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RESEARCH **Open Access**

Diagnostic Test of Randhawa Preoperative Scoring System in Predicting Laparoscopic Cholecystectomy Difficulty

Andreas[1a*], Muhammad Yusuf[1b], Ferry Erdani[1c], Imam Hidayat[1d], Muntadhar Muhammad Isa[1e]

[1] Department of Surgery, Faculty of Medicine, Universitas Syiah Kuala, Aceh, Indonesia

[a] Email address: andreas.hadinata@gmail.com
[b] Email address: yusufmuhammad@usk.ac.id
[c] Email address: ferryerdani@yahoo.com
[d] Email address: imam.hidayat@usk.ac.id
[e] Email address: muntadhar@unsyiah.ac.id

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Abstract

Despite its minimally invasive nature, laparoscopic cholecystectomy carries inherent risks of complications and unplanned conversions to open procedures. Scoring systems, such as the one developed by Randhawa and Pujahari, are used to assess this risk preoperatively. While the Randhawa scoring system shows great performance in the original study, external validation is essential before it can be widely implemented. To address this, we conducted a study with a cross-sectional analytical design where all data prospectively collected to externally validate the diagnostic value of the Rhandawa scoring system in predicting laparoscopic cholecystectomy difficulty. Using consecutive sampling, this study was conducted at the Dr. Zainoel Abidin General Hospital surgical ward and operating theatre between August and December 2025. Patients were evaluated preoperatively one day prior to surgery using the Randhawa scoring system, and intraoperative data, including duration, complications, and conversion, were recorded. Surgical difficulty was classified as easy, difficult, or very difficult based on these findings. Bivariate and multivariate analyses were performed to identify risk factors in the scoring system that were significantly associated with laparoscopic cholecystectomy difficulty. The area under the ROC curve (AUC) was calculated to assess the diagnostic performance of the scoring system, along with sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV). A history of hospitalization for acute cholecystitis was found to be significantly associated with laparoscopic cholecystectomy difficulty in both bivariate ($p = 0.009$) and multivariate (OR 4.85; 95% CI: 1.52–15.40; $p = 0.007$) analyses. The preoperative score and laparoscopic cholecystectomy difficulties were found to be significantly associated ($p < 0.05$). Our findings also demonstrated that the Randhawa preoperative scoring system demonstrated good diagnostic accuracy with an AUC of 0.836. Using a cutoff threshold of ≤5 and >5, the scoring system yielded 56.25% (95% CI: 29.88%–80.25%) sensitivity, 87.5% (95% CI: 67.64%–97.34%) specificity, 75% (95% CI: 57.80%–87.88%) accuracy, 75% (95% CI: 48.11%–90.73%) PPV, and 70% (95% CI: 63.80%–83.66%) NPV. We concluded that the Randhawa preoperative scoring system is reliable and beneficial in predicting laparoscopic cholecystectomy difficulty. Furthermore, we suggest for subsequent multicenter validation with larger patient samples.

Keywords: *cholelithiasis; acute cholecystitis; laparoscopic cholecystectomy; diagnostic accuracy, external validation.*

Corresponding Author:

Muhammad Yusuf
Department of Medical Laboratory Technology, Poltekkes Kemenkes Yogyakarta, Yogyakarta, Indonesia
Email: yusufmuhammad@usk.ac.id

1. INTRODUCTION

The worldwide prevalence of cholelithiasis is estimated to range from 5.5% to 6.7%, with variations largely attributable to differences in diagnostic criteria across studies (Wang et al., 2024). It reached 10-15% in developed countries and 3-10% in Asian countries (Damayanti et al., 2025). The incidence is higher in females, reaching 15.4% in Indonesia, according to the 2018 Indonesian research data (Biantara et al., 2023).

Laparoscopic cholecystectomy has been the gold standard therapy since the 1980s (Farhangmehr & Menzies, 2020). According to The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), indications for laparoscopic cholecystectomy include symptomatic cholelithiasis, biliary dyskinesia, acute cholecystitis, and complications arising from choledocholithiasis (Fisher et al., 2022). For the majority of acute cholecystitis cases, it provides superior postoperative results compared to open surgery (Ashok & Kumar, 2023). It is also preferred over open cholecystectomy due to its superior cost-effectiveness (Javid et al., 2018). However, this procedure still carries a 0.5–6% risk of complications, including common bile duct (CBD) and major vascular injuries, as well as gallbladder perforation with an incidence of up to 30% (Radunovic et al., 2016). Furthermore, the procedure carries a 1–15% probability of conversion to open cholecystectomy, which may lead to increased operative duration, higher complication rates, and prolonged hospital stay (Nassar et al., 2022). Beyond immediate surgical risks, long-term outcomes must also be considered; approximately 10% of patients experience persistent biliary-like symptoms after the procedure, a clinical entity recognized as post-cholecystectomy syndrome (Jebakumar et al., 2024).

The authors emphasize that the risks of intraoperative complications and the potential for conversion to open cholecystectomy must be predicted and clearly communicated to patients during preoperative counselling. Such prognostic assessments are essential for optimizing patient care by determining the most appropriate surgical strategy and whether to proceed with the laparoscopic approach, select primary open cholecystectomy, or refer the patient to a more experienced surgeon (Raza & Rajeev, 2019). Beyond the clinical benefits for the patient, medical practitioners must also predict the likelihood of complications and the potential for conversion to open cholecystectomy as a measure of professional self-protection. This necessity is underscored by Article 351 of the Indonesian Penal Code (known as Kitab Undang-Undang Hukum Pidana or KUHP), which stipulates that if a physician causes physical harm to a patient in the absence of valid informed consent, such action may be legally construed as a form of assault or maltreatment (Filia et al., 2019). Furthermore, this also assists hospital management in planning and predicting patient admissions and bed availability more effectively (Philip & Anjarbeedu, 2023).

In view of the aforementioned factors, it is concluded that predicting complications and the risk of conversion from laparoscopic to open cholecystectomy is of paramount importance.

One established method is using the scoring system developed by Randhawa and Pujahari, as a preoperative prognostic model. The Randhawa preoperative scoring system classified the surgical difficulties of the patients preoperatively into easy, difficult, and very difficult categories based on patient's characteristics, patient's history, clinical examination and ultrasonographic findings, which were subsequently compared against intraoperative findings—including operative duration, bile or stone spillage, cystic artery or duct injury, and conversion to open surgery—recorded and categorized using the same criteria (Randhawa & Pujahari, 2009). This original study found the following results: positive predictive value (PPV) of 88.8% for easy cases and 92.2% for difficult cases (Randhawa & Pujahari, 2009). At a cutoff score of 5, the model achieved a sensitivity of 75.00% and a specificity of 90.24% (Randhawa & Pujahari, 2009). Univariate and multivariate analyses of this original study then found several statistically significant predictors for laparoscopic cholecystectomy difficulty: BMI >27.5 kg/m² ($p>0.010$), a palpable gallbladder ($p>0.022$), previous hospitalization, and gallbladder wall thickness >4 mm on sonography (p=0.038) (Randhawa & Pujahari, 2009). Finally, this study also found an area under the ROC curve of 0.82, with a 95% confidence interval (Randhawa & Pujahari, 2009).

Beyond preoperative scoring, other validated instruments such as the G10 severity score utilize intraoperative findings to assess surgical difficulty, specifically

gallbladder appearance, gallbladder distension/contraction, obstacle for surgical access, evidence of sepsis and complications (Sugrue et al., 2019). The authors argue that the G10 scoring system is less than ideal as it assesses surgical difficulty at the intraoperative period rather than in the preoperative period. Consequently, G10 severity score unable to facilitated informed consent and selecting the most appropriate surgical strategy at the preoperative period.

While prediction models often demonstrate superior performance within their initial development datasets, external validation remains essential to ensure their accuracy and reliability are maintained when applied to independent patient populations (Collins et al., 2024; Ramspek et al., 2021). Theoretically, When a prediction model applied to a new patient population, it may introduce variations that impact performance level of a prediction model including factors such as patients from different regions or countries (geographic transportability), different care settings, and varying underlying disease and more or less advanced in their diseases (spectrum transportability) (Ramspek et al., 2021; Steyerberg, 2019). Furthermore, when a prediction model is found adequate by independent investigators in different specific settings, this will be considered more convincing than the results from the original study (Steyerberg, 2019). Thus, this study was conducted to externally validate the diagnostic value of the Randhawa scoring system in predicting laparoscopic cholecystectomy difficulty.

2. RESEARCH METHOD

The study design was a cross-sectional analytical study with all data was prospectively collected. The enrollment criteria for this study targeted adult patients diagnosed with symptomatic gallbladder disorders, specifically cholelithiasis and cholecystitis, who had been officially scheduled for elective laparoscopic cholecystectomy. Patients presenting with cholelithiasis and cholecystitis were selected, as these conditions constitute the most prevalent clinical indications for laparoscopic cholecystectomy. Consequently, this cohort is expected to serve as a representative sample of the broader patient population.

To ensure the statistical validity and power of the results, the required sample size was precisely calculated using standardized formulas for diagnostic accuracy studies, with particular emphasis on the descriptive Area Under the Curve (AUC) methodology. This method was chosen to create a strong framework for evaluating how well the scoring system works in the specific clinical population being studied. This calculation indicates that a total sample size of 36 subjects is required for this study, comprising 8 subjects expected to undergo a difficult procedure and 28 subjects expected to undergo an uncomplicated laparoscopic cholecystectomy.

The recruitment of study participants was conducted at the Dr. Zainoel Abidin General Hospital surgical ward and operating theater using a consecutive sampling method over five months from August to December 2025, ensuring a representative influx of clinical cases. A thorough preoperative assessment was conducted on patients in the surgical ward on the day before their scheduled surgery to collect essential clinical data. This assessment focused on the specific patient characteristics needed to fill in the variables of the scoring system, where the values assigned in square brackets represent the score for each criterion: patient's characteristics and history (age [≤ 50 years: 0; > 50 years: 1], sex [female: 0; male: 1], and history of hospitalization for acute cholecystitis [no: 0; yes: 4]), clinical examination (BMI [< 25: 0; 25–27.5: 1; > 27.5: 2], abdominal scar [none: 0; infra-umbilical: 1; supra-umbilical: 2], and palpable gallbladder [no: 0; yes: 1]), and ultrasonography findings (wall thickness [thin: 0; thick >4 mm: 2], pericholecystic collection [no: 0; yes: 1], and impacted stone [no: 0; yes: 1]). Through this proactive data collection, an accurate classification of patients' risks was enabled before surgery, ensuring that all prognostic indicators were carefully recorded before the procedure began.

The overall score was based on these preoperative data, which were then divided into three groups: easy (0–5), difficult (6–10), and very difficult (11–15). Information collected during the operation was also sorted into three groups based on the intra-operative findings: easy (operative duration < 60 min, no bile or stone spillage, and no injury to the duct or artery), difficult (operative duration 60–120 min, presence of bile or stone spillage, or injury to the duct, but with no conversion), and very difficult (operative duration > 120 min or the necessity for conversion to open surgery).

The data collected in this study are presented descriptively using a frequency table. The association between each variable in the scoring system and the difficulty level of laparoscopic cholecystectomy was analyzed using SPSS. Statistical significance was assessed using the chi-square test with a 95% confidence interval; p-values < 0.05 were considered significant. The Fisher's exact test with dummy variable (easy, difficult/very difficult) was employed as an alternative if the assumptions for the chi-square test were not met. Variables with p-values < 0.25 in the bivariate stage were selected as candidates for multivariate analysis using logistic regression to identify independent predictors.

The relationship between the Randhawa preoperative scoring values and laparoscopic cholecystectomy difficulty was evaluated using the chi-square test with a 95% confidence interval; p values < 0.05 were considered significant. Fisher's exact test was used as an alternative if the data did not meet the assumptions of the chi-square test. The AUC was used to assess the diagnostic performance of the preoperative score in predicting intraoperative outcomes, categorized into binary outcomes: easy and difficult. A 2x2 contingency table based on a preoperative score threshold of ≤5 and >5 was used to compute sensitivity, specificity, accuracy, PPV, and NPV.

The study was approved ethically on August 25, 2025, by the Dr Zainoel Abidin General Hospital Health Research Ethics Committee, with ethical clearance number: 281/ETIK-RSUDZA/2025. This approval process ensured the study adhered to ethical guidelines designed to protect each participant's welfare, rights, and dignity. Finally, this study follows the STARD (Standards for Reporting Diagnostic Accuracy Studies) guidelines for data reporting.

3. RESULTS AND DISCUSSION

The baseline clinical and demographic characteristics of the study population, along with their correlation to the laparoscopic cholecystectomy difficulty, are summarized in Table 1. From this Table 1, it can be seen that the study included 40 subjects, consisting of 23 patients (57.5%) aged < 50 years and 17 patients (42.5%) aged > 50 years. The subjects were predominantly female, consisting of 29 subjects (72.5%). Furthermore, this study found that subjects with excess body weight (BMI >25) accounted for 67.5% (n = 27), while those with a BMI <25 represented 32.5% (n = 13). Notably, Table 1 also illustrates the bivariate analysis of preoperative factors, which identifies a history of hospitalization for acute cholecystitis as the only variable with a statistically significant association with surgical difficulty (p = 0.009). Conversely, all other investigated factors, including age, sex, BMI, abdominal scar, palpable gallbladder, wall thickness, and impacted stones did not demonstrate a statistically significant correlation with the level of surgical difficulty (p > 0.05).

Table 1. Bivariate Analysis of Preoperative Factors Associated with Surgical Difficulty

Categories	Cholecystectomy Laparoscopy Difficulty			*p*-value (Fisher's Exact Test)
	Easy *n* (%)	Difficult *n* (%)	Very Difficult *n* (%)	
Age				
≤50 yrs	15 (65.2)	6 (26.1)	2 (8.7)	0.522
>50 yrs	9 (52.9)	5 (29.4)	3 (17.6)	
Sex				
Female	18 (62.1)	7 (24.1)	4 (13.8)	0.728
Male	6 (54.5)	4 (36.4)	1 (9.1)	
History of hospitalization for acute cholecystitis				
No	17 (81.0)	2 (9.5)	2 (9.5)	0.009
Yes	7 (36.8)	9 (47.4)	3 (15.8)	
Body Mass Index (BMI)				
<25	10 (76.9)	3 (23.1)	0 (0.0)	0.177
25-27,5	8 (53.3)	5 (33.3)	2 (13.3)	
>27,5	6 (50.0)	3 (25.0)	3 (25.0)	
Abdominal scar				
No	16 (61.5)	6 (32.1)	4 (15.4)	1.000
Infra-umbilical	8 (57.1)	5 (35.7)	1 (7.1)	
Supra-umbilical	-	-	-	
Palpable gallbladder				
No	20 (62.5)	9 (28.1)	3 (9.4)	0.690
Yes	4 (50.0)	2 (25.0)	2 (25.0)	
Wall thickness				
Thin	21 (63.6)	7 (21.2)	5 (15.2)	0.407
Thick > 4 mm	3 (42.9)	4 (57.1)	0 (0.0)	
Impacted stone				
No	24 (61.5)	11 (28.2)	4 (10.3)	0.400
Yes	0 (0.0)	0 (0.0)	1 (100.0)	

Building upon the bivariate analysis presented in Table 1, further statistical testing was conducted to identify the most significant predictors of surgical difficulty. Following the statistical protocol, not all preoperative variables were included in the final multivariate model. Only those demonstrating a p-value < 0.25 in the bivariate stage, specifically history of hospitalization and body mass index (BMI) were selected as candidates for the logistic regression analysis. The results of this multivariate logistic regression are summarized in Table 2. Our subsequent analyses confirmed that a history of hospitalization for acute cholecystitis was the sole risk factor with a statistically significant association with surgical difficulty (p = 0.007; OR = 4.85; 95% CI = 1.52–15.40). This finding highlights prior hospitalization as a critical indicator for preoperative risk stratification, enabling surgeons to anticipate technical challenges and optimize surgical planning.

Table 2. Multivariate Logistic Regression Analysis for Predicting Surgical Difficulty

Categories	Odds Ratio (OR)	95% CI	*p*-value
History of hospitalization for acute cholecystitis	4.85	1.52 – 15.40	0.007
BMI (25 – 27.5)	1.45	0.40 – 4.90	0.510
BMI (> 27.5)	2.10	0.80 – 5.20	0.112

Beyond the individual risk factors identified in the regression model, the cumulative impact of these variables was assessed using a standardized scoring system to predict overall surgical complexity, as illustrated in Table 3. Regarding preoperative scores, 28 subjects (70.0%) were categorized as easy, and 12 subjects (30.0%) as difficult. Notably, no subjects in this study fell into the very difficult category based on preoperative scores. Following the laparoscopic cholecystectomy procedure, intraoperative findings revealed that 60% of cases were categorized as easy, 27.5% as difficult, and 12.5% as very difficult. Among the subjects predicted as easy preoperatively, 21 of 28 (75%) were confirmed to have an easy based on intraoperative findings. Conversely, 9 of 12 subjects (75%) who were not categorized as easy preoperatively were categorized as difficult or very difficult based on intraoperative findings. Using Fisher's Exact test, the preoperative score and laparoscopic cholecystectomy difficulties were found to be significantly associated ($p < 0.05$).

Table 3. Association Between Preoperative Score and Intraoperative Difficulty in Laparoscopic Cholecystectomy

Preoperative Category	**Intra-operative Category**			
	Easy *n* (%)	Difficult *n* (%)	Very Difficult *n* (%)	Total *n* (%)
Easy (0-5)	21 (52.5)	4 (10.0)	3 (7.5)	28 (70.0)
Difficult (6-10)	3 (7.5)	7 (17.5)	2 (5.0)	12 (30,0)
Very Difficult (11-15)	-	-	-	-
Total, n (%)	24 (60)	11 (27,5)	5 (12,5)	40 (100)

The diagnostic value of the scoring system, based on the correlations established in Table 3, was further analyzed to determine its clinical utility. The diagnostic performance at preoperative cutoffs of ≤5 and >5 was 56.25% (95% CI: 29.88%–80.25%) sensitivity, 87.5% (95% CI: 67.64%–97.34%) specificity, 75% (95% CI: 57.80%–87.88%) accuracy, 75% (95% CI: 48.11%–90.73%) PPV, and 70% (95% CI: 63.80%–83.66%) NPV. Furthermore, the Randhawa scoring system demonstrated strong discriminative ability in predicting surgical difficulty, with an Area Under the Curve (AUC) of 0.836 (95% CI: 0.702–0.969), which is categorized as good diagnostic performance, as visualized in the ROC curve in Figure 1.

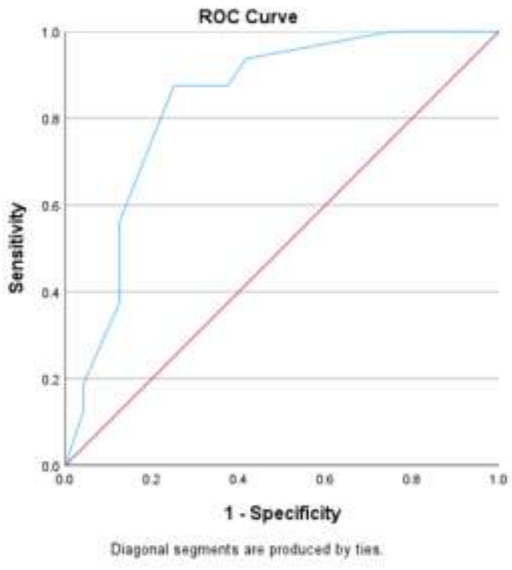

Figure 1 ROC curve for Randhawa scoring system

Reflecting the global obesity pandemic, the finding that over half of the subjects (57.5%) were aged <50 years aligns with the increasing prevalence of cholelithiasis in younger populations (Khan et al., 2026). The demographic and clinical profile of the subjects in this study remains highly consistent with the classic 4Fs mnemonic—Female, Fat, Forty, and Fertile—which has long summarized the primary risk factors for cholelithiasis (Aji et al., 2020). This alignment is clearly reflected in our findings, 72.5% of the subjects were female and 67.5% had excess body weight (BMI >25). Such a distribution reinforces the established literature across Indonesia, where hospital-based studies consistently report that females face a two- to three-fold higher risk of developing gallstones than males, with incidence rates rising sharply after the fourth decade of life (Anbiar et al., 2021; Febyan et al., 2017; Tuuk et al., 2016).

Consistent with the preoperative findings, where no cases were predicted as very difficult, the researchers attribute the absence of high-risk scores to the low prevalence of bad gallbladders within the study population. Bad gallbladder is defined as a complex surgical condition characterized by necrosis, gangrene, perforation, or Mirizzi syndrome, as well as extensive adhesions compromising anatomical visualization, a history of tube cholecystostomy, an operative duration exceeding 120 minutes, or the necessity for open conversion (Abdallah et al., 2025).

Laparoscopic cholecystectomy surgery is divided into two major parts: the dissection of Calot's triangle by identifying the cystic duct and cystic artery, and the separation of the gallbladder from the liver bed (Wei et al., 2024). Systemic inflammation, along with inflammation and fibrosis surrounding the gallbladder—particularly in proximity to Calot's triangle—are crucial factors in this (Tan & Lunevicius, 2024; Wei et al., 2024). Anatomical changes in this situation could result from hindered regenerative processes due to chronic inflammation, causing pathological extracellular matrix (Fakje et al., 2025). Our findings substantiate this challenge, identifying a history of hospitalization due to acute cholecystitis as the sole independent predictor of surgical difficulty (OR 4.85; 95% CI: 1.52–15.40; $p = 0.007$). This statistical robustness suggests that prior acute episodes likely lead to the severe fibrosis and adhesions described in previous literature (Agarwal et al., 2025).

In contrast to our findings, where a history of hospitalization was the sole independent predictor, the original study found significant associations were reported for BMI >27.5 kg/m² ($p<0.010$), history of hospitalization ($p<0.001$), a palpable gallbladder ($p<0.01$), and gallbladder wall thickness on ultrasonography ($p<0.038$) with laparoscopic cholecystectomy difficulty (Randhawa & Pujahari, 2009). A similar study identified that history of hospitalization ($p<0.001$), a palpable gallbladder ($p=0.01$), wall thickness ($p<0.05$) and BMI >27.5 kg/m² ($p<0.05$) were statistically significantly associated with laparoscopic cholecystectomy difficulty (Mahanta et al., 2025). The researchers suggest that the discrepancies in these findings may be attributed to differences in prevalence, epidemiology, sample size, and operator experience. Several factors may account for these discrepancies. First, surgeon experience and institutional settings may differ; advancements in laparoscopic techniques and equipment since 2009 might have mitigated the impact of factors like BMI or wall thickness on perceived surgical difficulty in our cohort. Second, patient demographics such as the mean BMI and the severity of inflammation at presentation might vary. Our study population may have had a lower prevalence of extreme obesity or acutely inflamed gallbladders compared to the original study, potentially diluting the statistical significance of these variables.

The predominance of the easy category in our study was consistent with the original article on the Randhawa scoring system, which reported difficulty levels of easy (71.9%), difficult (23.7%), and very difficult (4.4%) (Randhawa & Pujahari, 2009). This consistency suggests that the scoring system remains robust when applied to a standard clinical population. In contrast, a study conducted by Tongyoo et al., which utilized a modification of this scoring system but maintained similar difficulty categories, reported different results; they found a predominance of the difficult category (59.2%), followed by the easy (25.7%) and very difficult (15.1%) categories (Tongyoo et al., 2021). These variations may be attributed to differences in institutional settings or more complex patient presentations. Furthermore, the discrepancies in preoperative data between various studies underscore the robustness and adaptability of the scoring system, demonstrating its ability to yield consistent and clinically relevant results across diverse institutional settings with varying patient profiles.

From a diagnostic perspective, the performance of the Randhawa system in this study provides critical insights into its clinical utility. The high specificity (87.5%) observed in our study indicates that the Randhawa scoring system is highly effective at ruling in surgical difficulty; a score above the cutoff of 5 strongly correlates with actual intraoperative challenges. Conversely, the lower sensitivity (56.25%) suggests a higher rate of false negatives, with some cases predicted to be easy preoperatively still encountering intraoperative difficulties. Clinically, this implies that while a high preoperative score is a reliable warning for surgeons to prepare for a complex procedure, a low score should not lead to complacency, as it may under-predict the actual surgical complexity in a subset of patients.

The discriminative power of the Randhawa system in this study, reflected by an AUC of 0.836, aligns closely with the original study on the Randhawa scoring system, which reported an Area Under the Curve (AUC) of 0.820 (Randhawa & Pujahari, 2009). A higher predictive accuracy was reported in a study by Ahmed et al., which achieved an AUC value of 0.948 (Ahmed et al., 2025). The discrepancy in the Area Under the Curve (AUC) between this study (0.836) and the results reported by Ahmed et al. (0.948) may be primarily attributed to differences in sample size and population characteristics. In contrast, in general, the difference between reported and true accuracy decreases as sample size increases (Valverde, 2020). Furthermore, the Area Under the Curve (AUC) tends to be more stable and higher as the sample size increases, allowing for a more comprehensive representation of clinical variance (Pookhao et al., 2014).

Several limitations of this study must be acknowledged. This was a single-centre study conducted at Dr Zainoel Abidin General Hospital, which may limit the generalizability of the results to other healthcare settings. The small sample size (n=40) compared to the original study may have reduced the statistical power to detect significance in certain variables. Consequently, some categories within our variables had extremely low frequencies, resulting in wide confidence intervals in the multivariate analysis. This indicates a degree of instability in the point estimates, and as such, these results should be interpreted with caution. Additionally, there is a potential for observer bias, as the assessment of surgical difficulty remains somewhat subjective. Future multicentre studies with larger cohorts are recommended to validate these findings and provide more precise risk estimates.

Nevertheless, despite the aforementioned limitations, this study's findings offer several practical applications for surgical management. The scoring system can serve as a triage tool for operating room scheduling, enabling better time allocation for predicted difficult cases and preventing elective list overruns. Furthermore, it can guide consultant involvement by ensuring that senior surgeons are present for high-risk cases to mitigate intraoperative complications. Finally, this tool is beneficial for patient counselling, providing a more objective basis for informed consent regarding the potential for prolonged surgery or conversion to open cholecystectomy.

4. CONCLUSION

The Randhawa preoperative scoring system demonstrated an Area Under the Curve (AUC) of 0.836, placing it in the good category. Consequently, this system is a reliable tool for predicting the difficulty level of laparoscopic cholecystectomy in our clinical setting; however, further multicenter validation with larger samples is recommended to confirm its broader applicability and precision.

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