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Validation of Scoring System in Assessment of Difficulty in Laparoscopic Cholecystectomy

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Abstract

Introduction: Gallstone disease remains one of the most ubiquitous digestive disorders worldwide, affecting up to 20 % of adults in high-income countries and showing a worrying up-trend in rapidly industrialising regions[1].

Aims and Objectives

Aim: To validate scoring system for predicting operative difficulty in laparoscopic cholecystectomy.

Objectives

1. Quantify the sensitivity, specificity, and overall predictive accuracy of selected scoring system.
2. Correlate difficulty scores with key operative outcomes—conversion to open surgery, operative time, and peri-operative complications.
3. Recommend the most clinically useful scoring system for routine pre-operative assessment based on the above analyses.

Preoperative assessment of difficulty in cholecystectomy using scoring system

Material and Method

Study Design: A Prospective, single-arm observational study.

Study Period: From 01 January 2023 to 30 June 2024 with an overall study period of 18 months.

Place of study: Department of Surgery at a tertiary care centre, Maharashtra University of Health Sciences, Nashik

Sample Size: A total of 100 patients and Randomly collection.

Result: A total of 123 patients were included in this study. The mean age of the participants was 53.67 years, with a standard deviation (SD) of 13.35 years, and the age ranged from 18 to 81 years. The majority of participants were female (77.2%), while male participants accounted for 22.8%.

Discussion: Our study's findings are consistent with multiple recent investigations. Trehan et al. observed that a preoperative score >5 could reliably predict difficult cholecystectomies, with an AUC of 0.935 and prediction accuracy over 90%.

Keywords: Abdominal Surgery, Body Mass Index, Cholecystectomy, Gallbladder Wall, Laparoscopy, Morbidity

Introduction

Gallstone disease remains one of the most ubiquitous digestive disorders worldwide, affecting up to 20 % of adults in high-income countries and showing a worrying up-trend in rapidly industrialising regions[1]. The growing burden translates directly into a rising demand for cholecystectomy, both elective and emergency, and places gallbladder pathology among the most common indications for abdominal surgery.

Since the seminal laparoscopic cholecystectomies performed by Mouret, Dubois and Perissat in the late-1980s, minimal-access removal of the gall- bladder has displaced open surgery as the therapeutic gold standard[2]. Meta- analyses confirm that laparoscopy halves postoperative pain, shortens length of stay and accelerates return to work compared with open cholecystectomy, while maintaining equivalent rates of major morbidity[3].

Technical complexity is not uniformly reduced by laparoscopy. Large registry studies and contemporary guidelines place the incidence of common bile- duct injury (CBDI) after laparoscopic cholecystectomy (LC) at 0.3–0.9 %, a figure still two to four-fold higher than with open surgery and one that carries lifelong consequences for patients and health systems alike[4,5].

Narrative syntheses note that 15–25 % of laparoscopic cases fulfil difficulty criteria and that these patients experience longer operating times, greater blood loss, higher conversion rates and a near-quadrupling of bile duct injuries[6].

Morbid obesity, advanced age, male sex, recurrent attacks of acute cholecystitis, prior upper-abdominal surgery and radiological features such as gallbladder wall thickening or pericholecystic fluid significantly increase the odds of difficulty, emphasising the importance of structured risk stratification before the first port is placed [17,19].

A host of scoring instruments has emerged over the past two decades to objectify that risk. The operative 10-point scale proposed by Sugrue et al. quantifies adhesions, gall-bladder distension, access issues, septic/local complications and time to identify the cystic pedicle, classifying cases as mild (<2), moderate (2-4), severe (5-7) or extreme (8-10)[7].

Parallel advances in computer vision and machine learning promise to augment human scoring. Automated analysis of intra-operative video can now identify Parkland grades with performance comparable to expert surgeons, and AI derived PGS predictions correlate with prolonged operative phases and increased gall-bladder injury risk[13].

Aims and Objectives

Aim: To validate scoring system for predicting operative difficulty in laparoscopic cholecystectomy.

Objectives:

1. Quantify the sensitivity, specificity, and overall predictive accuracy of selected scoring system.
2. Correlate difficulty scores with key operative outcomes—conversion to open surgery, operative time, and peri-operative complications.
3. Recommend the most clinically useful scoring system for routine pre-operative assessment based on the above analyses.
4. Preoperative assessment of difficulty in cholecystectomy using scoring system

Material and Method

Study design: The investigation was conducted as a prospective, single-arm observational study that evaluated the diagnostic performance of pre-operative scoring system for predicting operative difficulty in laparoscopic cholecystectomy.

Study setting: The study was carried out in the Department of General Surgery at a high- volume tertiary care teaching hospital. The centre offered round-the-clock emergency services, advanced imaging, and minimally invasive surgical facilities, ensuring uniform peri-operative protocols and follow-up.

Study period and duration: Recruitment commenced on 01 January 2023 and concluded on 30 June 2024 with an overall study period of 18 months, which included patient enrolment, surgery, and postoperative follow-up until 30 days after discharge.

Study population and sample size: All consecutive adult patients (≥ 18 years) who were scheduled for elective laparoscopic cholecystectomy for symptomatic cholelithiasis or chronic cholecystitis constituted the sampling frame. A target sample size of 100 patients was determined a priori using Buderer's method for diagnostic accuracy studies, assuming an anticipated sensitivity and specificity of 80%, a 95% confidence level, and a precision of ± 10%.

Inclusion criteria

- Adults aged 18 years and above.
- Patients consenting to undergo elective laparoscopic cholecystectomy.

Exclusion criteria

- Refusal to provide written informed consent.
- Age < 18 years.
- Conversion to open cholecystectomy for indications unrelated to operative difficulty (e.g., equipment failure).
- Patients with deranged PT INR values
- Uncertain pre-operative diagnosis (e.g., suspected malignancy or Mirizzi syndrome).

Statistical analysis

Analyses were performed with IBM SPSS Statistics, version 20.0. Categorical variables were summarised as frequencies and percentages; continuous variables were reported as mean ± SD or median (IQR) based on distribution.

- Diagnostic accuracy: Sensitivity, specificity, positive predictive value, negative predictive value, and area under the ROC curve (AUC) were calculated for each scoring system against the operative difficulty reference standard.
- Associations: The Pearson χ^2 test or Fisher's exact test assessed relationships between categorical variables (e.g., score strata vs. difficulty category).
- Proportions: Z-test for two independent proportions compared binary outcomes (e.g., complication rates).

- Inter-observer reliability: Cohen's κ coefficient evaluated agreement between the two assessors. A *p*-value < 0.05 was considered statistically significant for all tests.

Result

A total of 123 patients were included in this study. The socio-demographic profile of the study participants was described in table-1.

Table 1: Socio-demographic profile of the study participants (N=123)

Variable	Category / Value	n (%) / Mean (SD)
Age (years)	Mean (SD)	53.67 (13.35)
	Range	18.00 – 81.00
Gender	Female	95 (77.2%)
	Male	28 (22.8%)
BMI (kg/m²)	Mean (SD)	23.43 (3.28)
	Range	16.50 – 30.10

A total of 123 patients were included in the study. The mean age of the participants was 53.67 years, with a standard deviation (SD) of 13.35 years, and the age ranged from 18 to 81 years. The majority of participants were female (77.2%), while male participants accounted for 22.8%. The mean body mass index (BMI) was 23.43 kg/m² with a standard deviation of 3.28, and the BMI values ranged from 16.50 to 30.10 kg/m².

Figure 1: Sex distribution of the study participants (N=123)

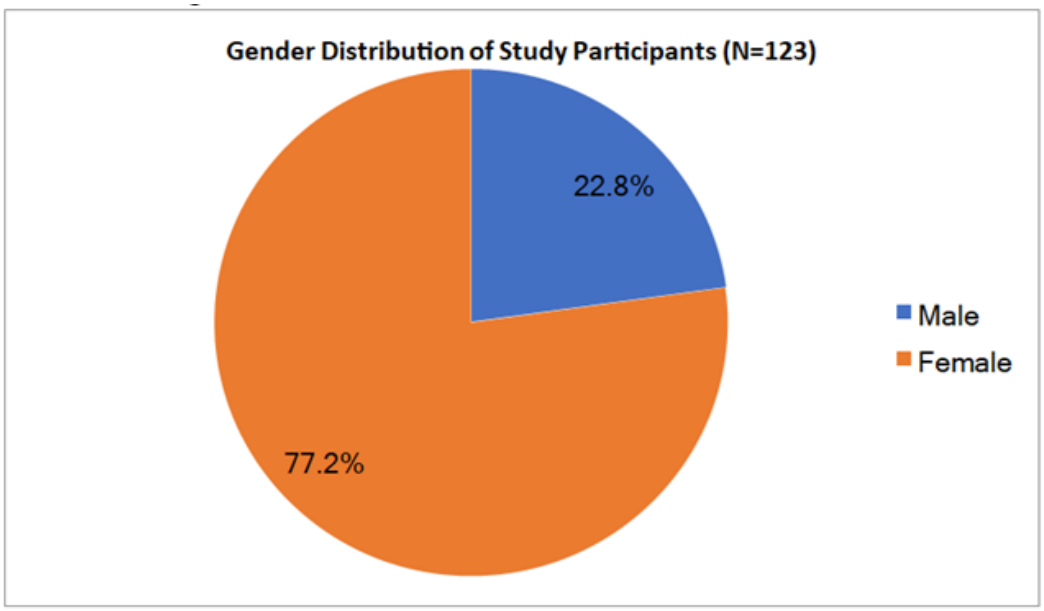


Table 2: Clinical history of the study participants (N=123)

Variable	Category / Value	n (%) / Mean (SD)
Previous Operative History	Tubal ligation	69 (56.1%)
	NIL	42 (34.1%)
	Hernioplasty	7 (5.7%)
	Laparotomy	2 (1.6%)
	Open appendicectomy	1 (0.8%)
	Tubal ligation / Laparoscopic appendicectomy	1 (0.8%)
	Tubal ligation / Open appendicectomy	1 (0.8%)
Previous Hospitalization for Similar Complaints	No	89 (72.4%)
	Yes	34 (27.6%)

Table 2 presents the clinical history of the study participants. A previous operative history was reported in a majority of cases, with tubal ligation being the most common procedure, recorded in 69 participants (56.1%). Other previous surgeries included hernioplasty in 7 participants (5.7%), laparotomy in 2 (1.6%), and open appendicectomy in 1 participant (0.8%). Additionally, 1 participant (0.8%) had undergone tubal ligation along with a laparoscopic appendicectomy, and another had a combination of tubal ligation and open appendicectomy. No prior operative history was reported in 42 participants (34.1%). Furthermore, 34 participants (27.6%) had been previously hospitalized for similar complaints.

Figure 2: Previous Operative History among the study participants (N=123)

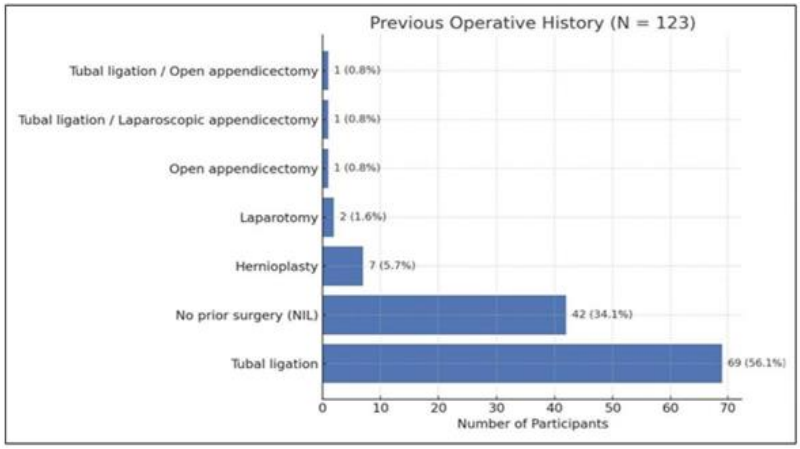


Table 3: Clinical symptoms among the study participants (N=123)

Symptom	n	%
Abdominal pain	119	96.7%
Vomiting	64	52.0%
Fever	25	20.3%

Table 3 summarizes the clinical symptoms reported by the study participants. The most frequently reported symptom was abdominal pain, which was present in 119 participants (96.7%). Vomiting was noted in 64 participants (52.0%), while fever was documented in 25 participants (20.3%).

Figure 3: Clinical profile of the study participants (n=123)

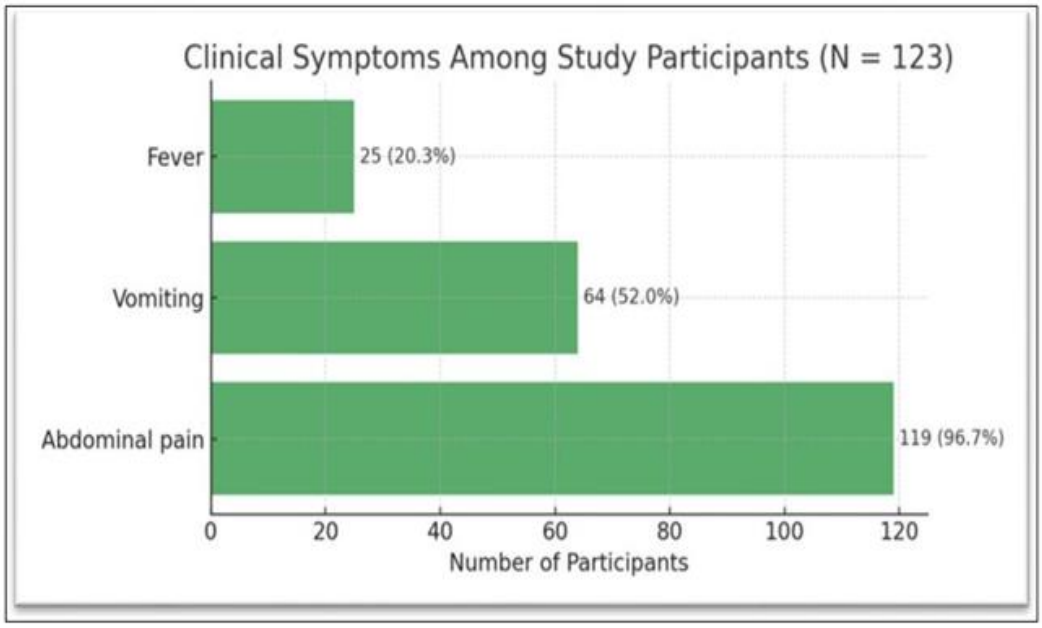


Table 4: Sonographic findings- GB Wall thickness (N=123)

GB Wall Thickness	n	%
2.0–2.9 mm	34	27.6%
3.0–3.9 mm	49	39.8%
4.0–4.9 mm	19	15.4%
5.0–5.9 mm	11	8.9%
≥6.0 mm	6	4.9%
Not specified	3	2.4%

Table 4 presents the distribution of gallbladder (GB) wall thickness as observed on sonography. The most common range was 3.0–3.9 mm, noted in 49 participants (39.8%), followed by 2.0–2.9 mm in 34 participants (27.6%). A thickness of 4.0–4.9 mm was observed in 19 participants (15.4%), while 11 participants (8.9%) had measurements between 5.0–5.9 mm. A smaller proportion, 6 participants (4.9%), had a wall thickness of 6.0 mm or more. GB wall thickness data were not specified for 3 participants (2.4%).

Figure 4: Sonographic findings- GB wall thickening (N=123)

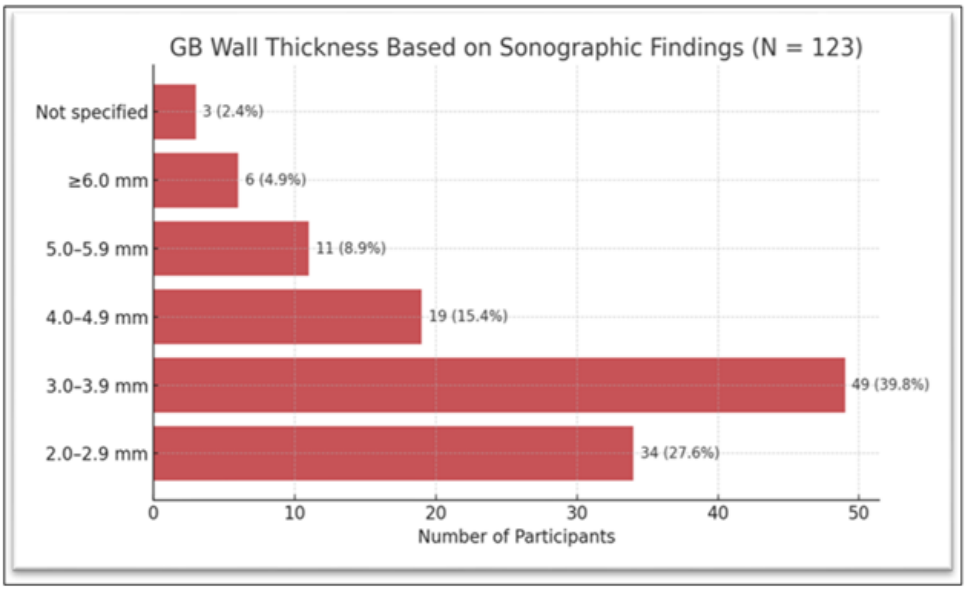


Table 5: Intra-operative time distribution among the study participants (n=123)

Operative Time Range	n	%
< 45 minutes	75	61.0%
45–90 minutes	47	38.2%
> 90 minutes	1	0.8%

Table 5 shows the distribution of intra-operative time among the participants. The majority of surgeries (75 participants; 61.0%) were completed in less than 45minutes. An operative time of 45 to 90 minutes was recorded in 47 participants (38.2%), while only 1 participant (0.8%) had a procedure lasting more than 90 minutes.

Figure 5: Intra-operative time distribution among the study participants (n=123)

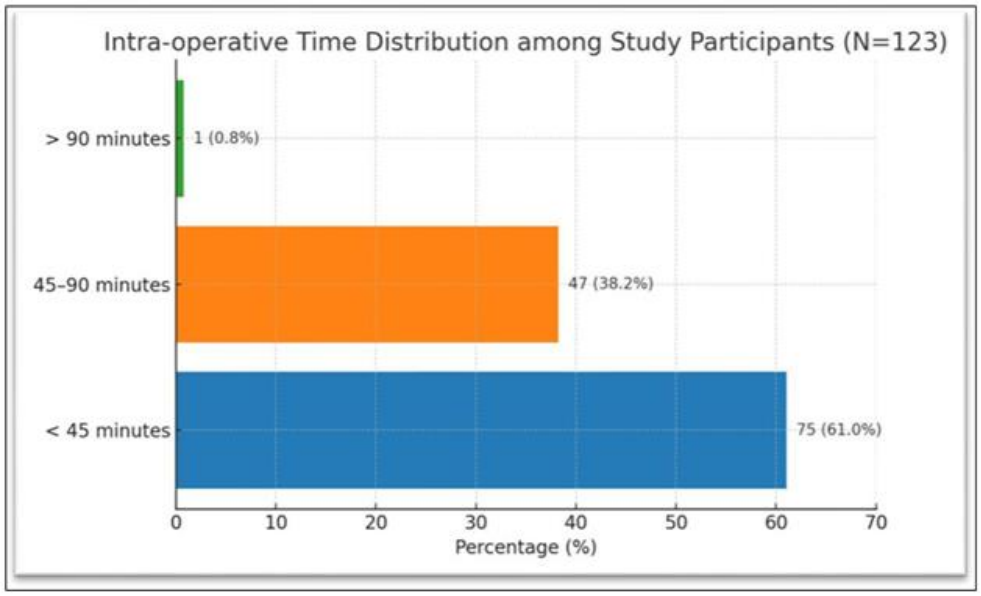


Table 6: Post operative difficulty assessment among the study participants (N=123)

Postoperative Classification	n	%
Easy	76	61.8%
Difficult	38	30.9%
Very Difficult	9	7.3%

Table 6 presents the postoperative difficulty assessment based on intraoperative findings. The majority of cases were classified as Easy, accounting for 76 participants (61.8%). Difficult surgeries were reported in 38 participants (30.9%), while 9 participants (7.3%) were categorized as Very Difficult.

Figure 6: Post operative difficulty assessment among the study participants (N=123)

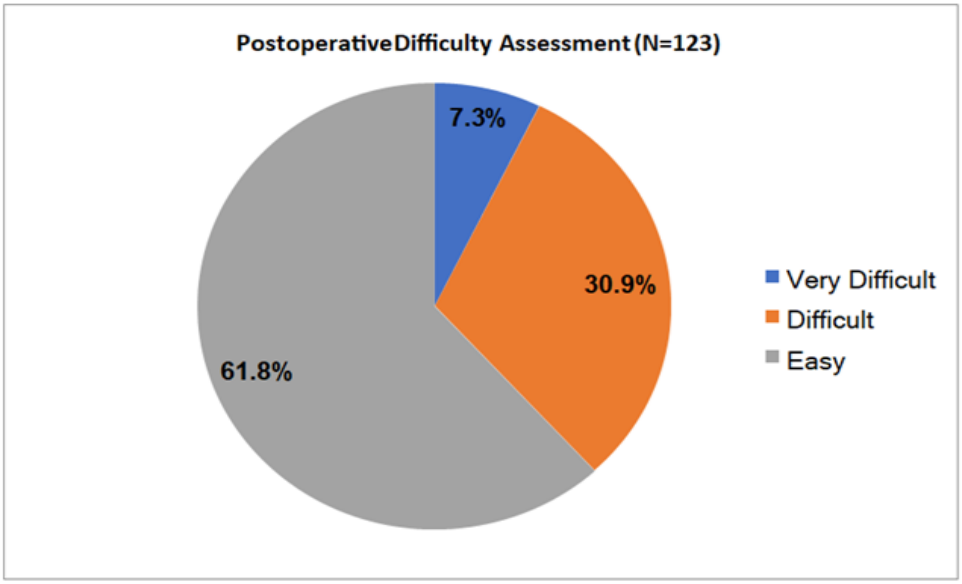
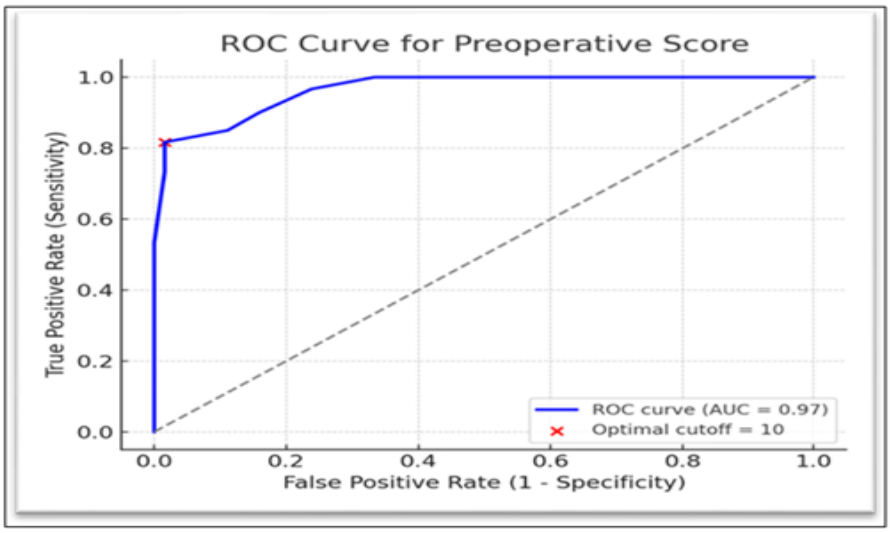


Table 7: ROC Analysis matrices for pre-operative score

Metric	Value
AUC (Area Under Curve)	0.97
Optimal Cutoff Score	10
Sensitivity at Cutoff	0.82
Specificity at Cutoff	0.98

Table 7 displays the results of the ROC analysis performed to evaluate the diagnostic accuracy of the pre-operative score in predicting surgical difficulty. The area under the curve (AUC) was 0.97, indicating excellent discriminatory ability. The optimal cutoff score was identified as 10, based on the Youden index. At this threshold, the sensitivity was 0.82, reflecting the proportion of difficult cases correctly identified, while the specificity was 0.98, indicating a high accuracy in identifying easy cases.

Figure 7: ROC curve for validation of pre-operative score for prediction of operative difficulty



Discussion

This study aimed to validate a preoperative scoring system for predicting difficulty in laparoscopic cholecystectomy (LC), an essential goal in optimizing surgical preparedness and patient safety. With a mean preoperative score of 3.54 and an area under the ROC curve (AUC) of 0.97, the scoring system demonstrated excellent discriminative ability. Using a cutoff of 10, the model yielded a sensitivity of 82% and specificity of 98%, suggesting strong potential for routine clinical application in triaging LC cases.

Our study's findings are consistent with multiple recent investigations and preoperative score >5 could reliably predict difficult cholecystectomies, with an AUC of 0.935 and prediction accuracy over 90%[1]. Similarly, Ramakrishna et al. found that thickened gallbladder wall, higher BMI, and previous hospitalizations significantly predicted surgical difficulty in 104 patients, with an AUC of 0.798[2].

In our cohort, the majority of patients were female (77.2%), but gender was not found to be a predictor of difficulty, unlike in other studies. This discrepancy may be due to demographic differences in study populations or surgeon expertise. Sonographic findings also played a crucial role in predicting surgical complexity. A GB wall thickness ≥4 mm was present in a notable subset of participants.

Nonetheless, our findings should be interpreted in light of certain limitations. The cohort was predominantly female and of moderate BMI, which may limit generalizability to populations with more diverse risk profiles. Additionally, while intraoperative findings correlated well with preoperative scores, inter-surgeon variability in classifying difficulty may introduce subjectivity. Multicenter validation and standardization of operative difficulty grading (e.g., using the Nassar scale) could enhance reproducibility across settings.

Conclusion

This study successfully validated a preoperative scoring system for predicting the difficulty of laparoscopic cholecystectomy, demonstrating high diagnostic accuracy with an AUC of 0.97, sensitivity of 82%, and specificity of 98%. Key predictors such as gallbladder wall thickness, gallbladder distension, and clinical history proved to be reliable indicators of intraoperative complexity. The scoring system effectively stratified

patients into risk categories, facilitating better surgical planning, reducing unexpected complications, and optimizing resource utilization. Incorporating this tool into routine preoperative assessment can enhance clinical decision-making and improve patient outcomes in elective cholecystectomy.

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