

PREDICTORS OF DIFFICULTY IN LAPAROSCOPIC CHOLECYSTECTOMY

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Abstract: Background: Laparoscopic cholecystectomy (LC) is the primary treatment of symptomatic gallstones. But in one out of six procedures, the procedure is likely to be technically challenging because of inflammation and adhesions, which leads to more vascular and biliary complications.

Aim: This research was conducted to determine and assess preoperative predictors of LC difficulty.

Methods: It was a prospective clinical study that was carried out in Al-Kindy Teaching Hospital, Baghdad, between May 1, 2023, and December 1, 2024. The sample population was comprised of 320 patients who were undergoing LC due to acute or chronic calculous cholecystitis. The data that was gathered before the surgery included age, gender, comorbidities, body mass index (BMI), smoking history, history of acute cholecystitis, and a history of prior abdominal surgery. The laboratory parameters were the white blood cell count, C-reactive protein and the erythrocyte sedimentation rate. At least 24 hours preoperative ultrasound assessment of the gallbladder was conducted to determine the nature of the gallbladder in terms of wall thickness, stones that are impacted, and pericholecystic collection. The cases were considered easy or difficult LC based on intraoperative findings. The analysis of the variables in clinical, laboratory, and ultrasonographic variables was carried out with respect to their association with the difficulty of the operative procedure, duration, as well as the outcomes.

Results: It was found that 47 cases (14.7%) had difficult LC, and 273 cases (85.3) were considered easy. In 30 cases (9.4%), there was spillage of bile stones, in 19 cases (5.9%), there was vascular or bile duct injury, in 6 cases (1.9%), conversion to open surgery, and in 39 cases (12.2%), prolonged operative time (>60 minutes). The age of more than 50 years was also significantly higher in the difficult group (44.7 vs. 24.9, $P = 0.005$). Difficulty (28.2 ± 5.7 vs. 25.3 ± 4.2 kg/m², $P = 0.011$), as well as smoking history (42.6% vs. 28.2%, $P = 0.048$) was also correlated with higher BMI. Major ultrasound predictors were a gallbladder wall thickness exceeding 4 mm ($P = 0.001$), presence of impacted stones ($P = 0.002$) and presence of pericholecystic collection ($P = 0.005$).

Conclusion: Diversity of ultrasound results: Old age, increased BMI, smoking, and the presence of ultrasound-detected signs in the pericholecystic collection (thickness of the gallbladder wall, presence of impacted stones, and presence of pericholecystic collection) are important predictors of difficulty in LC. The early detection of these factors can enhance the planning of surgery and prevent complications.

Keywords: Predictors, Laparoscopic, Cholecystectomy.

1. Introduction

Gallstones are a major health-economic challenge in the globe as the first major risk factor contributing to emergency biliary hospitalization and surgery [1]. Although open cholecystectomy is still considered as the crucial method used in case of very intricate or emergency cases [2], laparoscopic cholecystectomy (LC) is globally perceived as the golden standard. Presently, LC is considered to represent about 90 percent of all cholecystectomies since it is associated with less trauma, less pain and quicker recuperation [3, 4]. Nonetheless, LC has threats of certain complications such as bile duct trauma and bile spillage, which can result in open operation change in the event of secondary complications [5, 6] despite the merits.

Anticipating LC preoperative challenges is of vital importance to maximize the preoperative planning of surgery, patient selection, and risk management [7]. Patient-related and clinical factors significantly determine the complexity of the procedure; the age of the patient, his/her sex, high body mass index (BMI), and history of abdominal surgery may decrease the resilience of the tissue and restrict the visualization of the surgical process [8]. In addition, indicators of clinical interest, including fever, palpated gallbladder, and leukocytosis (WBC statically exceeding 10,000/mm³) are significant predictors of open surgery change [9]. The preoperative ultrasonography results also contribute to this diagnosis, with gallbladder wall thickness of 4 mm and above, gross distention, pericholecystic fluid, and stones that are affected in Hartmann pouch are highly predictive of difficult dissections [10].

In the process, biliary tree anatomical anomaly, dense adhesions, and other serious pathologies, such as empyema, gangrene, or Mirizzi syndrome may also complicate the surgery and increase the chances of bile duct injury [11]. In order to standardize the evaluation of these obstacles, such tools as the Parkland Grading Scale are used to mix anatomic and inflammatory alterations to accurately foresee the results of LC [12]. In extreme intraoperative complications that put the patient at risk, the surgeon needs to employ the use of bail-out. These options are subtotal cholecystectomy, open conversion, fundus-first technique, cholecystostomy or aborting the procedure altogether in case of the inability to attain the critical view of safety [13]. It is imperative to identify these factors both before and during the operation as a way of enhancing patient outcomes. Thus, the purpose of the current research is to find out and analyze the predictors of challenging laparoscopic cholecystectomy (LC).

2. Patients and Methods:

The proposed clinical trial was undertaken in the Al-Kindy Teaching Hospital in Baghdad, May 1, 2023 to December 1, 2024. The Scientific Committee at the Department of General Surgery, Iraqi Board of Medical Specialization and written informed consent were received by all the participants before data collection. Through a non-randomized, convenience sampling method, 320 patients in need of laparoscopic cholecystectomy (LC) who had an acute or chronic calculous cholecystitis were enrolled in the study. Patients were excluded in the case of LC performed at the same time as another laparoscopic procedure or when they had some conditions like jaundice, cholangitis, high level of alkaline phosphatase, common bile duct dilatation or stones, gallbladder empyema, or acalculous cholecystitis. In addition, the cohort was not allowed to include people with absolute contraindications to LC, such as severe cardiovascular or pulmonary diseases, coagulopathy, and end-stage liver disease.

Data Collection and Preoperative Assessment: Each patient received extensive preoperative data of the type of demographic, anthropometrics (BMI), smoking history, prior abdominal surgeries and length and nature of patient symptoms. Frequent laboratory test and assessments of renal functions were done along with abdominal ultrasonography. In order to have consistency, the same sonographer conducted all ultrasound scans at least 24 hours before surgery, namely the size of the gallbladder, the thickness of its wall, the size of the impacted stones, and the pericholecystic fluid. The standardization of diagnosis of acute cholecystitis was based on requirements such as presence of clinical presentation of right upper quadrant pain longer

than three hours, localized tenderness, fever ($>37.5^{\circ}\text{C}$), leukocytosis ($>10^4/\text{L}$) and supportive ultrasonographic picture of inflammation of the gallbladder.

Surgical Method The aim of the study was to remove the variation in the outcome as it was dependent on the operator; hence, all the operations were conducted by one surgical team that was very well trained in the advanced laparoscopy. The patients who presented with the case of acute cholecystitis first had to undergo conservative medical therapy and later elective LC was undertaken within 72 hours after the disappearance of symptoms. General anesthesia was used and a four-port pneumoperitoneum developed. The dissection of Calot triangle was done with the help of either direct infundibular or critical view of safety with respect to local inflammation severity. The monopolar electrocautery was used by the team mainly as an alternative to the method of blunt dissection especially where there were high chances of biliary or vascular damage due to severe inflammation. Patients were given normal postoperative care such as prophylactic antibiotics and early mobilization after routine clipping, division and extraction of the gallbladder with most of them being discharged within 24 hours.

Outcome Assessment and Statistical Analysis The main outcome of the study was that the surgical procedure was termed as either easy or difficult. The difficult LC was strictly determined by the presence of any of the following intraoperative characteristics: a total operative duration of more than 60 minutes (measured between the time of Veress needle insertion and the removal of the gallbladder), the spillage of bile or gallstones, the abrasion of a duct or a vessel, or the need to transform it to an open cholecystectomy. R software (version 4.3.0) was used to process the data, and statistical tests were conducted. The continuous variables were presented as means with standard deviations and compared based on Welch t-test. The categorical variables were converted into the frequencies and percentages and analyzed by either Chi-square test with Yates correction or Fisher exact test. Univariate and multivariate logistic regression analyses were performed to determine surgical difficulty independent predictors with a P-value of below 0.05 deemed statistically significant.

3. Results

Among the 320 cases included in this study, bile stone spillage occurred in 30 cases (9.4%), while injury to the bile duct or artery was noted in 19 cases (5.9%). Conversion to an open procedure was required in 6 cases (1.9%), and a prolonged operative duration (>60 min) was reported in 39 cases (12.2%). The procedures were classified as difficult in 47 cases (14.7%) and easy in 273 cases (85.3%) according to table 2.1. This was illustrated in figure 3.1.

Table 3.1: Intra-operative complications and grouping of patients into easy and difficult LC

Characteristic	n (%)
Duration of surgery > 60 minutes	39 (12.2%)
Bile stone spillage	30 (9.4%)
Injury to duct or vessel	19 (5.9%)
Conversion to open cholecystectomy	6 (1.9%)
Outcome	
Easy LC	273 (85.3%)
Difficult LC	47 (14.7%)

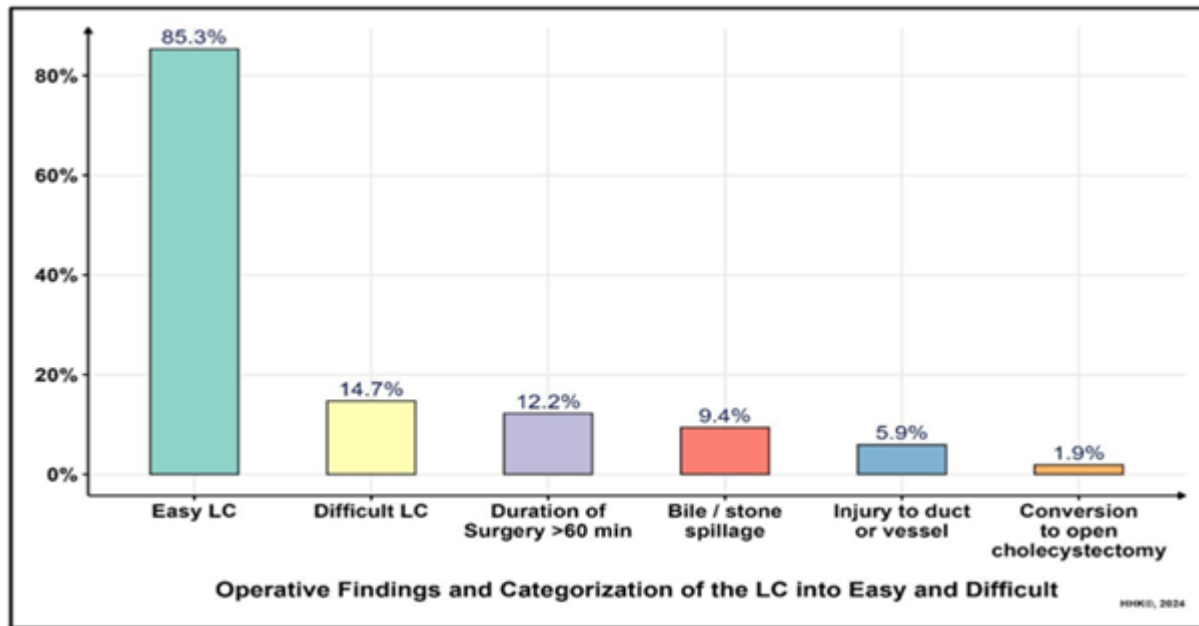


Figure 3.1: proportion of operative findings, and categorization of difficulty of LC.

Patients with difficult LC were more likely to be older than 50 years (44.7% vs. 24.9%, $P = 0.005$), have a higher BMI (28.2 ± 5.7 vs. 25.3 ± 4.2 kg/m², $P = 0.011$), and a history of smoking (42.6% vs. 28.2%, $P = 0.048$). Gender and comorbidities showed no significant differences between groups ($P > 0.05$). A prior history of acute cholecystitis was significantly more common in difficult cases (27.7% vs. 11.7%, $P = 0.004$).

Table 3.2: Description of demographics, anthropometrics, past medical history, and clinical parameters (N = 320)

Characteristic	Overall (N = 320)	Easy (N = 273)	Difficult (N = 47)	P-value
Age (years)				0.005
≤ 50 years	231 (72.2%)	205 (75.1%)	26 (55.3%)	
> 50 years	89 (27.8%)	68 (24.9%)	21 (44.7%)	
Gender				0.3
Female	185 (57.8%)	161 (59.0%)	24 (51.1%)	
Male	135 (42.2%)	112 (41.0%)	23 (48.9%)	
BMI (kg/m²)	26.7 ± 3.1	25.3 ± 4.2	28.2 ± 5.7	0.011
History of smoking	97 (30.3%)	77 (28.2%)	20 (42.6%)	0.048
Presence of comorbidities				
Hypertension	73 (22.8%)	58 (21.2%)	15 (31.9%)	0.11
Diabetes mellitus	34 (10.6%)	26 (9.5%)	8 (17.0%)	0.13
Cardiovascular disease	14 (4.4%)	10 (3.7%)	4 (8.5%)	0.13
Respiratory disease	9 (2.8%)	6 (2.2%)	3 (6.4%)	0.13
Renal disease	5 (1.6%)	4 (1.5%)	1 (2.1%)	0.6
Past hospitalization for acute cholecystitis	45 (14.1%)	32 ()		

The ultrasound findings for all patients were analyzed and compared between easy and difficult laparoscopic cholecystectomy cases. Gallbladder wall thickness was significantly greater in the difficult

group, with 46.8% of cases having a wall thickness >4 mm compared to 16.1% in the easy group ($P < 0.001$). Impacted stones were more frequently observed in the difficult group (12.8%) compared to the easy group (1.8%) ($P = 0.002$). Similarly, pericholecystic collection was more prevalent in the difficult group (25.5%) than in the easy group (10.6%) ($P = 0.005$). The number of stones did not differ significantly between the groups ($P = 0.10$). Single stones were more common in both groups but were slightly more frequent in the difficult cases (76.6%) compared to the easy cases (64.1%)

Table 3.3: Description of ultrasound findings in all patients and by difficulty category

Ultrasound findings	Overall (N = 320)	Easy (N = 273)	Difficult (N = 47)	P-value
Gallbladder wall thickness				<0.001
≤ 4 mm	254 (79.4%)	229 (83.9%)	25 (53.2%)	
> 4 mm	66 (20.6%)	44 (16.1%)	22 (46.8%)	
Impacted stone	11 (3.4%)	5 (1.8%)	6 (12.8%)	0.002
Pericholecystic collection	41 (12.8%)	29 (10.6%)	12 (25.5%)	0.005
Number of stones				0.10
Single	211 (65.9%)	175 (64.1%)	36 (76.6%)	
Multiple	109 (34.1%)	98 (35.9%)	11 (23.4%)	

The mean white blood cell (WBC) count was slightly higher in the difficult group ($11.2 \pm 2.6 \times 10^9/L$) compared to the easy group ($9.7 \pm 3.5 \times 10^9/L$), but the difference was not statistically significant ($P = 0.2$). Similarly, the proportion of cases with WBC counts $\geq 10 \times 10^9/L$ was higher in the difficult group (42.6%) than in the easy group (32.2%), though the difference remained nonsignificant ($P = 0.2$). The mean erythrocyte sedimentation rate (ESR) was also slightly higher in the difficult group (19.5 ± 9.4 mm/hr) compared to the easy group (16.9 ± 7.2 mm/hr), but the difference was not statistically significant ($P = 0.32$). C-reactive protein (CRP) levels were elevated in the difficult group (17.9 ± 13.2 mg/dL) compared to the easy group (12.7 ± 10.5 mg/dL), yet this difference did not reach statistical significance ($P = 0.15$).

Table 3.4: Distribution of biomarkers stratified by difficulty of LC (N = 320)

Biomarkers	Overall (N = 320)	Easy (N = 273)	Difficult (N = 47)	P-value
WBC count ($\times 10^9/L$)	10.7 ± 3.7	9.7 ± 3.5	11.2 ± 2.6	0.2
< 10	212 (66.3%)	185 (67.8%)	27 (57.4%)	0.2
≥ 10	108 (33.8%)	88 (32.2%)	20 (42.6%)	
ESR (mm/hr)	18.3 ± 8.6	16.9 ± 7.2	19.5 ± 9.4	0.32
CRP (mg/dL)	15.2 ± 12.0	12.7 ± 10.5	17.9 ± 13.2	0.15

4. Discussion

Laparoscopic cholecystectomy (LC) is a procedure that is widely practiced all over the world and is constantly undergoing changes to make it safer and cost-effective [14]. The intraoperative conditions of a difficult laparoscopic cholecystectomy (DLC) include; obscured anatomy, severe inflammation of Calot triangle, or bile duct injury, or open conversion, Mirizzi syndrome, or scleroatrophic gallbladder, or pericholecystic abscess [15].

LC was found to be difficult in 47 out of 320 procedures (14.7%). This was classified according to challenges encountered during intraoperative such as long operative time, biliary or vascular injuries and open conversion. This difficulty level corresponds to the 10 to 20 percent range that is commonly found in the literature. As an example, Bhandari et al. [16] found that the DLC rate was 15.4 percent, whereas Bhattarai et al. [17] found that the incidence was 17.8 percent. In contrast, Nogoy et al. [18] and Ary

Wibowo et al. [19] noted larger rates of difficulty of 62% and 40.3, respectively, which is probably due to the fact that they defined difficulty in terms of long operative duration.

A number of clinical parameters were significantly related with a higher surgical difficulty. Age was also found to be a significant predictor where patients over 50 years showed close to twice the odds ratio of difficult procedures. Older patients are more difficult as they have a higher comorbidity rate, and the tissue is very delicate, and the biliary fibrosis caused by prior cholecystitis complicates dissection [20]. On the same note, Stoica et al. [21] established that the mean of DLC patients was significantly greater in comparison to the control population ($p = 0.009$). Interestingly, gender was not a predictor of DLC in our study as was the case of Bhandari et al. [16] and Stoica et al. [21] who found male gender as a significant risk factor.

The difficult group ($28.2 \pm 5.7 \text{ kg/m}^2$) had a significantly greater BMI than the easy group ($25.3 \pm 4.2 \text{ kg/m}^2$, $P = 0.011$). Obesity clouds the operating theater with the fat in the abdominal area and distorts the liver structures. Laparoscopic access is also hindered by the increase in the thickness of the abdominal wall, which requires more time of operation and a higher rate of conversion [22]. This is in line with the results of Nogoy et al. [18], and Ary Wibowo et al. [19].

The history of smoking was also a major factor related to DLC (42.6 percent of the difficult group and 28.2 percent of the easy group, $P = 0.048$). Smoking is also associated with the pathogenesis of gallstones and wound healing is also compromised [23]. Although this can be an indicator of underlying chronic inflammation to increase procedural difficulty, other studies have not found any significant correlation between smoking and DLC [19, 21]. Also, a history of acute cholecystitis hospitalization in the past also was a major predictor (27.7% vs. 11.7%). Acute cholecystitis results in fibrosis and adhesions, which increases the risk of injury of the adjacent structures or open conversion, and this is firmly supported by the literature [16, 19, 27].

The parameters in preoperative ultrasound exhibited close correlations with the difficulty of the operation. The thickness of the gallbladder wall was associated with the difficult group ($>4 \text{ mm}$) at a statistically significant rate (46.8% vs. 16.1, $P < 0.001$). The presence of thickening is a sign of chronic inflammation; it results in dense adhesion and makes dissection difficult and increases the risk of biliary damage [19]. Affected stones in the cystic duct/neck of the gallbladder were also a good predictor (12.8 vs. 1.8 percentage, $P = 0.002$). They block the biliary flow and are related with acute cholecystitis with a higher risk of perforation or ductal injury [24]. Difficult group had pericholecystic fluid collections in 25.5 per cent of patients, whereas easy group had 10.6 per cent of patients ($P = 0.005$). These are signs of inflammation and cause adhesions hiding anatomic landmarks [24]. The previous research is consistent in these sonographic findings [25, 26, 27].

Lastly, inflammatory markers in the laboratories were not always able to predict the complexity of the surgery among this group. High levels of white blood cell (WBC) count, erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) were also reported in the DLC group but were not statistically significant ($P = 0.2$, $P = 0.32$, and $P = 0.15$, respectively). Such findings have been contrary to the findings in Ary Wibowo et al. [19] and Stoica et al. [21], who reported that the leukocyte counts, neutrophil counts, and neutrophil to lymphocyte ratios were considerably high and were useful predictors of difficult cases of LC.

5. Conclusion

Age (greater than 50 years), hospitalization history of acute cholecystitis, and special ultrasound imaging, which included gallbladder wall thickness (greater than 4 mm), presence of stones, and presence of pericholecystic collection were found to be important predictors of challenging laparoscopic cholecystectomy.

A palpable gallbladder was linked to a low probability of difficulty, which suggests that it can be a good clinical indicator. The rest of the variables such as smoking history and hypertension showed tendencies towards significance but failed to reach statistical significance levels whilst BMI, diabetes, and WBC counts were not predictive.

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