that was comparable to patients who had a successful daytime LC+LCBDE. We speculate that this key finding may be due to shorter time to ERCP, in that the incoming morning team can plan for timely ERCP, sometimes as soon as the morning after failed LC+LCBDE, whereas failed daytime LC+LCBDE may have to wait overnight and until the next day for ERCP. The median time to postoperative ERCP in failed nighttime LC+LCBDE was 13.8 hours compared with 19.9 hours for failed daytime LC+LCBDE. While not reaching statistical significance, this analysis is limited by the few numbers of failed LC+LCBDE. The 'OR first' model, which provides a primary attempt at duct clearance, avoids any delays that might arise from practice patterns of trending liver function tests (LFTs) or obtaining magnetic resonance cholangiopancreatography (MRCP) imaging prior to ERCP that often occur when these patients.[23 24] Further, developing predictors of failed LCBDE during LC may help identify patients in which early gastroenterology involvement for possible ERCP could further reduce LOS and hospital costs.

At our institution, patients who have a successful clearance of the bile duct after LC+LCBDE are not immediately discharged from the recovery area and are often observed for at least a portion of the day after surgery. While not our current practice, cases that have a successful LC+LCBDE may potentially be able to be discharged from the recovery room. This would likely further

decrease LOS and could remove/reduce costs associated with hospital admission. Future studies are under way to develop pathways for early discharge after successful clearance of the biliary tree at our institution.

This study has several limitations. Data were collected from the medical record and are only as accurate as documentation and data entry. Significant comorbid conditions were not collected. We could not account for the differences between individual surgeon preferences to perform preoperative ERCP, the level of the trainees and the staff, or changes in practice patterns during the time period of the study. Similarly, we could not account if individual surgeons chose to postpone potential 'high risk' operative candidates until daytime hours. ERCP was performed at the availability of the gastroenterology service and unplanned emergencies that postponed ERCP in our patients could not be accounted for and may have increased time from failed LC+LCBDE to ERCP. Further, there is no consensus on what defines nighttime surgery.[4 6 8 9] Our definition of nighttime relates to the time period when all daytime members of the surgical team have switched over (attending surgeons, house staff, and advanced practice providers) and not necessarily when the paring down of support staff occurs. Our definition was therefore somewhat arbitrary but we thought that it allowed us to evaluate those cases that were done after most operating rooms (ORs) had shut down and when the fewest number of support staff and surgical team members were present. Finally, there were only 60 patients in this study, thus limiting the power of our analysis.

In conclusion, nighttime LC+LCBDE cases are equivalent in safety and success rate to daytime cases but have reduced LOS. Even unsuccessful nighttime cases have similar LOS to successful daytime LC+LCBDE cases, presumably due to shorter interval to ERCP and the avoidance of advanced imaging. Widespread adoption of ACS-driven management of choledocholithiasis via LC+LCBDE during cholecystectomy may decrease LOS, especially in nighttime cases.

Contributors GRS, ASG, MEB, and ALS implemented the study, interpreted the data, and drafted and critically revised the article. LPN, AMN, and PRM are principal investigators and were responsible for study conception and design, implementation of study, completion of study, interpretation of data, article drafting, and critical revision. GRS is the guarantor and accepts full responsibility for the finished work and/or the conduct of the study, had access to the data, and controlled the decision to publish

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