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Retrospective analysis of risk factors predicting operative difficulty and conversion to open surgery in laparoscopic cholecystectomy

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ABSTRACT

Introduction: Laparoscopic cholecystectomy (LC) may become technically demanding because of inflammation, adhesions, or altered anatomy. Identifying preoperative risk factors for operative difficulty and conversion to open surgery is important for surgical planning and patient counseling. This study aimed to evaluate these two outcomes separately and identify their independent predictors.

Materials and Methods: This retrospective study reviewed 303 consecutive patients who underwent LC at a tertiary training and research hospital over a five-year period (January 2020–August 2025). Operative difficulty was defined as the presence of intraoperative adhesions, edema/inflammation, abscess, or bleeding. Group comparisons were performed using the Mann–Whitney U and Fisher's exact tests, and multivariable logistic regression was used to identify independent predictors.

Results: Operative difficulty was observed in 93 patients (30.7%), and conversion was required in 11 (3.6%). In multivariable analysis, a history of cholecystitis was the only independent predictor of operative difficulty (OR, 3.15; 95% CI, 1.64–6.04; p<0.001). For conversion, emergency admission (OR, 19.81; 95% CI, 4.49–87.40; p<0.001) and ASA score (OR, 6.77; 95% CI, 2.10–21.86; p=0.001) were independent predictors. CRP, gallbladder wall thickness, and pericholecystic fluid were significant in univariable analyses for both outcomes, whereas NLR was significant only for conversion.

Conclusions: Operative difficulty and conversion have distinct predictive profiles. A history of cholecystitis predicts intraoperative difficulty, whereas emergency admission and a higher ASA score predict conversion. Preoperative inflammatory markers and imaging findings may further assist in risk stratification.

Keywords: ASA score, cholecystitis, conversion, laparoscopic cholecystectomy, operative difficulty, risk factors

Introduction

Since its introduction in the late 1980s, laparoscopic cholecystectomy (LC) has become the preferred operative approach for symptomatic gallstone disease. Compared with the open technique, LC is associated with less postoperative discomfort, earlier discharge, a quicker return to daily activities, and improved cosmetic outcomes.[1,2] Despite these advantages and ongoing technical improvements, the procedure may still become technically demanding in certain patients. Dense adhesions, severe inflammation, edema, abscess formation, or uncontrolled bleeding can complicate dissection, prolong operative time, and increase the risk of intraoperative complications, particularly bile duct injury.[3,4]

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Conversion from laparoscopic to open cholecystectomy remains an important intraoperative decision when the safe continuation of laparoscopy is no longer feasible. Reported conversion rates vary widely in the literature, ranging from 1% to 15%, depending on patient characteristics, disease severity, surgeon experience, and differences in study definitions.[5,6] Although conversion should not be considered a surgical failure, it is associated with longer hospital stays, increased morbidity, higher healthcare costs, and delayed recovery.[7,8] For this reason, accurate preoperative identification of patients at higher risk of operative difficulty or conversion may improve surgical planning, patient counseling, operating room preparation, and the early involvement of experienced surgeons when necessary.[9]

Several studies have investigated potential predictors of difficult LC, including demographic characteristics, comorbidities, laboratory parameters, and ultrasonographic findings.[10,11] In addition, different scoring systems, such as the Nassar scale, Parkland Grading Scale, and Sugrue Operative Difficulty Score, have been developed to standardize the assessment of operative difficulty.[3,12,13] However, there is still no universally accepted method for predicting difficult LC preoperatively, and the predictive value of individual risk factors differs among patient populations.[14]

The primary aim of this study was to determine the preoperative factors associated with operative difficulty and conversion to open surgery in patients undergoing LC by analyzing these outcomes separately. The secondary aim was to develop a clinically practical approach to preoperative risk stratification.

Materials and Methods

Study Design and Setting

This retrospective observational study was conducted at a single center within the General Surgery Department of a tertiary training and research hospital in İstanbul, Türkiye. Ethical approval was obtained from the University of Health Sciences, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital Ethics Board (Date: 08.10.2025, Decision No. 2025/359). Owing to the retrospective design, the ethics board granted a waiver of individual informed consent. All procedures were conducted in accordance with the principles outlined in the Declaration of Helsinki.

Study Population

All consecutive patients who underwent laparoscopic cholecystectomy (LC) between January 2020 and August 2025 were screened for inclusion. The inclusion criteria were as follows: (1) age≥18 years, (2) diagnosis of benign gallbladder disease (cholelithiasis, chronic cholecystitis, acute cholecystitis, biliary colic, or biliary pancreatitis), and (3) availability of complete operative notes and laboratory results. The exclusion criteria were as follows: (1) suspected or confirmed gallbladder malignancy, (2) concurrent surgical procedures other than common bile duct exploration, (3) cholecystectomy initiated as an open procedure, (4) more than 30% missing data, and (5) unavailable operative notes or postoperative follow-up records. After application of these criteria, 303 patients were included in the final analysis.

Data Collection

Data were collected retrospectively from electronic medical records and included the following variables:

Demographic and clinical data: age, sex, American Society of Anesthesiologists (ASA) physical status score, admission type (elective vs. emergency), history of cholecystitis, pancreatitis, cholangitis, previous endoscopic retrograde cholangiopancreatography (ERCP), previous abdominal surgery, diabetes mellitus, underlying chronic liver disease, and viral hepatitis serostatus (HBV and HCV).

Preoperative laboratory parameters: white blood cell count (WBC), neutrophil count, lymphocyte count, C-reactive protein (CRP), total and direct bilirubin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), amylase, and lipase. The neutrophil-to-lymphocyte ratio (NLR) was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count.

Imaging findings: gallbladder wall thickness (mm), pericholecystic fluid accumulation, gallbladder contracture, and maximum stone diameter as assessed by preoperative ultrasonography.

Intraoperative findings: presence of adhesions, edema/inflammation, abscess, and bleeding, as documented in the operative notes.

Postoperative data: conversion to open surgery and the reason for conversion, postoperative complications grad-

ed according to the Clavien–Dindo classification, total length of hospital stay, postoperative length of hospital stay, histopathological diagnosis, 30-day readmission, and 30-day reintervention.

Outcome Definitions

Two primary outcomes were evaluated as separate endpoints:

Operative difficulty was defined as the presence of at least one of the following intraoperative findings documented in the operative report: (1) adhesions in Calot's triangle or around the gallbladder, (2) edema or inflammation of the gallbladder wall or surrounding tissues, (3) abscess formation, or (4) clinically significant bleeding requiring additional hemostatic measures. This composite definition was chosen to capture the full spectrum of surgical difficulty encountered during LC, as it reflects objective intraoperative findings independent of surgeon experience or operative speed.

Conversion to open surgery was defined as the intraoperative decision to abandon the laparoscopic approach and complete the cholecystectomy through an open incision, regardless of the underlying reason, including anatomical difficulty, uncontrolled bleeding, suspected bile duct injury, or inability to establish the critical view of safety.

Statistical Analysis

Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). All continuous variables were tested for normality using the Kolmogorov–Smirnov test. As all variables demonstrated non-normal distributions, they were expressed as median (interquartile range [IQR]) and compared between groups using the Mann–Whitney U test. Categorical variables were expressed as frequencies and percentages and compared using Fisher's exact test for 2×2 tables or the chi-square test for larger contingency tables.

For operative difficulty, variables reaching a significance level of $p<0.25$ in univariable analyses were incorporated into a multivariable binary logistic regression model to determine independent predictors. Model fit was assessed using the Hosmer–Lemeshow test and Nagelkerke pseudo-R^2. For the conversion analysis, because of the limited number of events (n=11), multivariable logistic regression was restricted to a maximum of two covariates in accordance with the events-per-variable rule. The two variables with the highest clinical relevance and statistical significance in univariable analysis were selected for the final multivariable model. Additionally, univariable logistic regression was performed for each significant predictor to report individual odds ratios with 95% confidence intervals.

Analyses were conducted using available data (available-case analysis). A two-tailed $p<0.05$ was considered statistically significant.

Results

Patient Characteristics

A total of 303 patients who underwent LC during the study period met the inclusion criteria. The median age was 50 years (IQR, 39–61), and the majority were female (226, 74.6%). The ASA score distribution was ASA I in 110 (36.3%), ASA II in 154 (50.8%), and ASA III in 39 (12.9%) patients. Most patients were admitted electively (282, 93.1%), whereas 21 (6.9%) required emergency surgery. The most common comorbidities were a history of cholecystitis (116, 38.4%), previous abdominal surgery (115, 38.1%), and diabetes mellitus (57, 18.8%). Baseline demographic and clinical characteristics of the cohort are presented in Table 1.

Operative Difficulty

Operative difficulty, defined as the presence of at least one intraoperative finding, was identified in 93 patients (30.7%). The most common intraoperative findings were adhesions (67, 22.2%) and edema/inflammation (61, 20.2%), followed by bleeding (20, 6.6%) and abscess (5, 1.7%).

In univariable analysis, patients with operative difficulty were significantly older (median, 53 vs. 48 years; $p=0.009$) and had higher levels of CRP (median, 5.30 vs. 2.88 mg/L; $p<0.001$), total bilirubin ($p=0.010$), AST ($p=0.006$), ALP ($p=0.010$), and GGT (median, 30 vs. 19 U/L; $p<0.001$). Gallbladder wall thickness was significantly greater in the difficulty group (median, 4 vs. 3 mm; $p<0.001$). Among categorical variables, a history of cholecystitis (63.0% vs. 27.6%; $p<0.001$), emergency admission (17.2% vs. 2.4%; $p<0.001$), pericholecystic fluid (21.5% vs. 5.7%; $p<0.001$), male sex (36.6% vs. 20.5%; $p=0.002$), a history of pancreatitis (8.7% vs. 2.4%; $p=0.026$), and contracted gallbladder (10.8% vs. 4.3%; $p=0.041$) were significantly associated with operative difficulty. Previous abdominal surgery,

Table 1. Demographic and clinical characteristics of patients (n=303)

Variable	n (%) or Median (IQR)	Mean±SD
Age (years)	50 (39–61)	49.0±13.9
Sex		
Female	226 (74.6)	
Male	77 (25.4)	
ASA score		
I	110 (36.3)	
II	154 (50.8)	
III	39 (12.9)	
Admission type		
Elective	282 (93.1)	
Emergency	21 (6.9)	
History of cholecystitis	116 (38.4)	
History of pancreatitis	13 (4.3)	
History of cholangitis	2 (0.7)	
History of ERCP	14 (4.6)	
Previous abdominal surgery	115 (38.1)	
Diabetes mellitus	57 (18.8)	
Chronic liver disease	5 (1.7)	
HBV	8 (2.6)	
HCV	2 (0.7)	
Laboratory values		
WBC (×10³/μL)	7.92 (6.23–9.65)	8.15±2.67
Neutrophil (×10³/μL)	4.80 (3.72–6.11)	5.22±2.35
Lymphocyte (×10³/μL)	2.29 (1.86–2.83)	2.50±1.29
NLR	2.07 (1.56–2.75)	2.35±1.43
CRP (mg/L)	3.00 (1.59–7.45)	15.25±44.07
Total bilirubin (mg/dL)	0.40 (0.29–0.61)	0.53±0.57
Direct bilirubin (mg/dL)	0.16 (0.12–0.23)	0.20±0.14
ALT (U/L)	16 (12–26)	25.5±38.8
AST (U/L)	16 (14–20)	22.6±42.2
ALP (U/L)	79 (65–96)	85.2±38.5
GGT (U/L)	22 (14–44)	42.3±63.8
Laboratory values		
Amylase (U/L)	63 (48–81)	67.9±31.7
Lipase (U/L)	28 (21–41)	33.9±19.2
Imaging findings		
Gallbladder wall thickness (mm)	3 (2–4)	3.2±1.6
Pericholecystic fluid	32 (10.6)	
Contracted gallbladder	19 (6.3)	
Stone size		
≤1 cm	101 (33.3)	
1–2 cm	120 (39.6)	
≥2 cm	82 (27.1)	
Intraoperative findings		
Adhesions	67 (22.2)	
Edema/inflammation	61 (20.2)	
Bleeding	20 (6.6)	
Abscess	5 (1.7)	
Postoperative outcomes		
Conversion to open surgery	11 (3.6)	
Complications	7 (2.3)	
Total hospital stay (days)	2 (2–4)	3.2±2.7
Postoperative stay (days)	1 (1–2)	1.9±2.5
30-day readmission	9 (3.0)	
30-day reintervention	2 (0.7)	

Continuous variables are presented as median (IQR) and mean±SD. Categorical variables are presented as n (%). ALP: Alkaline phosphatase; ALT: Alanine aminotransferase; ASA: American Society of Anesthesiologists; AST: Aspartate aminotransferase; CRP: C-reactive protein; ERCP: Endoscopic retrograde cholangiopancreatography; GGT: Gamma-glutamyl transferase; HBV: Hepatitis B virus; HCV: Hepatitis C virus; IQR: Interquartile range; NLR: Neutrophil-to-lymphocyte ratio; SD: Standard deviation; WBC: White blood cell count.

diabetes mellitus, and a history of ERCP did not differ significantly between the groups (Table 2).

In multivariable logistic regression analysis, a history of cholecystitis was the only independent predictor of operative difficulty (OR, 3.15; 95% CI, 1.64–6.04; p<0.001). Emergency admission, contracted gallbladder, and pericholecystic fluid were not independently associated with operative difficulty after adjustment (Table 3).

Table 2. Comparison of preoperative variables according to operative difficulty

Variable	Difficulty (+) (n=93)	Difficulty (−) (n=210)	p
Continuous variables, median (IQR)			
Age (years)	53 (44–62)	48 (37–59.8)	**0.009**
WBC (×10³/μL)	8.12 (6.53–10.56)	7.85 (6.10–9.28)	0.086
NLR	2.04 (1.46–3.00)	2.07 (1.61–2.72)	0.605
CRP (mg/L)	5.30 (2.00–14.00)	2.88 (1.31–5.73)	**<0.001**
Total bilirubin (mg/dL)	0.45 (0.34–0.68)	0.39 (0.27–0.57)	**0.010**
Direct bilirubin (mg/dL)	0.17 (0.14–0.30)	0.16 (0.12–0.23)	**0.033**
ALT (U/L)	17.5 (13–30)	16 (12–24)	0.050
AST (U/L)	18 (14–23)	16 (13–19)	**0.006**
ALP (U/L)	87 (65–109)	77 (65–90)	**0.010**
GGT (U/L)	30 (21–59)	19 (13–32.5)	**<0.001**
GB wall thickness (mm)	4 (3–5)	3 (2–3)	**<0.001**
Hospital stay (days)	3 (2–5)	2 (2–3)	**<0.001**
Postop stay (days)	1 (1–2)	1 (1–1)	**<0.001**
Categorical variables, n (%)			
Male sex	34 (36.6)	43 (20.5)	**0.002**
Emergency admission	16 (17.2)	5 (2.4)	**<0.001**
History of cholecystitis	58 (63.0)	58 (27.6)	**<0.001**
History of pancreatitis	8 (8.7)	5 (2.4)	**0.026**
History of ERCP	6 (6.5)	8 (3.8)	0.373
Previous abdominal surgery	35 (38.0)	80 (38.1)	1.000
Diabetes mellitus	17 (18.3)	40 (19.0)	1.000
Pericholecystic fluid	20 (21.5)	12 (5.7)	**<0.001**
Contracted gallbladder	10 (10.8)	9 (4.3)	**0.041**

Mann–Whitney U test was used for continuous variables and Fisher's exact test for categorical variables. Operative difficulty was defined as the presence of intraoperative adhesions, edema/inflammation, abscess, or bleeding. Bold p-values indicate statistical significance (p<0.05).
ALP: Alkaline phosphatase; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; CRP: C-reactive protein; ERCP: Endoscopic retrograde cholangiopancreatography; GB: Gallbladder; GGT: Gamma-glutamyl transferase; IQR: Interquartile range; NLR: Neutrophil-to-lymphocyte ratio; WBC: White blood cell count.

Conversion to Open Surgery

Conversion to open surgery was required in 11 patients (3.6%). Patients who required conversion were significantly older (median, 63 vs. 49.5 years; p=0.022), predominantly male (63.6% vs. 24.0%; p=0.007), and more frequently admitted on an emergency basis (45.5% vs. 5.5%; p<0.001). The ASA score demonstrated a strong association with conversion (χ^2=18.20; p<0.001), with conversion rates of 0.9%, 2.6%, and 15.4% for ASA I, II, and III, respectively.

Among laboratory parameters, the conversion group had markedly elevated CRP levels (median, 57.0 vs. 3.0 mg/L; p<0.001), higher NLR (median, 3.00 vs. 2.03; p=0.008), higher ALP levels (p=0.025), and higher GGT levels (median, 39 vs. 22 U/L; p=0.007). Gallbladder wall thickness was significantly greater in the conversion group (median, 5 vs. 3 mm; p=0.005). Pericholecystic fluid was present in 45.5% of patients who underwent conversion compared with 9.2% of those in the non-conversion group (p=0.003). A history of ERCP was notably more frequent in the conversion group (27.3% vs. 3.8%; p=0.011). Intraoperative adhesions (81.8% vs. 19.9%; p<0.001), edema/inflammation (54.5% vs. 18.8%; p=0.011), and bleeding (27.3% vs. 5.8%; p=0.029) were all significantly more common in converted cases (Table 4).

Table 3. Multivariable logistic regression analysis for operative difficulty (n=249)

Variable	OR	95% CI	p
History of cholecystitis	**3.15**	1.64–6.04	**<0.001**
Emergency admission	2.78	0.48–16.22	0.255
Contracted gallbladder	2.64	0.76–9.19	0.128
Pericholecystic fluid	2.52	0.82–7.75	0.107
Total bilirubin	2.29	0.83–6.33	0.111
History of pancreatitis	1.37	0.33–5.63	0.662
GB wall thickness (mm)	1.16	0.95–1.43	0.149
AST	1.03	1.00–1.06	0.094
Age	1.02	0.99–1.04	0.204
Male sex	1.09	0.52–2.29	0.816
CRP	1.00	0.99–1.01	0.979

Variables with p<0.25 in univariable analysis were included. Pseudo R^2=0.199. History of cholecystitis was the only independent predictor. AST: Aspartate aminotransferase; CI: Confidence interval; CRP: C-reactive protein; GB: Gallbladder; OR: Odds ratio.

Table 4. Comparison of variables according to conversion to open surgery

Variable	Conversion (+) (n=11)	Conversion (–) (n=292)	p
Continuous variables, median (IQR)			
Age (years)	63 (48.5–64.5)	49.5 (38–60)	**0.022**
NLR	3.00 (2.34–4.74)	2.03 (1.56–2.72)	**0.008**
CRP (mg/L)	57.0 (6.58–242)	3.00 (1.55–7.00)	**<0.001**
Total bilirubin (mg/dL)	0.57 (0.40–0.97)	0.40 (0.29–0.61)	0.083
ALP (U/L)	95 (83.5–123)	79 (64.5–95)	**0.025**
GGT (U/L)	39 (30–76)	22 (13.5–43)	**0.007**
GB wall thickness (mm)	5 (4–7)	3 (2–4)	**0.005**
Hospital stay (days)	6 (4–7.5)	2 (2–4)	**<0.001**
Postop stay (days)	5 (3–5.5)	1 (1–1)	**<0.001**
Categorical variables, n (%)			
Male sex	7 (63.6)	70 (24.0)	**0.007**
Emergency admission	5 (45.5)	16 (5.5)	**<0.001**
History of cholecystitis	7 (63.6)	109 (37.3)	0.113
History of ERCP	3 (27.3)	11 (3.8)	**0.011**
Pericholecystic fluid	5 (45.5)	27 (9.2)	**0.003**
Intraop adhesions	9 (81.8)	58 (19.9)	**<0.001**
Intraop edema/inflammation	6 (54.5)	55 (18.8)	**0.011**
Intraop bleeding	3 (27.3)	17 (5.8)	**0.029**
ASA score (chi-square)	I:1 / II:4 / III:6	I:109 / II:150 / III:33	**<0.001**
Conversion rate: ASA I/II/III	0.9% / 2.6% / 15.4%		

Mann–Whitney U test was used for continuous variables, Fisher's exact test for categorical variables, and chi-square test for ASA score. Bold p-values indicate statistical significance (p < 0.05). GB: Gallbladder, ALP: Alkaline phosphatase; ASA: American Society of Anesthesiologists; CRP: C-reactive protein; ERCP: Endoscopic retrograde cholangiopancreatography; GB: Gallbladder; GGT: Gamma-glutamyl transferase; IQR: Interquartile range; NLR: Neutrophil-to-lymphocyte ratio.

Table 5. Logistic regression analysis for conversion to open surgery

Variable	OR	95% CI	p
A. Univariable logistic regression			
Emergency admission	**14.38**	3.96–52.19	**<0.001**
ERCP history	**9.55**	2.22–40.99	**0.002**
Pericholecystic fluid	**8.18**	2.34–28.58	**0.001**
Male sex	**5.55**	1.58–19.52	**0.008**
ASA score	**5.36**	1.94–14.81	**0.001**
GB wall thickness (mm)	**1.61**	1.22–2.13	**<0.001**
NLR	**1.37**	1.08–1.72	**0.009**
CRP	**1.02**	1.01–1.02	**<0.001**
Age	**1.06**	1.01–1.12	**0.027**
B. Multivariable model (n=303)			
Emergency admission	**19.81**	4.49–87.40	**<0.001**
ASA score	**6.77**	2.10–21.86	**0.001**

A: Separate univariable logistic regression for each significant variable. B: Multivariable model limited to 2 variables per the events-per-variable rule (11 events). Pseudo R^2=0.281. ASA: American Society of Anesthesiologists; CI: Confidence interval; CRP: C-reactive protein; ERCP: Endoscopic retrograde cholangiopancreatography; GB: Gallbladder; NLR: Neutrophil-to-lymphocyte ratio; OR: Odds ratio.

In univariable logistic regression analysis, emergency admission (OR, 14.38; 95% CI, 3.96–52.19; p<0.001), history of ERCP (OR, 9.55; 95% CI, 2.22–40.99; p=0.002), pericholecystic fluid (OR, 8.18; 95% CI, 2.34–28.58; p=0.001), male sex (OR, 5.55; 95% CI, 1.58–19.52; p=0.008), ASA score (OR, 5.36; 95% CI, 1.94–14.81; p=0.001), gallbladder wall thickness (OR, 1.61 per mm; 95% CI, 1.22–2.13; p<0.001), NLR (OR, 1.37; 95% CI, 1.08–1.72; p=0.009), CRP (OR, 1.02; 95% CI, 1.01–1.02; p<0.001), and age (OR, 1.06; 95% CI, 1.01–1.12; p=0.027) were all significant predictors of conversion. In the multivariable model restricted to two variables, emergency admission (OR, 19.81; 95% CI, 4.49–87.40; p<0.001) and ASA score (OR, 6.77; 95% CI, 2.10–21.86; p=0.001) remained independently significant (Table 5).

Postoperative Outcomes

Postoperative adverse events were observed in 7 cases (2.3%). The median total hospital stay was 2 days (IQR, 2–4), and the median postoperative stay was 1 day (IQR, 1–2). Patients who underwent conversion had significantly longer total hospital stays (median, 6 vs. 2 days; p<0.001) and postoperative stays (median, 5 vs. 1 day; p<0.001). Similarly, patients with operative difficulty had longer total hospital stays (median, 3 vs. 2 days; p<0.001) and postoperative stays (median [IQR], 1 [1–2] vs. 1 [1–1] day; p<0.001) than those without difficulty. Thirty-day readmission occurred in 9 patients (3.0%), and reintervention was required in 2 patients (0.7%).

Discussion

In the present study, we evaluated operative difficulty and conversion to open surgery as two separate outcomes in 303 patients who underwent laparoscopic cholecystectomy. The overall rate of operative difficulty was 30.7%, and the conversion rate was 3.6%. A history of cholecystitis was the only factor independently associated with operative difficulty in multivariable analysis, whereas emergency admission and a higher ASA score independently predicted conversion.

The finding that a history of cholecystitis independently predicts intraoperative difficulty is consistent with several recent reports. Bhandari et al.[15] analyzed 338 patients and similarly identified a history of cholecystitis as a significant predictor of difficult cholecystectomy. Beyond a history of cholecystitis, other preoperative parameters have also been shown to contribute to operative difficulty. In a recent retrospective analysis of 255 patients with acute cholecystitis, NLR, age, male sex, and diabetes were identified as significant predictors of operative difficulty, with higher complication rates observed in the difficult cholecystectomy group.[16] From a pathophysiological per-

spective, this association is expected: recurrent inflammatory episodes promote fibrosis, dense adhesions around the gallbladder and Calot's triangle, and distortion of normal anatomical planes, all of which make safe dissection more challenging.[3] Although emergency admission, contracted gallbladder, and pericholecystic fluid were not independently associated with operative difficulty after adjustment, all demonstrated elevated odds ratios, suggesting a potential contribution to operative complexity that may warrant further investigation in larger cohorts. This may partly reflect the moderate sample size and the correlation between these variables and a history of cholecystitis.

Our conversion rate of 3.6% is relatively low compared with the rates of 1–15% commonly reported in the literature.[5,6] This may be partly attributable to the high proportion of elective cases in our cohort (93.1%), as emergency cholecystectomy is a well-established risk factor for conversion. The strong association between emergency admission and conversion (OR, 19.81) is also well recognized. Emergency cholecystectomy is generally performed for acute cholecystitis, in which the degree of inflammation, edema, and tissue friability is considerably greater than in elective cases, limiting the ability to safely identify critical structures.[1,7] The independent predictive value of the ASA score for conversion is also noteworthy. In our cohort, the conversion rate increased from 0.9% in ASA I patients to 15.4% in ASA III patients. A recent systematic review that included 30 studies and more than 108,000 patients similarly reported that emergency admission and a higher comorbidity burden were among the most consistent predictors of conversion.[17] This suggests that both the severity of the acute disease and the overall physiological status of the patient contribute to the likelihood of conversion.

Among the laboratory parameters evaluated in univariable analysis, CRP showed the most striking difference between the conversion and non-conversion groups (median, 57.0 vs. 3.0 mg/L). Elevated CRP reflects the intensity of the systemic inflammatory response, which in turn correlates with local tissue changes that make laparoscopic dissection more difficult. This observation is consistent with the report by Wevers et al.,[18] who showed that a combination of CRP and age could predict conversion in acute cholecystitis. Similarly, NLR was significantly higher in the conversion group (median, 3.00 vs. 2.03; p=0.008). Molasy et al.[19] recently reported that elevated NLR values were associated with both conversion risk and postoperative complications, supporting the role of this readily available biomarker in preoperative risk assessment. Gallbladder wall thickness, another marker of local inflammation, was also significantly increased in both the operative difficulty and conversion groups. These findings collectively suggest that preoperative inflammatory markers, particularly CRP and NLR, together with ultrasonographic wall thickness, may serve as practical tools for identifying higher-risk patients, even though they did not remain independently significant in our multivariable models.

An important aspect of the present study is the separate evaluation of operative difficulty and conversion as two distinct outcomes. Many previous studies have focused exclusively on conversion or have combined difficulty and conversion into a single endpoint.[5,6,17] However, our results demonstrate that the predictive factors for these two outcomes are not identical. While a history of cholecystitis predicts intraoperative difficulty, it is the combination of emergency presentation and poor physiological reserve that drives the decision to convert. This distinction may have practical implications: prediction of operative difficulty may guide preoperative preparation, such as allowing additional operative time or ensuring the availability of experienced supervision, whereas prediction of conversion risk may influence the choice of surgical approach and the informed consent process.

Another finding worth mentioning is the association between previous ERCP and conversion (27.3% vs. 3.8%; p=0.011). Although this variable did not remain significant in the multivariable model because of the limited number of events, the univariable odds ratio was notable (OR, 9.55). Previous ERCP may indicate more complex biliary pathology and may contribute to fibrotic changes in the hepatoduodenal region, making subsequent cholecystectomy more challenging. In a large cohort of 2015 patients undergoing elective cholecystectomy, preoperative ERCP was identified as an independent predictor of conversion in multivariable analysis.[20]

Limitations

This study has several limitations that should be acknowledged. First, its retrospective design carries inherent risks of selection bias and incomplete data collection. Second, operative difficulty was defined based on surgeon-documented intraoperative findings rather than a validated standardized grading system, which introduces a degree

of subjectivity and may limit reproducibility across different institutions and surgeons. Third, operative time, which could have served as an additional objective surrogate measure of technical difficulty, was not consistently available in the medical records and therefore could not be included in the analysis. Fourth, the small number of conversion events (n=11) limited the multivariable analysis to only two variables, resulting in relatively wide confidence intervals. Finally, as a single-center study, the findings may not be directly generalizable to other healthcare settings with different patient populations, disease severity profiles, or surgical practices. Future multicenter prospective studies using standardized difficulty grading systems and larger conversion cohorts are needed to validate these findings and improve preoperative risk stratification.

Conclusion

The present analysis identified a history of cholecystitis as an independent predictor of operative difficulty, while emergency admission and a higher ASA classification were independent predictors of conversion to open surgery among patients undergoing laparoscopic cholecystectomy. In univariable analyses, preoperative CRP, together with ultrasonographic features such as gallbladder wall thickness and pericholecystic fluid accumulation, was significantly associated with both clinical endpoints, whereas NLR was associated only with conversion. These readily available parameters may support clinicians in perioperative risk assessment and operative planning. Future multicenter prospective studies employing standardized difficulty grading systems and larger patient cohorts are needed to validate these findings.

Disclosures

Ethics Committee Approval: The study was approved by University of Health Sciences, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital Ethics Committee (No: 2025/359, Date: 08.10.2025).

Informed Consent: Due to the retrospective design of the study, the ethics committee granted an exemption from obtaining individual informed consent.

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