

PREDICTING INTRAOPERATIVE DIFFICULTY IN LAPAROSCOPIC CHOLECYSTECTOMY USING PREOPERATIVE SCORING: A PROSPECTIVE CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Laparoscopic cholecystectomy (LC) is the standard treatment for symptomatic gallstone disease; however, operative difficulty can vary widely depending on patient and disease-specific factors. Preoperative prediction of surgical complexity enables optimal planning, risk stratification, and informed patient counselling. The objective is to evaluate the efficacy of a preoperative scoring system in predicting intraoperative difficulty during LC in a tertiary care setting. **Materials and Methods:** This prospective cross-sectional study was conducted at the Department of General Surgery, PSG IMSR, Coimbatore, from December 2023 to March 2025. Fifty patients diagnosed with symptomatic calculous cholecystitis who underwent LC were included. Patients with cholangitis, acalculous cholecystitis, pancreatitis, elevated alkaline phosphatase, or common bile duct stones were excluded. Preoperative demographic, clinical, and ultrasonographic parameters were collected using a structured proforma. Intraoperative difficulty was graded based on established criteria. Data were analyzed using SPSS v19. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of the preoperative scoring system were determined. Statistical significance was defined as $p < 0.05$. **Result:** Among participants, 48% of patients ≤ 50 years had easy intraoperative difficulty, compared with 12% of patients > 50 years; difficulty was significantly associated with advanced age ($p < 0.05$). Male gender, previous hospitalization for cholecystitis, history of ERCP, total leukocyte count $> 11,000/\mu\text{L}$, gallbladder wall thickening, presence of pericholecystic fluid, and impacted gallstones were significantly associated with increased intraoperative difficulty ($p < 0.05$). BMI, diabetes mellitus, past abdominal surgery, and palpable or contracted gallbladder were not significantly associated. Preoperative scoring demonstrated a sensitivity of 85%, specificity of 86.7%, PPV of 81%, NPV of 89.7%, and overall diagnostic accuracy of 86%. Intraoperative challenges included dense adhesions, altered biliary anatomy, frozen Calot's triangle, and need for subtotal cholecystectomy or conversion to open surgery in selected cases. **Conclusion:** The preoperative scoring system effectively predicted intraoperative difficulty in LC, with high sensitivity and specificity. Implementation of such predictive tools can aid surgical planning, optimize operative outcomes, and improve patient counselling.

INTRODUCTION

Gallstone disease is one of the most frequently encountered gastrointestinal conditions worldwide, with an annual rise in incidence of approximately 0.6% and a reported prevalence of nearly 15% in the

adult population. In recent years, an increasing trend has also been observed among children, with prevalence rising from 1.9% to 4%, largely attributed to the growing incidence of childhood obesity. Gallstones are typically classified into cholesterol, pigment, and mixed types. Pigment

stones commonly develop as a result of excessive hemolysis, whereas cholesterol stones arise from the interplay of genetic predisposition and environmental influences that lead to supersaturation of bile with cholesterol. Several risk factors—including age, female sex, high body mass index (BMI), and metabolic conditions such as diabetes mellitus—have been implicated in the development of gallstone disease. Modifiable factors such as obesity and insulin resistance contribute significantly to altered cholesterol metabolism and thereby increase the risk of gallstone formation.^[1,2]

Clinically, gallstone disease may range from an asymptomatic state to presentations involving biliary colic, dyspepsia, or more severe complications such as pancreatitis. Laparoscopic cholecystectomy (LC) remains the gold standard treatment for symptomatic gallstone disease.^[3] However, LC can present substantial technical challenges in the presence of dense adhesions in the Calot's triangle, acutely inflamed or gangrenous gallbladder, contracted or fibrotic gallbladder, cholecystoenteric fistula, or distorted anatomy.^[4] Numerous factors such as advanced age, male gender, obesity, recurrent attacks of acute cholecystitis, leukocytosis, previous abdominal surgery, and ultrasonographic features—including gallbladder wall thickening, distension, impacted stones, and pericholecystic fluid—have been associated with increased operative difficulty.^[5] Multiple preoperative scoring systems have been proposed to predict the likelihood of a difficult cholecystectomy.^[6-8] Although these models correlate with intraoperative difficulty, many lack standardized criteria for defining operative complexity, have not undergone external validation, or are limited by small sample sizes.^[9-11] Other prediction tools have been developed specifically to estimate the probability of conversion to open cholecystectomy.^[12-14] However, conversion rates may vary widely depending on surgeons' experience, available technology, and institutional practices. Moreover, with the advent of advanced laparoscopic techniques, conversion has become a less definitive marker of operative difficulty than it was in the early years of minimally invasive surgery.

Nassar et al.^[15] introduced an intraoperative difficulty grading system based on specific operative findings, which has since been widely utilized due to its clarity and practicality. Subsequent studies have demonstrated that higher difficulty scores are associated with adverse postoperative outcomes, including increased complication rates, prolonged hospital stay, conversion to open surgery, and higher 30-day mortality.^[16] These predictive tools are valuable for operative planning, risk stratification, anticipating technical challenges, and counseling patients and their families regarding potential complications.

The present study was undertaken to evaluate the applicability of a preoperative scoring system in predicting operative difficulty in laparoscopic cholecystectomy within a tertiary care setting in a developing country. The primary objective was to assess how effectively preoperative variables correlate with intraoperative difficulty, as measured using a validated operative grading scale.

Objectives

To study the efficacy of the preoperative scoring system for predicting difficult laparoscopic cholecystectomy.

MATERIALS AND METHODS

Study Design and Setting: This prospective cross-sectional study was conducted in the Department of General Surgery at PSG Institute of Medical Sciences and Research (PSG IMSR), Coimbatore. The study was carried out over a period of 16 months, from December 2023 to March 2025.

Study Population: The study population consisted of patients diagnosed with gallstone disease who underwent laparoscopic cholecystectomy during the study period.

Inclusion Criteria

Patients aged 18 years and above who were diagnosed with gallstone disease subsequently underwent laparoscopic cholecystectomy.

Exclusion Criteria

Patients were excluded if they presented with any of the following conditions:

- Clinical or laboratory evidence of cholangitis
- Elevated alkaline phosphatase levels
- Dilated common bile duct on imaging
- Common bile duct stones
- Acalculous cholecystitis
- Concurrent pancreatitis

Sample Size and Sampling Technique: A total of 50 patients who fulfilled the eligibility criteria and underwent laparoscopic cholecystectomy were included in the study. Participants were selected using a convenient sampling method.

Ethical Considerations: Ethical approval for the study was obtained from the Institutional Human Ethics Committee prior to commencement. Written informed consent was obtained from all participants in accordance with institutional and ethical guidelines.

Data Collection: After obtaining written informed consent, each participant was evaluated using a pre-structured proforma. Demographic information, presenting symptoms, and relevant clinical history were recorded by the principal investigator. A detailed clinical examination was performed, and the diagnosis was confirmed based on clinical and imaging findings. Preoperative grading parameters were documented and entered into a data collection sheet using Microsoft Excel. All patients subsequently underwent laparoscopic cholecystectomy, during which intraoperative

findings and difficulty parameters were systematically recorded by the operating team. These intraoperative variables were also entered into the data collection database for analysis.

Data Analysis: All collected data were compiled in Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS), version 19. Descriptive statistics, including mean, standard deviation, and proportions, were used to summarize quantitative and categorical variables. Inferential statistical tests such as the Chi-square test and independent sample t-test were employed to evaluate associations between variables and test study hypotheses. Diagnostic performance measures, including sensitivity, specificity, and predictive values, were calculated to assess the accuracy of the preoperative scoring system. A p-

value of <0.05 was considered statistically significant.

RESULTS

Comparison of age with intraoperative difficulty: In this study among participants undergoing elective cholecystectomy the intra operative scoring level was noted to be easy among 48% of the participants and difficult among 16% of the participants in the age group of ≤ 50 years, whereas 12% and 24% of the participants were in the easy and difficult level among >50 years of age respectively. The association between intra operative scoring difficulty and elderly patients was found to be statistically significant with p value 0.004.

Table 1: Comparison of age with intraoperative difficulty

Age group	Intraoperative score		Total	p value
	Difficult	Easy		
≤ 50 years	8 (16)	24 (48)	32 (64)	0.004*
>50 years	12 (24)	6 (12)	18 (36)	
Total	20 (40)	30 (60)	50 (100)	

*Significant

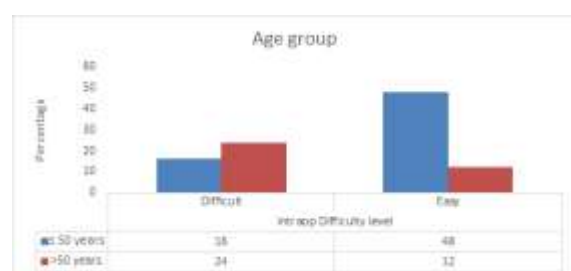


Figure 1: Comparison of Age with intraoperativedifficulty

Comparison of gender with intraoperative difficulty: On assessing the gender vs intraoperative scores, among 74% of the female participants in this study for 52% of the patients it was easy whereas for 22% of the patients it was difficult. Similarly, among the total 26% of the male participants the intraoperative score was easy for 8% and difficult for 18% of the cases. There was significant association recorded between male gender and intraoperativedifficulty in our study (p value =0.012).

Table 2: Comparison of gender with intraoperative difficulty

Gender	Intraoperative score		Total	p value
	Difficult	Easy		
Female	11 (22)	26 (52)	37 (74)	0.012*
Male	9 (18)	4 (8)	13 (26)	
Total	20 (40)	30 (60)	50 (100)	

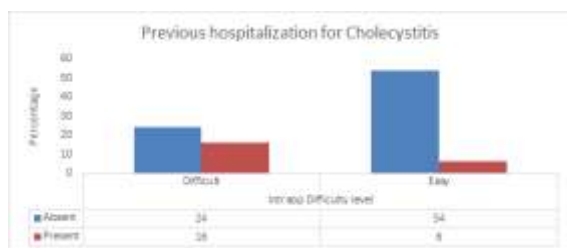


Figure 2: Comparison of gender with intraoperativedifficulty

Comparison Of History Of Hospitalization For Cholecystitis With Intraoperative Difficulty: Based on the history of hospitalization for cholecystitis, intraoperative score was easy for 54% and difficult for 24% of the cases who had no record of previous hospitalization for cholecystitis whereas among cases with previous hospitalization record, 6% of the cases were easy and 16% of the cases were difficult intraoperatively. There was significant statistical association noted for previous hospitalization for cholecystitis and intraoperativedifficulty (p value =0.012).

Table 3: Comparison of history of hospitalization for cholecystitis with intraoperative difficulty

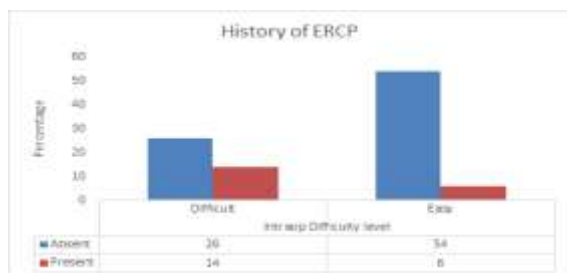
Previous hospitalization for cholecystitis	Intraoperative score		Total	p value
	Difficult	Easy		
Absent	12 (24)	27 (54)	39 (78)	0.012*
Present	8 (16)	3 (6)	11 (22)	
Total	20 (40)	30 (60)	50 (100)	

**Figure3: Comparison of history of hospitalization for cholecystitis with intraoperative scores**

Comparison of history of ERCP with intraoperative difficulty:Based on the history of ERCP, among 80% participants without ERCP history 54% and 26% of the cases had easy and difficult Intraoperative score respectively. Likewise, among 20% of the participants with ERCP history 6% had easy level while 14% of the cases had difficult intraoperative score. The association for ERCP history and intraoperativedifficulty was recorded as significant (p value =0.030).

Table 4: Comparison of history of ERCP with intraoperative difficulty

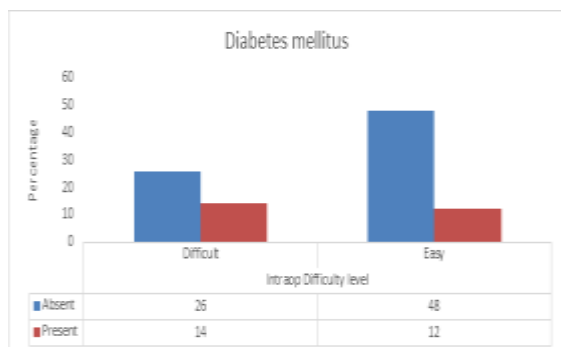
History of ERCP	Intraoperative score		Total	p value
	Difficult	Easy		
Absent	13 (26)	27 (54)	40 (80)	0.030*
Present	7 (14)	3 (6)	10 (20)	
Total	20 (40)	30 (60)	50 (100)	

**Figure 4: Comparison of history of ERCP with intraoperativedifficulty**

Comparison of presence of diabetes mellitus with intraoperative difficulty: Among cases without diabetes mellitus, 48% of the cases had easy intraoperative score and 26% of the cases had difficult intraoperative level. Among cases with diabetes mellitus, 12% and 14% of them had easy and difficult intraoperative score respectively. The association between diabetes mellitus and intraoperative difficulty was recorded to be insignificant (p value =0.236).

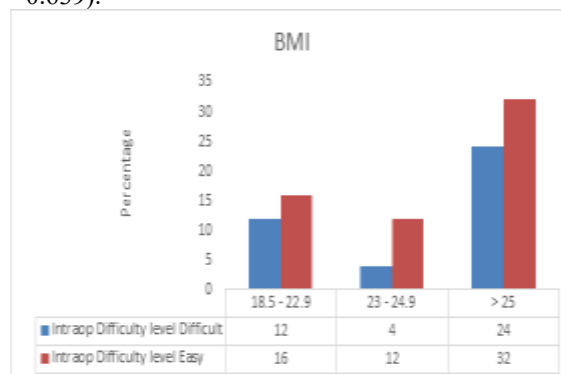
Table 5: Comparison of presence of diabetes mellitus with intraoperative difficulty

Diabetes mellitus	Intraoperative score		Total	p value
	Difficult	Easy		
Absent	13 (26)	24 (48)	37 (74)	0.236
Present	7 (14)	6 (12)	13 (26)	
Total	20 (40)	30 (60)	50 (100)	

**Figure 5: Comparison of presence of diabetes mellitus with intraoperative scores**

Comparison of BMI with Intraoperative Difficulty: On assessing the BMI with intraoperative difficulty, patients with BMI between 18.5-22.9, 16% were easy and 12% were difficult, while among patients with BMI in the range of 23-24.9, 12% cases had easy intraoperative scoring and

4% cases difficult intraoperatively. Among patients with BMI >25, 32% cases had easy scores while, 24% of the cases had difficult scores in this present study. The association between BMI and intraoperative difficulty was insignificant (p value =0.639).

**Figure 6: Comparison of BMI with intraoperative difficulty**

Comparison of past history of abdominal surgery with intraoperative difficulty: In this current study, among cases without past abdominal surgery 34% of the cases had easy intraoperative scores and 24% of the cases had difficult intraoperative scores. Among cases with past abdominal surgery 26% and 16% of the cases had easy and difficult intraoperative scores respectively. The association between past

abdominal surgery and Intraoperative score was recorded to be insignificant (p value =0.815).

Table 6: Comparison of BMI with intraoperative difficulty

BMI	Intraoperative score		Total	p value
	Difficult	Easy		
18.5-22.9	6 (12)	8 (16)	14 (28)	0.639
23-24.9	2 (4)	6 (12)	8 (16)	
> 25	12 (24)	16 (32)	28 (56)	
Total	20 (40)	30 (60)	50 (100)	

Table 7: Comparison of past history of abdominal surgery with intraoperative difficulty

Past history of abdominal surgery	Intraoperative score		Total	p value
	Difficult	Easy		
Absent	12 (24)	17 (34)	29 (58)	0.815
Present	8 (16)	13 (26)	21 (42)	
Total	20 (40)	30 (60)	50 (100)	

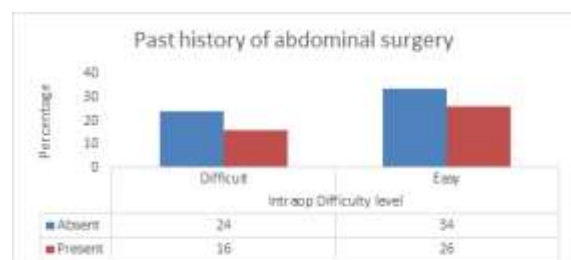


Figure 7: Comparison of past history of abdominal surgery with intraoperative difficulty

Among cases with no palpable gall bladder, 60% of the cases had easy scoring and 38% of the cases had difficult scoring whereas among cases with palpable gall bladder, 2% of them had difficult intraoperative scoring. There was no association recorded between palpable gall bladder and intraoperative score in this study. (p value =0.216).

Table 8: Comparison of palpable gall bladder with intraoperative difficulty

Palpablegall bladder	Intraoperative score		Total	p value
	Difficult	Easy		
No	19 (38)	30 (60)	49 (98)	0.216
Yes	1 (2)	0	1 (2)	
Total	20 (40)	30 (60)	50 (100)	

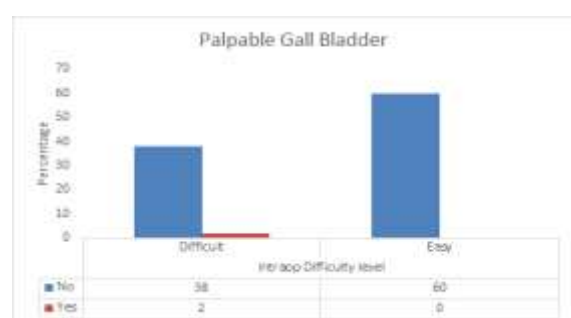


Figure 8: Comparison of palpable gall bladder with intraoperative difficulty

Comparison of total leukocyte counts with intraoperative difficulty: Among cases with total leukocyte counts >11,000 cells/ μ L, 12% of them had easy level and 22% of them were difficult intraoperatively whereas, among cases with total leukocyte counts \leq 11000 cells/ μ L, 48% of the cases had easy intraoperative scoring and 18% of the cases were difficult intraoperatively. The association

between total leukocyte counts and intraoperative score was statistically significant (p value =0.010).

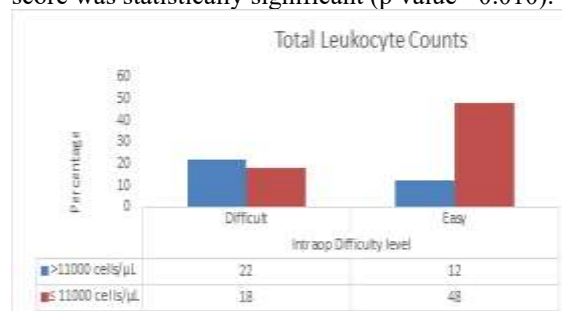


Figure 9: Comparison of total leukocyte counts with intraoperative difficulty

Comparison of gall bladder wall thickening on ultrasound with intraoperative difficulty: Among cases with no gallbladder (GB) wall thickening, 50% of them were easy and 18% of them were difficult intraoperatively. Among cases with GB wall thickening, 10% of the cases had easy

intraoperative scores and 22% of the cases had difficult intraoperative scores. The association between GB wall thickening and intraoperative

difficulty was statistically significant (p value =0.004).

Table 9: Comparison of total leukocyte counts with intraoperative difficulty

TLC	Intraoperative score		Total	p value
	Difficult	Easy		
>11000 cells/ μ L	11 (22)	6 (12)	17 (34)	0.010*
\leq 11000 cells/ μ L	9 (18)	24 (48)	33 (66)	
Total	20 (40)	30 (60)	50 (100)	

Table 10: Comparison of USG – GB wall thickening with intraoperative difficulty

GB wall thickening	Intraoperative score		Total	p value
	Difficult	Easy		
Absent	9 (18)	25 (50)	34 (68)	0.004*
Present	11 (22)	5 (10)	16 (32)	
Total	20 (40)	30 (60)	50 (100)	

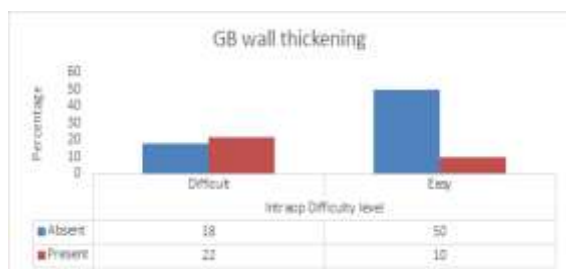


Figure 10: Comparison of USG – GB wall thickening with intraoperative difficulty

Comparison of pericholecystic fluid on ultrasound with intraoperative difficulty: Based on the USG- Pericholecystic fluid, among cases who had no pericholecystic fluid on ultrasound, 60% and 34% of the cases had easy and difficult levels of scoring respectively. Similarly, among cases with pericholecystic fluid, 6% of the cases were difficult intraoperatively. There was significant association noted for Pericholecystic fluid and Intraoperative score (p value =0.029).

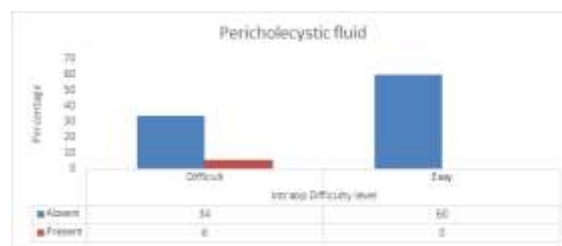


Figure 11: Comparison of USG- Pericholecystic fluid with intraoperative difficulty

Comparison of impacted gb calculus on ultrasound with intraoperative difficulty: Upon comparing the USG- Impacted GB calculus and intraoperative difficulty, among cases who had no impacted GB calculus, 52% and 18% of the cases had easy and difficult levels of scoring respectively. Similarly, among cases with impacted GB calculus, 8% and 22% of the cases were easy and difficult intraoperatively, respectively. There was significant association noted for Impacted GB Calculus and Intraoperative score (p value =0.002).

Table 11: Comparison of USG- Pericholecystic fluid with intraoperative difficulty

Pericholecystic fluid	Intraoperative score		Total	p value
	Difficult	Easy		
Absent	17 (34)	30 (60)	47 (94)	0.029*
Present	3 (6)	0	3 (6)	
Total	20 (40)	30 (60)	50 (100)	

Table 12: Comparison of USG- Impacted GB calculus with intraoperative difficulty

Impacted GB Calculus	Intraoperative score		Total	p value
	Difficult	Easy		
Absent	9 (18)	26 (52)	35 (70)	0.002*
Present	11 (22)	4 (8)	15 (30)	
Total	20 (40)	30 (60)	50 (100)	

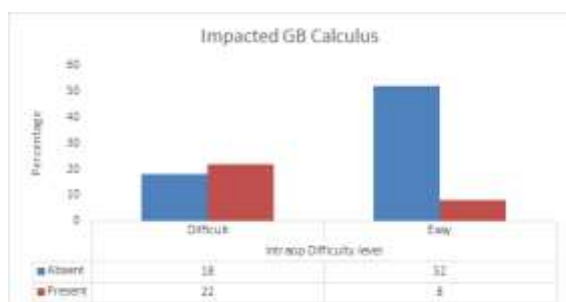
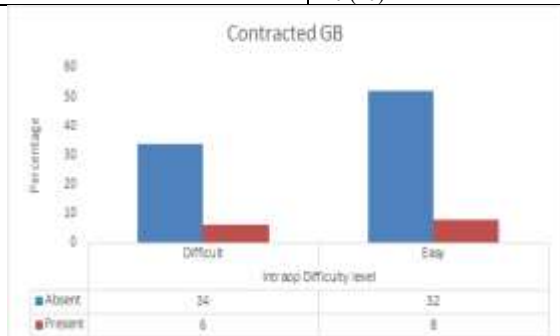


Figure 12: Comparison of USG- Impacted GB calculus with intraoperative difficulty

Comparison Of Contracted Gall Bladder On Ultrasound With Intraoperative Difficulty: In this present study, among cases with no contracted GB on ultrasound, 52% of the cases had easy and 34% of the cases had difficult intraoperative scores. Likewise, among cases with contracted GB on ultrasound, 8% of the cases were easy and 6% of the cases were difficult intraoperatively, but the association between contracted GB and intraoperative score was not significant (p value =0.868).

Table 13: Comparison of USG - Contracted GB with intraoperative difficulty

Contracted GB	Intraoperative score		Total	p value
	Difficult	Easy		
Absent	17 (34)	26 (52)	43 (86)	0.868
Present	3 (6)	4 (8)	7 (14)	
Total	20 (40)	30 (60)	50 (100)	

**Figure 13: Comparison of USG - Contracted GB with intraoperative difficulty**

Comparison of preoperative difficulty with intraoperative difficulty: Upon comparing preoperative scoring level with intraoperative score 8% of the cases difficult preoperative scoring had easy intraoperative scoring while 34% of the cases with difficult preoperative level were difficult intraoperatively too, while among cases with easy pre-operative scoring levels, 52% of the cases had easy intraoperative scores and 6% of the cases had difficult intraoperative levels. There was high statistical association found between preoperative scoring with intraoperative difficulty scores in this study (p value =<0.001).

Table 14: Comparison of preoperative scoring with intraoperative difficulty

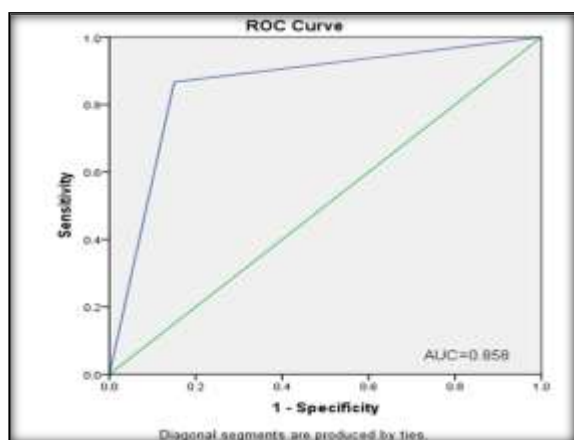
Preop Scoring level	Intraoperative score		Total	p value
	Difficult	Easy		
Difficult	17 (34)	4 (8)	21 (42)	< 0.001*
Easy	3 (6)	26 (52)	29 (58)	
Total	20 (40)	30 (60)	50 (100)	

**Figure 14: Comparison of preoperative scoring with intraoperative difficulty**

In this current study based on the scoring level before the operative procedure and during the operative procedure, the sensitivity was noted to be 85%, specificity was 86.7% and Positive Predictive value was 81% and Negative predictive value recorded as 89.7% with Diagnostic accuracy of 86%. The 95% CI as provided in the table.

Table 15: Diagnostic accuracy comparing preoperative and intraoperative scores

Variables	Value	95% CI
Sensitivity	85%	62.1% - 96.8%
Specificity	86.7%	69.3%-96.2%
PPV	81%	62.6% - 91.5%
NPV	89.7%	75.2% - 96.1%
Diagnostic accuracy	86%	73.3% - 94.2%

**Figure 15: AUROC of Preop and Intraoperative scores**

DISCUSSION

The present study provides a comprehensive evaluation of the factors influencing intraoperative difficulty during elective laparoscopic cholecystectomy (LC), integrating demographic, clinical, biochemical, and ultrasonographic parameters. The findings reinforce the multifactorial nature of operative difficulty and highlight the importance of structured preoperative assessment in anticipating surgical challenges.

One of the most significant observations in this study is the impact of age on intraoperative complexity. Patients older than 50 years demonstrated a markedly higher incidence of difficult procedures compared with younger patients. Age-related fibrotic changes, recurrent

subclinical inflammation, and reduced tissue compliance likely contribute to these findings, making dissection in the Calot's triangle more demanding. These results align with multiple previous studies that have consistently identified advanced age as a robust predictor of difficult LC.

Gender differences were also evident, with male patients experiencing more difficult procedures compared with female patients. Several theories may explain this disparity, including higher rates of chronic cholecystitis in men, greater tissue fibrosis, and differences in fat distribution leading to limited exposure. This trend is well-documented in global literature and was confirmed in the present analysis. Recurrent inflammatory episodes emerged as a major determinant of difficulty. Participants with a history of hospitalization for cholecystitis or previous ERCP were significantly more likely to undergo difficult operations. ERCP, while therapeutically beneficial, can contribute to scarring or distortion of the biliary anatomy, thereby complicating dissection. Similarly, recurrent cholecystitis is known to produce dense adhesions and a frozen Calot's triangle, which increase the risk of bile duct injury. These findings underscore the importance of detailed clinical history in preoperative planning.

In contrast, the absence of a significant association between diabetes mellitus or BMI and operative difficulty in this study is noteworthy. Although obesity and metabolic disease have been traditionally considered risk factors, their impact varies across populations. The relatively modest proportion of obese participants in this cohort may explain the lack of association. Likewise, while previous abdominal surgery can result in adhesions, the absence of a significant effect suggests that these adhesions may not have involved the upper abdomen to an extent that would hinder LC.

Hematological and ultrasonographic parameters proved to be strong predictors of operative difficulty. Elevated total leukocyte count, gallbladder wall thickening, pericholecystic fluid, and impacted gallstones were each significantly associated with challenging dissections. These features reflect active or chronic inflammation and correlate well with intraoperative findings such as edema, distortion of planes, and fibrotic adhesions. Importantly, impacted calculi often obstruct dissection of the infundibulum, further increasing operative risk.

Interestingly, palpable gallbladder and contracted gallbladder were not significantly associated with difficulty in this study, highlighting that clinical examination alone may be insufficient in assessing operative risk in elective cases. Instead, reliance on ultrasonographic indicators of inflammation appears to provide more reliable predictive value.

A major strength of this study lies in the evaluation of a preoperative difficulty scoring system. The scoring model demonstrated high sensitivity, specificity, and overall diagnostic accuracy,

indicating its strong potential as a predictive tool. The close alignment between preoperative difficulty grades and actual intraoperative difficulty underscores the practical utility of structured scoring systems in surgical planning. Identification of high-risk patients allows for appropriate allocation of experienced surgeons, preparedness for conversion or subtotal cholecystectomy, and improved patient counseling.

Intraoperatively, several factors contributed to difficulty, including prolonged time required to identify the cystic duct and artery, failure to achieve the critical view of safety, and the presence of dense omental or visceral adhesions. Anatomical variations—such as short or dilated cystic ducts, accessory ducts, and low insertion of the cystic duct—were also noted to complicate dissection and increase the likelihood of bile duct injury. The small number of cases requiring subtotal cholecystectomy or conversion to open surgery highlights the clinical significance of these challenging scenarios.

The findings of this study show strong concordance with previous research. Studies by Gupta, Vivek, Agrawal, Nidoni, Saleem, Chand, and Akhtar et al^{7,17-22} have similarly identified impacted stones, pericholecystic collection, wall thickening, ERCP history, and elevated inflammatory markers as key predictors of difficult LC. The sensitivity and specificity of difficulty scoring systems reported in the literature are comparable to those observed in the present study, emphasizing the consistency and reproducibility of such predictive models.

Collectively, these observations highlight the clinical relevance of integrating multiple preoperative markers—clinical, biochemical, and ultrasonographic—into a unified assessment strategy. Such an approach enhances preoperative decision-making, facilitates accurate risk stratification, and contributes to safer surgical practice. Recognizing potential difficulty in advance enables surgeons to optimize operative preparedness, allocate adequate time and resources, and anticipate technical challenges that may necessitate alternative strategies such as subtotal cholecystectomy or conversion.

Overall, the findings support the incorporation of standardized scoring systems into routine preoperative evaluation for patients undergoing laparoscopic cholecystectomy. However, this study is not without its limitations. The study was conducted in a single institution, which may limit the generalizability of the findings to broader or more diverse populations. A relatively small sample size may reduce the statistical power of the study, particularly when assessing subgroups such as those with prior ERCP, diabetes, or palpable gallbladder. The assessment of intraoperative difficulty was based on the surgeons' subjective interpretation (e.g., adhesions, anatomy, difficulty levels), which may vary between surgeons and introduce interobserver variability. Preoperative ultrasound findings such as wall thickness, pericholecystic

fluid, or impacted stones depend heavily on the skill of the sonologist, potentially introducing measurement variability. Variables such as surgeon experience, equipment variation, and perioperative management were not controlled for, although they can significantly influence difficulty and outcomes. Some clinically relevant subgroups (e.g., patients with contracted gallbladder, ERCP history, prior abdominal surgery) were small, making it difficult to statistically validate predictors in these categories.

CONCLUSION

This study identifies several preoperative factors that meaningfully correlate with the likelihood of encountering a difficult laparoscopic cholecystectomy. Older age, male sex, previous admissions for cholecystitis, a history of ERCP, elevated leukocyte counts, gallbladder wall thickening, pericholecystic fluid, and impacted calculi were all significantly associated with increased operative difficulty. The preoperative scoring system used in this study demonstrated strong predictive ability, with high sensitivity, specificity, and overall accuracy, reinforcing its value as a practical tool for anticipating challenging operative scenarios.

Intra operative difficulty was most often driven by dense adhesions, altered or obscured anatomy, and circumstances that prevented attainment of the critical view of safety. Recognizing these predictors in advance may help surgeons optimize operative planning, better counsel patients regarding risks, and prepare for alternative strategies including subtotal cholecystectomy or conversion when necessary.

The findings suggest that systematic preoperative assessment can play a meaningful role in improving the safety and efficiency of laparoscopic cholecystectomy. Further research across larger and more varied patient populations is warranted to strengthen and refine predictive models for intraoperative difficulty.

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