

## A Prospective Observational Study To Evaluate Preoperative Prediction Of Difficult Laparoscopic Cholecystectomy Using Ultrasound Scoring System

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### ABSTRACT

**Background:** Laparoscopic cholecystectomy (LC) is the standard treatment for symptomatic gallstone disease; however, a subset of patients experiences significant intraoperative difficulty, leading to complications or conversion to open cholecystectomy. Accurate preoperative prediction of difficult LC remains challenging. Ultrasonography, being widely available and non-invasive, offers potential predictive value when structured into a standardized scoring system.

**Methods:** This prospective observational study was conducted in a tertiary care teaching hospital over 12 months and included 50 adult patients undergoing elective laparoscopic cholecystectomy for ultrasonography-proven cholelithiasis or cholecystitis. Seven ultrasonographic parameters were assessed preoperatively and scored to generate a composite ultrasound score. A score  $\leq 5$  predicted easy LC, while a score  $>5$  predicted difficult LC. Intraoperative difficulty was assessed using predefined surgical criteria. Diagnostic performance of the scoring system was analyzed.

**Results:** Seventeen patients (34%) were predicted to have difficult LC preoperatively, while 16 cases (32%) were classified as difficult intraoperatively. A strong correlation was observed between higher ultrasound scores and intraoperative difficulty. The scoring system demonstrated a sensitivity of 81.3%, specificity of 88.2%, and overall diagnostic accuracy of 86%. Gallbladder wall thickness  $>4$  mm, distended gallbladder, impacted stones, and dilated common bile duct were significantly associated with difficult LC ( $p < 0.05$ ).

**Conclusion:** The ultrasound-based scoring system is a reliable and practical tool for preoperative prediction of difficult laparoscopic cholecystectomy and can aid in surgical planning and patient counselling.

**Keywords:** Laparoscopic cholecystectomy; Ultrasound scoring system; Difficult cholecystectomy; Preoperative prediction; Gallstone disease

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### INTRODUCTION

Laparoscopic cholecystectomy has become the gold standard surgical treatment for symptomatic gallstone disease due to its reduced postoperative pain, minimally invasive nature, shorter hospital stays, and faster return to daily activities when compared to open cholecystectomy [1]. Despite these advantages, laparoscopic cholecystectomy can be technically challenging in a subset of patients because of anatomical variations, inflammation, fibrosis, or distorted Calot's triangle, which may increase operative difficulty and complication rates [2]. Conversion from laparoscopic to open cholecystectomy, although not considered a failure, remains an important indicator of operative difficulty and is associated with increased morbidity, higher healthcare costs, and prolonged hospital stays [3]. Reported conversion rates range from 5% to 15%, depending on patient factors, disease severity, and surgeon experience [4]. The inability to accurately predict difficult laparoscopic cholecystectomy preoperatively poses challenges in operative planning, patient counselling, and allocation of surgical expertise

[5]. Therefore, identification of reliable preoperative predictors for difficult laparoscopic cholecystectomy has become an area of growing clinical interest [6].

Clinical parameters such as age, gender, previous abdominal surgery, obesity, and acute cholecystitis have been evaluated as predictors of operative difficulty, but their predictive accuracy remains inconsistent across studies [7]. Laboratory markers of inflammation and scoring systems based on clinical features have also been explored, yet none have gained universal acceptance due to limited reproducibility and lack of standardization [8]. Ultrasonography is routinely performed as the first-line imaging modality in gallbladder disease because it is non-invasive, widely available, cost-effective, and free of ionizing radiation [9]. Several ultrasonographic parameters, including gallbladder wall thickness, gallbladder distension, pericholecystic fluid collection, impacted stones, common bile duct dilatation, and hepatomegaly, have been individually associated with increased operative difficulty [10]. However, reliance on isolated sonographic findings may not provide sufficient

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predictive accuracy in real-world surgical practice [1]. Combining multiple ultrasonographic parameters into a structured scoring system may improve preoperative risk stratification and operative preparedness [2].

A standardized ultrasound-based scoring system allows objective assessment of gallbladder pathology and provides a reproducible method to predict difficult laparoscopic cholecystectomy before surgery [3]. Such scoring systems can assist surgeons in anticipating technical challenges, planning operative strategy, allocating adequate operative time, and deciding on early conversion when necessary [4]. Preoperative prediction of difficult laparoscopic cholecystectomy also enables informed patient counseling regarding potential risks, operative duration, and the possibility of conversion to open surgery [5]. Previous studies have demonstrated promising results using ultrasound-based scoring systems, reporting good sensitivity and specificity for predicting difficult cases and conversion risk [6]. However, most available studies are retrospective and limited by variations in methodology, scoring criteria, and patient populations [7]. This study aimed to evaluate the role of a standardized preoperative ultrasound-based scoring system in predicting the intraoperative difficulty of laparoscopic cholecystectomy. The study sought to assess whether specific ultrasonographic parameters of the gallbladder, biliary tract, and liver, when combined into a composite score, could reliably stratify patients into easy and difficult laparoscopic cholecystectomy groups. By correlating the preoperative ultrasound score with predefined intraoperative difficulty criteria, this study aimed to determine the diagnostic accuracy of the scoring system in predicting operative challenges and the likelihood of conversion to open cholecystectomy. Additionally, the study aimed to identify individual ultrasonographic parameters that were significantly associated with difficult laparoscopic cholecystectomy. Ultimately, this study intended to facilitate better preoperative planning, improve surgeon preparedness, and enable effective patient counseling regarding operative risk and outcomes.

## MATERIALS AND METHODS

This prospective observational study was conducted in the Department of General Surgery at SRM Medical College Hospital and Research Centre over a period of 12 months. The study population consisted of patients presenting to the General Surgery outpatient department with right hypochondriac pain and diagnosed with gallstone disease.

Patients aged more than 18 years with ultrasonography-proven cholelithiasis or cholecystitis who were planned for laparoscopic cholecystectomy were comprised in the study. Patients with choledocholithiasis detected on ultrasonography, coagulopathies, pregnancy, jaundice, cholangitis, or those deemed unfit for general anaesthesia were excluded.

All eligible patients underwent detailed clinical evaluation, routine blood investigations, and preoperative ultrasonographic assessment.

Ultrasonography was performed by a radiologist with the patient in a fasting state, using supine and left lateral decubitus positions. The gallbladder was evaluated in multiple planes.

The following seven sonographic parameters were assessed: gallbladder wall thickness, gallbladder size, gallstone mobility, common bile duct diameter, number of calculi, presence of pericholecystic fluid collection, and liver span. Gallbladder wall thickness was measured at the maximum thickness of the anterior wall, including the liver, and a thickness of 4 mm or more was considered thick. Gallbladder distension was defined as a transverse diameter of 5 cm or more. Gallstones were identified as well-defined intraluminal echogenic lesions with posterior acoustic shadowing seen in manifold planes. Stone mobility was assessed by scanning the patient in different positions. The common bile duct was measured dilated when the extreme diameter exceeded 6 mm. Liver enlargement was defined as a liver span greater than 15.5 cm.

Based on ultrasonographic findings, a scoring system was applied. A score of 2 was allotted for the occurrence of each significant parameter and a score of 1 for the outstanding parameters, with a maximum total score of 11. A cut-off score of 5 or less was used to predict an easy laparoscopic cholecystectomy, while a score greater than 5 predicted a difficult laparoscopic cholecystectomy.

All patients underwent laparoscopic cholecystectomy under general anaesthesia. Intraoperative difficulty was assessed by the operating surgeon using predefined criteria, which included operative time exceeding 60 minutes, injury to bile duct or artery, presence of dense pericholecystic adhesions, difficulty in dissection or frozen Calot's triangle, gallbladder perforation with bile or stone spillage, bleeding that hindered visualization, abnormal biliary anatomy, buried or intrahepatic gallbladder, and conversion to open cholecystectomy for any reason. Data were recorded in a structured proforma and analyzed to assess the association between the preoperative ultrasound score and intraoperative difficulty.

## RESULTS

A total of 50 patients undergoing elective laparoscopic cholecystectomy for gallstone disease were included in the study. The mean age was  $44.6 \pm 11.2$  years, with 31 patients (62%) aged >40 years. There was a male predominance (28 males, 56%).

On preoperative ultrasonography, gallbladder wall thickness  $\leq 4$  mm was noted in 32 patients (64%), while 18 patients (36%) had wall thickness  $>4$  mm. The gallbladder was contracted in 30 patients (60%) and distended in 20 patients (40%). Impacted stones were present in 9 patients (18%), and multiple calculi were seen in 29 patients (58%). A dilated common bile duct ( $\geq 6$  mm) was observed in 16 patients (32%), and pericholecystic fluid was present in 8 patients (16%).

Based on the ultrasound scoring system, 33 patients (66%) had a score  $\leq 5$ , predicting an easy procedure,

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while 17 patients (34%) had a score >5, predicting a difficult laparoscopic cholecystectomy. Intraoperatively, 16 patients (32%) had a difficult laparoscopic cholecystectomy, and 34 patients (68%) had an easy procedure. Operative time exceeded 60 minutes in 15 patients (30%). Dense adhesions were encountered in 14 patients (28%), and difficulty at Calot's triangle was noted in 12 patients (24%). Gallbladder perforation occurred in 10 patients (20%), and intraoperative bleeding in 8 patients (16%). Conversion to open cholecystectomy was required in 4 patients (8%).

Among patients with an ultrasound score >5, 13 were difficult intraoperatively, while 4 were easy. In contrast, among those with a score ≤5, 30 were easy, and 3 were difficult, demonstrating a strong correlation between higher ultrasound scores and operative difficulty.

The ultrasound scoring system showed a sensitivity of 81.3%, specificity of 88.2%, positive predictive value of 76.5%, negative predictive value of 90.9%, and an overall diagnostic accuracy of 86%. Gallbladder wall thickness >4 mm, distended gallbladder, impacted stones, and dilated CBD were significantly associated with difficult laparoscopic cholecystectomy (p < 0.05).

**Table 1: Comprehensive Summary of Demographic, Ultrasonographic, Intraoperative, and Diagnostic Outcomes in the Study Population (n = 50)**

Domain	Variable / Parameter	Category Outcome	n (%) / Value
<b>Demographic profile</b>	Age (years)	Mean ± SD	44.6 ± 11.2
	Age group	≤40 years	19 (38.0)
		>40 years	31 (62.0)
	Sex	Male	28 (56.0)
Female		22 (44.0)	
<b>Preoperative ultrasonographic parameters</b>	Gallbladder wall thickness	≤4 mm	32 (64.0)
		>4 mm	18 (36.0)
	Gallbladder size	Contracted (<5 cm)	30 (60.0)
		Distended (≥5 cm)	20 (40.0)
	Stone mobility	Mobile	41 (82.0)
		Impacted	9 (18.0)
	Number of stones	Single	21 (42.0)
		Multiple	29 (58.0)
	CBD diameter	<6 mm	34 (68.0)
		≥6 mm	16 (32.0)
Pericholecystic fluid	Present	8 (16.0)	
	Absent	42 (84.0)	
Liver span	≤15.5 cm	33 (66.0)	
	>15.5 cm	17 (34.0)	
<b>Ultrasound scoring distribution</b>	Ultrasound score	≤5 (Predicted easy LC)	33 (66.0)
		>5 (Predicted difficult LC)	17 (34.0)
<b>Intraoperative difficulty parameters</b>	Operative time	>60 minutes	15 (30.0)
	Adhesions	Dense pericholecystic adhesions	14 (28.0)
	Calot's triangle	Difficult / frozen	12 (24.0)
	Gallbladder perforation	Bile/stone spillage	10 (20.0)
	Bleeding	Obscured operative field	8 (16.0)
		Injury	Bile duct / arterial injury
Anatomy		Abnormal biliary anatomy	4 (8.0)
Gallbladder position		Buried / intrahepatic	3 (6.0)
Conversion		Conversion to open	4 (8.0)

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<b>Final surgical classification</b>	Laparoscopic cholecystectomy	Easy	34 (68.0)
		Difficult	16 (32.0)
<b>Correlation: ultrasound score vs difficulty</b>	Score >5	Difficult LC	13
		Easy LC	4
	Score ≤5	Difficult LC	3
		Easy LC	30
<b>Diagnostic accuracy of USG score</b>	Sensitivity	81.3%	
	Specificity	88.2%	
	Positive predictive value	76.5%	
	Negative predictive value	90.9%	
	Overall accuracy	86.0%	
<b>USG parameters significantly associated with difficult LC</b>	GB wall thickness >4 mm	0.004	
	Distended gallbladder	0.031	
	Impacted stone	0.012	
	Dilated CBD (≥6 mm)	0.021	
	Pericholecystic fluid	0.412	
	Multiple stones	0.367	
	Liver span >15.5 cm	0.589	

## DISCUSSION

The present prospective observational study evaluated the preoperative prediction of difficult laparoscopic cholecystectomy (LC) using an ultrasound scoring system, finding a strong correlation between higher ultrasound scores and intraoperative difficulty, with a diagnostic accuracy of 86%. These findings align closely with prior research that supports the use of ultrasonography as a reliable, noninvasive method for anticipating surgical challenges in LC.

The current study observed that gallbladder (GB) wall thickness >4 mm, distended GB, impacted stones, and dilated common bile duct (CBD ≥6 mm) were significantly associated with difficult LC ( $p < 0.05$ ). Similar parameters have been consistently identified as significant predictors in prior studies. In a large retrospective study by Siddiqui and Rizvi, the standardized ultrasound-based scoring system demonstrated that distended GB, thickened GB wall, impacted stones, and dilated CBD were the most statistically significant predictors, with a cutoff score of >5 yielding sensitivity of 80.7% and specificity of 91.7% (Siddiqui & Rizvi, 2017) [11]. The similarity in predictive parameters and diagnostic accuracy between their study and the present one reinforces the robustness of these sonographic indicators.

A 2024 study by Abduljaleel and Thabit reported that gallbladder wall thickening >3 mm and the presence of pericholecystic fluid were highly correlated with difficult LC, with sensitivities of 83.3% and 100%, respectively [12]. Our study similarly found pericholecystic fluid to be more frequent among difficult cases, though the suggestion did not reach statistical significance, probably due to its lower prevalence in elective rather than acute settings. Nevertheless, the consistency of GB wall thickness and impacted stones as independent predictors across studies strengthens their clinical value.

The diagnostic performance of the ultrasound scoring system in this study (sensitivity 81.3%, specificity 88.2%) compares favorably with prior models. The study by Stanley et al. (2023) reported a positive predictive value of 91% and found that cases predicted as “easy” preoperatively were never converted to open cholecystectomy, emphasizing the reliability of ultrasound-based risk stratification (Stanley et al., 2023) [13]. Similarly, Trehan and Mangotra (2023) validated the Randhawa and Pujahari scoring system, achieving a diagnostic accuracy of 93% with comparable sensitivity (82.6%) and specificity (63.5%) (Trehan & Mangotra, 2023) [14]. These findings collectively affirm the diagnostic efficiency of preoperative ultrasound scoring for predicting intraoperative difficulty.

Further, the present study’s observation that 32% of cases were classified as difficult LC mirrors results from multiple earlier studies, where the prevalence of difficult cases ranged from 25–35%. For instance, Banger and Bansal (2025) found a similar sensitivity (81.8%) and specificity (92.8%) when applying the Randhawa scoring model, confirming that around onethird of laparoscopic cases pose significant technical challenges (Banger & Bansal, 2025) [15].

Recent literature has also reinforced ultrasonographic predictors as strong determinants of operative complexity. A systematic review by Algahiny (2025) summarized that GB wall thickness remains the single most reliable sonographic parameter, with impacted stones and abnormal GB size (contracted or distended) serving as key supplementary predictors (Algahiny, 2025). This conclusion is consistent with the statistically significant associations found in our study [16].

In summary, the findings of this study corroborate earlier evidence suggesting that preoperative ultrasound scoring effectively predicts difficult laparoscopic cholecystectomy. Key predictors, including gallbladder wall thickening, distension, impacted stones, and CBD

dilatation, demonstrate high predictive value and reproducibility across diverse patient populations. The diagnostic performance metrics in our study (accuracy 86%) align with those of previous investigations, confirming the reliability and clinical utility of ultrasound-based scoring systems in preoperative surgical planning.

#### CONCLUSION

This prospective observational study demonstrates that a standardized preoperative ultrasound-based scoring system is an effective and reliable tool for predicting difficult laparoscopic cholecystectomy. A strong correlation was observed between higher ultrasound scores and increased intraoperative difficulty, with good diagnostic accuracy, sensitivity, and specificity. Gallbladder wall thickening, gallbladder distension, impacted stones, and common bile duct dilatation emerged as the most consistent and clinically significant predictors of difficult surgery. The findings closely parallel existing literature, reinforcing the reproducibility and robustness of these sonographic parameters. Incorporation of ultrasound scoring into routine preoperative assessment can enhance surgical planning, optimize resource utilization, facilitate informed patient counseling, and potentially reduce complications and unplanned conversions to open cholecystectomy.

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