

Factors that Extend the Operative Time in Laparoscopic Cholecystectomy

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Abstract

Objective: The research aims to identify preoperative factors that prolong surgical time in laparoscopic cholecystectomy (LC) before the procedure and to inform patient and surgeon selection decisions.

Materials and Methods: Retrospective cross-sectional review of surgical records was conducted involving 400 LC cases. The patients who had LC are divided into two groups. An operative time of up to 90 minutes was classified as Group I, while a duration exceeding 90 minutes was categorized as Group II. The parameters compared for operative time of surgery are; gender, age, medical co-morbidity, single or multiple stones, previous surgery, gallbladder wall thickness, history of endoscopic retrograde cholangio pancreatography (ERCP) and endoscopic sphincterotomy (ES), laparoscopy performed by a resident or specialist, white blood cell count, and presence of adhesions in the sac site.

Results: When patients who had ERCP and/or ES prior to LC in Group I and Group II were compared, preoperative ERCP/ES was associated with prolonged operative time [odds ratio (OR): 2.48; 95% confidence interval (CI): 1.3-4.58; $p=0.03$]. Additionally, trainee-led procedures increased operative time (OR: 1.85; 95% CI: 1.18-2.88; $p=0.02$). As a result of statistical analyses, the surgeon's experience (assistant or specialist) and preoperative ERCP or ES were identified as two key determinants contributing to the extended duration of LC.

Conclusion: Preoperative estimation of prolonged operative time before LC facilitates improved surgical, anesthetic, and staffing planning. Preoperative ERCP/ES, ($p=0.03$) and surgeon inexperience ($p=0.05$) independently prolonged the operative time (OR: 2.48 and 1.85, respectively). Prioritizing experienced surgeons for such cases optimizes OR scheduling.

Keywords: Laparoscopic cholecystectomy, operative time, ERCP, endoscopic sphincterotomy

INTRODUCTION

Acute cholecystitis (AC) and biliary obstruction by stones constitute a large percentage of patients presenting to the emergency department with epigastric and right upper quadrant pain. Severe episodic pain localized to these areas is characteristically seen in AC. Physical examination reveals tenderness and rebound in the right upper quadrant. The Tokyo guide is widely used in the diagnosis and treatment of AC in emergency departments. Grade I (mild) and Grade II (moderate) AC: If the Charlson comorbidity index (CCI) and the American Society of Anesthesiologists Physical Status Classification Score

(ASA-PS) indicate that the patient can withstand surgery, laparoscopic cholecystectomy (LC) should ideally be performed soon after onset. While early LC is advocated for AC (Tokyo Guidelines), prolonged operative times remain a barrier to efficient OR management. Identifying preoperative predictors of surgical complexity is critical for resource allocation.

LC is a minimally invasive surgical procedure that has become one of the preferred approaches in the treatment of gallbladder stones. Beneficial features encompass reduced postoperative discomfort, a decreased length of hospital stay, quicker resumption of work life, and favorable cosmetic outcomes [1-5]. Technical difficulties encountered during laparoscopy and



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the level of training of the surgeon can extend the duration of LC. Prediction can detect cases with extended durations to maintain patient load balance, achieve patient and surgeon satisfaction, and facilitate efficient operating room (OR) management [3].

Predicting the operative time can be helpful for the surgeon who will perform the laparoscopy. With the highlights of this information, better planning of surgical discipline and anesthesia can be achieved. [1,6] In addition, informing the patient about the possibility of prolonged duration or conversion to open cholecystectomy will be valuable to prepare for potential outcomes.

The success of laparoscopic surgery depends on appropriate patient selection, technical equipment, and the experience of the physician performing the laparoscopy. Severe coagulopathy contraindicates laparoscopy. Other absolute contraindications are “frozen abdomen”, intestinal obstruction with severe abdominal distension, hemorrhagic shock, severe cardiac dysfunction, and other coexisting diseases requiring laparotomy [7].

This study aims to identify parameters that can assist in predicting operative time prior to surgery and guide surgical planning based on the data found to be significant. For this purpose, variables influencing the surgical time in LC were evaluated based on patient-related, diagnostic, and surgical factors. According according to Tokyo guidelines, patients without comorbidities who present to the emergency department with AC may undergo LC without delay.

Materials and Methods

Study Design and Collecting Patients' Data

The records of 400 LC cases (60% of cases from the emergency department), who underwent cholecystectomy in a

tertiary care training and research hospital, were reviewed retrospectively. Ethics committee approval was not obtained for the study because there was no requirement for ethics committee approval for retrospective studies conducted for graduation thesis purposes without any intervention on the patient before the Regulation on Clinical Research published in the Official Gazette No. 28617 dated 13 April 2013. Patients with prior known coagulopathy, body mass index (BMI) greater than 35, pregnancy, portal hypertension, sepsis, were excluded from a study. Surgical interventions that were initiated laparoscopically and converted to open surgery (n=47) were also excluded to isolate factors affecting purely laparoscopic operative time. Operative time was defined based on the interval from skin incision to skin closure. The patients were categorized into two groups: Group I, with an operative time of 90 minutes or less, and Group II, with an operative time exceeding 90 minutes. The factors that were predicted to prolong the operative time before surgery in patients of these groups were recorded, evaluated, and compared. In this analysis, the determinant factors influencing surgical duration include age, gender, medical co-morbidity (e.g., diabetes, hypertension, cardiovascular disease), single or multiple gallstones, previous surgery, gallbladder wall thickness (≤ 3 mm or >3 mm), presence of preoperative endoscopic retrograde cholangio pancreatography (ERCP) and endoscopic sphincterotomy (ES), performing the operation by a specialist or a resident (under the supervision of a specialist), and the white blood cell (WBC) count. In addition, the adhesion status of the gallbladder anatomic location observed during surgery and its effects on the operative time were investigated.

Statistical Analysis

Statistical analysis was performed using the SPSS program (SPSS Inc. Released 2007. SPSS for Windows, Version 16.0. Chicago, SPSS Inc.). According to these results, p values less than 0.05

Table 1. Patient demographic data

Parameters	Grup-I	Grup-II	Total
Female	223	98	321
Male	50	29	79
No history of surgery	234	102	336
History of surgery present	39	25	64
Single stone	109	41	150
Multiple stones	164	86	250
Wall thickness <3 mm	250	118	368
Wall thickness >3 mm	23	9	32
No adhesions	231	97	328
Adhesions present	42	30	72
No comorbidities	181	80	261
Comorbidities present	92	47	139

were found to be significant. In the statistical analysis, a chi-square test was used for attribute variables, and a Mann Whitney U test was used for continuous variables. Logistic regression analysis was used to evaluate the factors increasing the operative time.

Results

Four hundred LC cases were included in the study. Descriptive demographics are shown in Table 1. Preoperative ERCP and ES applications and the performance of the surgery by specialists or a resident (under the supervision of a specialist) were found to be effective among the predicted factors for prolonging the operative time. It was determined that 50 of 400 patients underwent ERCP and/or ES. In 248 of 350 patients who did not undergo ERCP and/or ES, the operative time was found to be less than 90 minutes, while in 102 patients, it was over 90 minutes (Figure 1) (Table 2).

ERCP and ES were carried out in 9.2% of LC cases in Group I and 19.7% of cases in Group II. A comparison of patients who underwent ERCP and/or ES in Group I and Group II revealed a significant difference in the operative time extension ($p=0.03$).

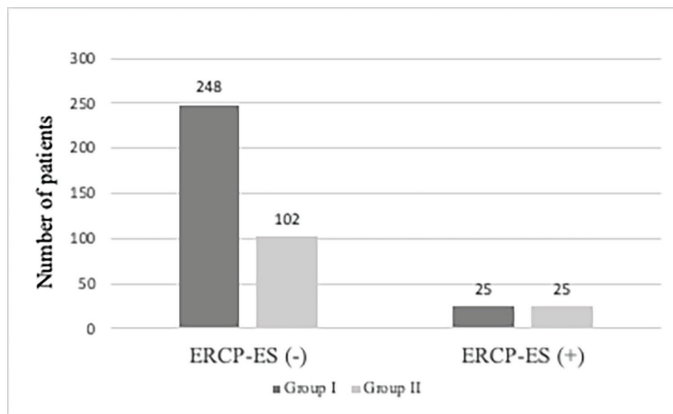


Figure 1. Distribution of patients with and without ERCP and ES in Group-I and Group-II

ERCP: Endoscopic retrograde cholangio pancreatography, ES: Endoscopic sphincterotomy

The risk coefficient was 2.48 (1.3-4.58). Correct discrimination was determined to be 68%.

80 of the 273 (29.3%) LC operations in Group-I were performed by residents (under the supervision of a specialist) at the beginning of the learning curve, and 193 (70.7%) of them were performed by specialists. While residents were present in 53 (41.7%) cases in Group-II, specialists were found in 74 (58.3%) cases (Table 2). The logistic regression analysis revealed a statistically significant variation in operative time between residents and specialists within the groups. The risk coefficient is 1.85, and the confidence interval is 1.18-2.88 (85%).

Among the factors analyzed for their potential influence on operative duration, the mean age was 52.5 years in with the 273 patients whose LC lasted less than 90 minutes (Group I), and 51.6 years in with the 127 patients with operative times exceeding 90 minutes (Group II). There was no statistically significant difference. Similarly, mean WBC counts were $6600/10^3 \mu\text{L}$ in Group I and $8700/10^3 \mu\text{L}$ in Group II, with no significant difference observed. In terms of gender distribution, 81.7% ($n=223$) of Group I and 77.2% ($n=98$) of Group II were female, while 18.3% ($n=50$) and 22.8% ($n=29$), respectively, were male. Gender did not significantly affect operative duration.

Regarding comorbidities, 66.3% ($n=181$) of Group I and 62.9% ($n=80$) of Group II had no associated medical conditions, with no significant difference between groups. Similarly, previous surgical history was absent in 85.7% ($n=234$) of Group I and 81% ($n=102$) of Group II, showing no significant association with operative time. A single gallbladder stone was detected in 39.9% ($n=109$) of Group I and 32.3% ($n=41$) of Group II, while multiple stones, were observed in 60.1% ($n=164$) and 67.7% ($n=86$), respectively. The number of stones had no significant effect on operative duration. Gallbladder wall thickness was ≤ 3 mm in 91.6% ($n=250$) of Group I and 92.9% ($n=118$) of Group II, and >3 mm in 8.4% ($n=23$) of Group I and 7.1% ($n=9$) of Group II, respectively, with no statistically significant difference observed. Intraoperative adhesions at the gallbladder site were absent in 84.6% ($n=231$) of Group I and 77% ($n=97$) of Group

Table 2. Number of patients with and without ERCP/ES and specialists/residents in groups

Groups	ERCP and/or ES (-)	ERCP and/or ES (+)	Total
Group-I	248	25	273
Group-II	102	25	127
	Resident	Specialist	Total
Group-I	80	193	273
Group-II	53	74	127
Total	133	267	400

ERCP: Endoscopic retrograde cholangio pancreatography, ES: Endoscopic sphincterotomy

II, and present in 15.4% (n=42) and 23% (n=30), respectively. Adhesion presence was not significantly associated with prolonged operative time.

Discussion

Cholecystitis, gallstone-related pancreatitis, cholangitis and biliary colic are the main reasons for emergency department visits related to hepatobiliary system LC is still the first choice for the treatment of symptomatic and some asymptomatic gallstones [1]. Recently, robotic cholecystectomy has emerged as an alternative to the laparoscopic approach. However, despite its advantages, challenges such as insufficient availability of a qualified surgical workforce and the absence of clear clinical superiority have limited its adoption as a primary method [2]. LC has the advantages of less post-surgery pain, short hospital stay, faster recovery period, earlier return to work, and better cosmetic results [1-5]. The Tokyo guide is widely used in the diagnosis and treatment of AC in emergency departments. Grade I (mild) and Grade II (moderate) AC: If the CCI and ASA-PS indicate that the patient can withstand surgery, LC should ideally be performed soon after onset. Therefore, LC is important in the management of patients diagnosed with AC in the emergency department. It is also recommended that LC be performed for AC instead of open cholecystectomy (level of evidence 2A) [8].

Although there is little difference in operative time between laparoscopic and open surgery, laparoscopy may take longer if difficulties are experienced in the operation. Predicting the operative duration in elective laparoscopic surgery is meaningful for achieving high efficiency in scheduling [3].

The prolongation of operative duration is likely attributable to multiple factors. Patient factors like gender, age, BMI, ASA score, and abnormal liver function tests (LFT) are significant indicators of challenging procedures, characterized by an operative time exceeding 60 minutes [4]. Unfortunately, except for age and gender, other demographic factors were not included in this study. There would be more comprehensive outcomes if those factors could be studied. Two important factors affecting the duration of laparoscopic surgery were found. These factors are: ERCP and/or ES existence before surgery and the experience of the surgeon performing the surgery. ERCP, with or without ES, is broadly recognized as the standard diagnostic and therapeutic method for patients with common bile duct (CBD) stones [4]. Using ERCP, CBD stone removal is successful in approximately 97% of cases. LC following ERCP is an established treatment approach for gallstone disease with CBD stones. The conversion rate of LC after ERCP is higher compared to elective LC for uncomplicated cholelithiasis [5]. A plausible explanation for this could be that ERCP induces cholangitis, resulting in inflammation and adhesions around the extrahepatic biliary tree, thereby complicating the laparoscopic procedure [6]

According to the results, the risk coefficient increased by 2.4 in the presence of ERCP and/or ES before the surgery, while the risk coefficient increased by 1.8 when the resident performed the surgery (under the supervision of a specialist). Moreover, understanding reliable indicators of challenging LC would aid in developing an appropriate treatment plan and optimizing resource allocation to better anticipate difficult cases [3]. The laparoscopic approach to difficult cholecystectomy is technically more challenging than open cholecystectomy and it requires a qualified surgeon. In this study, no significant difference was found in the effect of age, gender, thickness of the gallbladder wall, and the presence of single or multiple stones on the duration of surgery.

Bharamgoudar et al. [9] developed a scoring tool (Choles dataset) designed to predict the likelihood of a LC lasting more than 90 minutes based on pre-operative patient factors. This tool has undergone successful external validation using a separate dataset and has demonstrated strong predictive accuracy. The findings revealed that the proportion of operations exceeding 90 minutes significantly increases from 5.8% in low-scoring individuals to 41.4% in high-scoring individuals. Contrary to Bharamgoudar et al.'s [9] scoring system (Choles), adhesions did not affect operative time in our cohort, possibly due to low rates of upper abdominal surgeries.

The standard approach for managing concomitant cholelithiasis and choledocholithiasis involves either a one-stage or two-stage procedure. This typically consists of LC combined with CBD exploration during the operation, or LC alongside preoperative, postoperative, or even intraoperative ERCP cholangio pancreatography with ES (ERCP-ES) for stone removal. The most commonly used method worldwide is preoperative ERCP-ES with stone extraction, followed by LC, ideally performed the following day [10].

Ahn et al. [11] reported that preoperative ERCP is a significant contributor to the complexity of LC. Therefore, it is recommended that experienced surgeons perform LC following preoperative ERCP. As the level of surgical difficulty does not vary based on the timing of cholecystectomy after ERCP, there is no justification for delaying LC after the procedure [11]. da Costa et al. [12] also stated that surgeons should anticipate a challenging cholecystectomy following mild gallstone pancreatitis, particularly in cases involving males, previous sphincterotomy, and delayed cholecystectomy.

In this study, it was determined that ERCP and/or ES before surgery could be an important independent factor prolonging the operative time, together with technical difficulties. This situation may be related to the increased prevalence of acute biliary pancreatitis in patients undergoing ES. It was also found that previous surgical operations did not affect the operative time. The effect of the presence of adhesions at the

gallbladder's anatomical location on the operative duration was investigated in our study, and it was determined that it could not be an important factor in prolonging the operative time. Compared to patients with a history of lower abdominal surgery or no prior abdominal surgeries, those who had undergone previous upper abdominal surgery experienced longer operative times and higher complication rates [13].

While some series suggest that LC is a more difficult operation for men, and the rate of conversion to open cholecystectomy is high, it is stated that this is not the case in other series. In this study, it was determined that there was no statistically significant difference between male and female patients, which would extend the operative time. In addition, Stoica et al. [14] also found a good correlation between total leukocyte count, fibrinogen, and difficult LC.

Yuzbasioglu et al. [15] declared that the grading of AC is necessary for not only defining the severity of AC, but also planning early or elective cholecystectomy. Patients were classified into three stages namely mild, moderate, and severe, according to the severity of AC using the Tokyo guidelines [8,15,16]. Procalcitonin level could also discriminate grade III from grade I-II with 72.4% sensitivity and 90.06% specificity. Although no grading was made regarding the AC stages in the study, the potential relationship between this grading and surgical time can be investigated in subsequent studies.

Complications and conversion rates of LC depend on the experience of the surgeon and the difficulty of surgical intervention. There is a relationship between surgical difficulty and the experience of surgeons. The study suggests that LC of patients who underwent ERCP and/or ES before surgery would be more appropriate in terms of operative time and surgical outcomes. In addition, predicting which LCs may prolong the operative time and be converted into open surgery can be useful to inform the patient about these possibilities.

There is a learning curve for LC that includes operative time, rate of conversion to open surgery, and complication rates. Laparoscopic surgery has a long learning curve and Pietra Lombardi et al. [17] reported that approximately 25 LCs should be performed in order to gain enough experience. Therefore, patients should be carefully selected to minimize the complications that may arise at the beginning of the learning curve. Preoperative estimation of a long operation time is very useful for patients and surgeons who are scheduled for LC. As it provides better planning of surgery and anesthesia in every aspect, the choice of surgeon (specialist or assistant) could be made according to this foresight.

Study Limitations

This study was limited by the availability of all patient factors and lack of information on surgeon experience. There is no exact information about how long LC is performed after emergency room admission. BMI and ASA scores were not analyzed but may affect operative difficulty. Operative time variability due to unmeasured factors (e.g., equipment availability) cannot be excluded.

Conclusion

Predicting the operative time for LC operations will facilitate the selection of surgeons and patients, as well as help in programming OR scheduling. The existence of ERCP and/or ES before LC and at the beginning of the learning curve, residents are important factors that may prolong the operative time. It may be preferable for LC operations to be performed by surgeons with more experience, especially in patients who have previously had ERCP and/or ES. In addition, patient-specific factors including increased BMI, increased age, male sex, increased ASA, and abnormal LFT are also significant predictors of prolonged LC operative time and may be indicators of increased procedural difficulty. In addition to these results, although traditional approaches have adopted the idea that patients should first receive antibiotic treatment in AC cases and then undergo elective LC after the acute condition has subsided, current approaches, as explained in the Tokyo 18 guideline, report that Grade I and Grade II AC cases presenting to the emergency department can also undergo LC without any loss of time. Future studies may be conducted to evaluate both approaches.

Ethics

Ethics Committee Approval: Ethics committee approval was not obtained for the study because there was no requirement for ethics committee approval for retrospective studies conducted for graduation thesis purposes without any intervention on the patient before the Regulation on Clinical Research published in the Official Gazette No. 28617 dated 13 April 2013.

Informed Consent: Retrospective study.

Footnotes

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