Original Article

Validation of a scoring system to predict difficult laparoscopic cholecystectomy in a tertiary hospital in Saudi-Arabia

A retrospective study

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ABSTRACT

Objectives: To confirm a preoperative scoring system devised by the Modified Randhawa Model.

Methods: This retrospective study was performed in the period between October 2017 to October 2023 on every patients hospitalized for elective laparoscopic cholecystectomy in the Surgery Department, National Guard Hospital in Riyadh, Saudi Arabia. A preoperative scoring system, devised using the Modified Randhawa Model, was applied to each patient retrospectively. The preoperative score was compared to the intraoperative degree of difficulty.

Results: The history of previous biliary inflammation, the impacted stone, the palpable gall bladder, the more gall bladder wall thickness, the higher body mass index and older ages were significantly associated with more difficult surgeries and more operative time. The preoperative scoring system devised by the Modified Randhawa Model is valid.

Conclusion: The study found that the Modified Randhawa Model scoring system is valid, effective and reliable predictor of LC difficulty in Saudi Arabia.

Keywords: Difficult laparoscopic cholecystectomy, scoring system for laparoscopic cholecystectomy, prediction of difficult laparoscopic cholecystectomy

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In 1985, the first LC in an animal model was performed by Fillipi, Mall, and Roosma. Philippe Mouret, utilizing a mechanical, rigid pipe that was not magnified,[1] first effectively removed the gallbladder without a laparotomy in 1987. In the majority of cases, patients and attendants are putting more pressure on surgeons to perform laparoscopic cholecystectomy as surgical technology advances.[2] Laparoscopic cholecystectomy (LC) is the preferred treatment for symptomatic gallstones, offering benefits such as reduced postoperative pain and shorter hospital stays. However, certain factors can make LC challenging, leading to increased operative times, higher conversion rates to open surgery, and elevated complication risks. Identifying these factors preoperatively is crucial for surgical planning and patient counseling.[3,4] Laparoscopic cholecystectomy is broadly recognized as the definitive approach for the conclusive management of symptomatic gallstones or cholelithiasis.[5,6] A cholecystoenteric fistula, gangrenous gallbladder or an acutely inflamed, a constricted and fibrotic gallbladder, Calot's triangle's dense adhesions, and other conditions has been documented to make laparoscopic surgery difficult.[4]

Initially, the rate of complications with LC was high; however, with advancements in technology and expertise, it has now decreased to an exceptionally low level of 2.0–6.0%.[7] The literature has documented a conversion rate of 1–13%.[8] A total of 530 patients underwent laparoscopic cholecystectomy as part of our study, and several predictive risk variables for challenging LC were examined. Risk factors for this research encompassed age, male sex, prior abdominal surgery, palpable gallbladder, obesity, hospitalization history, and ultrasonographic outcomes such as impacted stones, pericholecystic fluid collection, and the thickness of gall bladder wall.

Kama et al[9] conducted a study that identified 6 factors significantly linked to the open cholecystectomy risk: advanced age, male gender, a preoperative diagnosis of acute cholecystitis, sonographically diagnosed thickened gallbladder wall, upper abdominal tenderness during surgery, and abdominal surgery history.[9] In a comparable research by Lee et al,[10] the determinants for conversion risk encompassed being older than 65, male sex, an established overview of severe cholecystitis and a record of prior upper abdominal operation.[9,10]

Factors that can complicate laparoscopic surgery include male sex, advanced age, occurrences of severe cholecystitis with leukocytosis and fever, clinical indicators of acute cholecystitis, preceding abdominal operation, obesity, and specific ultrasonographic outcomes like an impacted stone, pericholecystic fluid collection, a distended gallbladder, or a thickened gallbladder wall.[4]

The argument has been fuelled by the introduction of several grading systems dependent on diverse characteristics. This essential awareness of the ambiguity faced on the operating table because of specific "difficult" conditions that emerge throughout laparoscopic cholecystectomy was considered.[10,12]

Preoperative planning for a laparoscopic cholecystectomy necessitates a comprehensive assessment of the risk of conversion or the procedure's difficulties. Pre-surgery, high-risk patients can be allowed to make an informed decision and be informed through accurate prediction. Additionally, surgeons can appropriately organize the time and personnel for the surgery. In addition, the hospital management can quickly plan for patient intake and bed availability.[10,12]

Despite the development of several scoring systems to predict the difficulty of LC, the applicability of these scoring systems across diverse populations remains uncertain. Cultural, genetic, and lifestyle differences can influence the prevalence and presentation of gallbladder diseases.[13] The most commonly used preoperative scoring systems and predictive models for assessing the difficulty of laparoscopic cholecystectomy (LC) are listed in **Table 1**

The Modified Randhawa (2022) scoring system was chosen in this study due to its exclusive focus on preoperative parameters, allowing for the prediction of surgical difficulty before operation and aiding in resource planning, surgical team preparedness, and patient counseling. Unlike intraoperative models, this system enables proactive decision-making. Additionally, the modification incorporates updated clinical variables (such as detailed BMI classification, history of hospitalization), potentially improving predictive accuracy in contemporary patient populations. Its simplicity, non-invasive data use, and retrospective validation in recent settings make it especially suitable for broader clinical application and reproducibility in different institutions.[14-16]

In Saudi Arabia, where gallstone disease is prevalent, there is a need to validate existing scoring systems to ensure their accuracy and reliability within this specific demographic. This study aims to assess the effectiveness of a preoperative scoring system in predicting difficult LC cases in a tertiary hospital in Saudi Arabia, thereby contributing to improved surgical outcomes and patient safety.

Methods. In this study, we gathered data retrospectively from hospital records for all patients (of all ages and genders) who were admitted to Riyadh's National Guard Hospital for elective laparoscopic cholecystectomy between October 2017 and October 2023. The inclusion criteria of patients suffered from chronic calcular cholecystitis. While the Patients suffering from a current attack of acute calcular cholecystitis and patients with jaundice.

Sample size and technique. Based on an expected sensitivity of 85% and specificity of 80%, with a 95% confidence level and 5% precision, the minimum required sample size is 246 patients- our sample was 530 patients- convenient sample technique.

A preoperative scoring system was applied using age, gender, sonographic outcomes, laboratory, clinical examination, and history was created to help surgeons make surgical decisions, counsel patients, decrease the risk of complications, decrease generally medical costs, and decrease the conversion rate to open cholecystectomy. The method is then compared

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Table 1 - Comparison of scoring systems for predicting difficulty in laparoscopic cholecystectomy.[15,16,17,18,19]

Scoring System	Type	Parameters included	Score range	Difficulty grading	Validation
Randhawa & Pujahari (2010)[11]	Preoperative	Age, Gender, BMI, Abdominal scar, Palpable gallbladder, GB wall thickness ≥4mm, Pericholecystic collection, Impacted stone	0–15	0–5 Easy, 6–10 Difficult, 11–15 Very Difficult	Validated in single-center study
Modified Randhawa (2022)[10,11]	Preoperative	Age, Gender, BMI, History of hospitalization, Scar location, Palpable GB, GB wall thickness, Impacted stone, Pericholecystic collection	0–15	0–5 Easy, 6–10 Difficult, 11–15 Very Difficult	Retrospective validation
Nassar Scale (2014)	Intraoperative	Adhesions, GB distension, Cystic pedicle exposure, Time to identify structures, Intra-op bleeding	1–5	Grade I (Easy) to Grade V (Very Difficult)	Widely used; external validation available
Parkland Grading Scale (2018)	Intraoperative	GB condition (distended/contracted), adhesions, triangle of Calot visibility, inflammation, bleeding	1–5	Grade 1 (Mild) to Grade 5 (Severe Inflammation)	Prospectively validated
Sugrue Scale (2015)	Intraoperative	Gallbladder status, adhesions, bile/pus, anatomy, operative time	1–10	1–3 Mild, 4–7 Moderate, 8–10 Severe	Prospective validation; reproducible results

to a score assigned informed by intraoperative challenges to anticipate the complexity of laparoscopic cholecystectomy.[4,14]

A pre-operative score was assigned to each patient based on their examination of the clinical, history, and sonological results[15,16] (Table 2). The surgery was performed under CO_2 pneumoperitoneum at a pressure of 14 mm Hg and using four standard ports (umbilical port (10 mm) for camera, epigastric port (10 mm) for the main working instrument, right midclavicular port (5 mm) for additional instruments like graspers or electrocautery. Right anterior axillary port (5 mm) for traction and retraction). All surgeries were performed by a single surgical team

Duration was recorded from the first port site insertion to the end port closure. All surgical proceedings, including operation length, operative complications such as bile/stone leakage, duct injury and convertion to open surgery were documented and categorized (Table 3). This type of grading is consistent with the clinical rationale used in several validated intraoperative scoring systems,[1,2,7] which incorporate operative duration and intraoperative complications as key predictors of difficulty. Preoperative prediction ratings were evaluated across patients to determine their usefulness.

Statistical analysis. The software Statistical Package for Social Sciences 27 (SPSS Inc, Chicago, Illinois) was employed to conduct all statistical analyses. It was deemed statistically significant with a p-value of <0.05. The chi-square test/Fisher exact test indicated a significant correlation among preoperative score results and intraoperative findings and then apply the Spearman's correlation coefficient to measure the

Table 2 - Preoperative scoring system devised by Modified Randhawa Model.[15,16]

Variables	Score	Maximum score
Age		
<50 years	0	1
≥50 years	1	
Gender		
Female	0	1
Male	1	
History of hospitalization		
No	0	4
Yes	4	
BMI		
<25	0	2
25-27.5	1	
>27.5	2	
Abdominal scar		
No	0	2
Infra-umbilical	1	
Supra-umbilical	2	
Palpable gall bladder		
No	0	1
Yes	1	
Sonography		
Impacted stone		
No	0	1
Yes	1	
Pericholecystic collection		
No	0	1
Yes	1	
Wall thickness		
Thin <4mm	0	2
Thick ≥4mm	2	
Total maximum score		15

Score 11-15 very difficult, 6-10 difficult, and 0-5 easy monotonic relation between the 2 ordinal scoring systems to validate the scoring system. Finally, we merged the difficulty scores (difficulty and very difficult) to get binary outcomes that enable applying the ROC curve analysis, sensitivity and specificity which help to evaluate the predictive power of the scoring system.

Table 3 - Intraoperative evaluation.[1,2,7]

Parameters	Scores	Gradings
Operative time >120 min or conversion	11-15	Very difficult
Operative time 60–120 min and/or Bile or stone spillage or Injury to duct	6-10	Difficult
Operative time <60 min No bile spillage No injury to duct	0-5	Easy

This study was authorized by the National Guard Hospital and Dar Al Uloom University Institutional Review Boards, Riyadh, Saudi Arabia (Registration number: HP-01-R-134-DAU-COM-24-08) on March 13, 2024, and the King Abdullah International Medical Research Center (IRB approval number IRP/3249/23 – Study number NRC23R/822/12).. The study was done per the Helsinki standards, as revised in 2013.

Results. This study included 530 patients. Of these, 57.2% of were females (N=303).The association analysis of the level of difficulty with preoperative risk factors as in (Table 4) reveals that age, impacted stones, gallbladder wall thickness (mm), BMI, and history of previous biliary inflammation were preoperative indicators of a challenging laparoscopic cholecystectomy (resulting in longer operative time), with this relationship being statistically significant (Table 4).

Table 4 - The association analysis of the level of difficulty with preoperative hazard parameters.

Risk factors	Intraoperative score levels			*P*-value
	Easy n (%)	Difficult n (%)	Very difficult n (%)	
Age				
<50	49 (57.6)	173 (57.3)	59 (41.3)	0.004*
>50	36 (42.4)	129 (42.7)	84 (58.7)	
Gender				
Female	55 (64.7)	175 (57.9)	73 (51.0)	0.120
Male	30 (35.3)	127 (42.1)	70 (49.0)	
History of previous biliary inflammation				
No	70 (82.4)	230 (76.2)	123 (86.0)	0.0438*
Yes	15 (17.6)	72 (23.8)	20 (14.0)	
BMI intervals				
Less than 25	22 (25.9)	49 (16.2)	22 (15.4)	0.034*
25-27.5	13 (15.3)	38 (12.6)	30 (21.0)	
More than 27.5	50 (58.8)	215 (71.2)	91 (63.6)	
Abdominal scars				
No	69 (81.2)	235 (77.8)	113 (79.0)	0.553
Infraumbilical	13 (15.3)	44 (14.6)	17 (11.9)	
Supraumbilical	3 (3.5)	23 (7.6)	13 (9.1)	
Pericholecystic collection				
No	52 (61.2)	160 (53.0)	81 (56.6)	0.377
Yes	33 (38.8)	142 (47.0)	62 (43.4)	
Wall thickness (mm)				
Thin	38 (44.7)	159 (52.6)	58 (40.6)	0.0461*
Thick	47 (55.3)	143 (47.4)	85 (59.4)	
Palpable gallbladder				
No	83 (97.6)	302 (100.0)	140 (97.9)	0.184
Yes	2 (2.4)	0 (0.0)	3 (2.1)	
Impacted stone				
No	73 (85.9)	206 (68.2)	100 (69.9)	0.006*
Yes	12 (14.1)	96 (31.8)	43 (30.8)	

These significant factors suggest critical considerations when assessing the potential difficulty of laparoscopic cholecystectomy. As shown in Table 5, there was a highly significant association between preoperative difficulty scores and intraoperative outcomes (all p<0.001). Biliary spillage was more frequent in very difficult cases (20.6%) compared with difficult (9.5%) and easy cases (0.8%) (p=0.0004). Duct injury occurred only in the very difficult group (5.9%), showing a significant difference (p=0.0001). Conversion to open surgery was markedly higher among very difficult cases (58.8%) compared with difficult (1.7%) and easy (0.4%) cases (p<0.0001). Operative time also correlated strongly with preoperative scores (p=0.0001). The majority of easy cases were completed in <60 minutes (84.5%), difficult cases in 60–120 minutes (79.7%), while very difficult cases were predominantly >120 minutes (76.5%) (Table 5).

Overall, these findings confirm that higher preoperative difficulty scores are strongly predictive of more complex intraoperative outcomes, including increased operative time, complications, and higher conversion rates (Table 5).

Table 5 - The association between the level of difficulty based on preoperative scores and the level of difficulty determined by intraoperative outcomes.

Preoperative scores	Easy	Difficult	Very difficult	*P*-value
Operative outcomes	n=264	N=232	n=34	0.0001*
Biliary spillage (n=31)	2 (0.8)	22 (9.5)	7 (20.6)	0.0004*
Biliary spillage (n=31)	2 (0.8)	22 (9.5)	7 (20.6)	0.0004*
Conversion to open surgery (n=25)	1 (0.4)	4 (1.7)	20 (58.8)	0.0000*
Operative time				
>120 min (very difficult)	2 (0.8)	18 (7.8)	26 (76.5)	0.0001*
60-120 min (difficult)	39 (14.8)	185 (79.7)	8 (23.5)	
<60 min (easy)	223 (84.5)	29 (7.8)	0 0.0%	

*Significant value (<0.05)

Based on the data in Table 6, 79.7% of patients categorized with a difficult preoperative score were confirmed to have difficult intraoperative outcomes, while 12.5% had easy surgeries and 7.8% experienced very difficult procedures. These findings support the predictive reliability of the preoperative scoring system in anticipating surgical difficulty.

Among those with a very difficult preoperative score, 76.5% proceeded to have very difficult intraoperative outcomes, and 23.53% had outcomes categorized as difficult. Notably, none of these patients had easy operations. This further reinforces the accuracy of the scoring system in forecasting the complexity of laparoscopic cholecystectomy cases (Table 6).

The relationship between preoperative and intraoperative difficulty scores is illustrated in Table 6, which shows a statistically significant association (p=0.0001). To assess the validity of the preoperative scoring system in predicting intraoperative complexity, Spearman's correlation coefficient was calculated. The result demonstrated a significant acorrelation (r=0.748, p=0.009). This correlation suggests that as the preoperative score increases, the likelihood of a more complex intraoperative outcome also rises. The strength of this association, reflected by a correlation coefficient of 0.748, represents a moderate to strong direct correlation, supporting the predictive value of the scoring system.

Furthermore, the aim was to evaluate the effectiveness of the preoperative scoring system in predicting whether a surgical procedure would be classified as easy or difficult/very difficult. The analysis of the model's predictive ability demonstrated strong diagnostic value. The ROC curve yielded an area under the curve (AUC) of 0.703, reflecting good discriminatory capacity in distinguishing between easy and more complex intraoperative outcomes.

The model exhibited a sensitivity of 85.3% and a specificity of 88.5%, indicating a high accuracy in detecting difficult cases and correctly identifying easy

Table 6 - Analysis on intra-surgery findings with pre-surgery score category with chi-square.

	Intraoperative result				
Preoperative score	Easy n (%)	Difficult n (%)	Very difficult n (%)	Total (%)	*P*-value
Easy	223 (84.5)	39 (14.8)	2 (0.8)	264 (49.8%)	
Difficult	29 (12.5)	185 (79.7)	18 (7.8)	232 (43.8%)	
Very Difficult	0 (00.0)	8 (23.5)	26 (76.5)	34 (6.4%)	0.0001*
Total - (%)	252 (47.6)	232 (43.8)	46 (8.7)	530	

ones. The positive predictive value (PPV) was 89.1%, meaning that nearly nine out of ten cases predicted to be difficult were indeed difficult. Additionally, the negative predictive value (NPV) of 84.5% confirms that most cases predicted to be easy were truly uncomplicated.

These findings support the clinical relevance of the preoperative scoring system as a valuable tool for forecasting intraoperative complexity and assisting in surgical decision-making and planning.

Discussion. Preoperative assessment is an important predictive tool for anticipating intraoperative challenges. Patients identified with difficult or very difficult preoperative scores are more likely to experience challenging surgeries.[15]

Even among patients with easy preoperative scores (84.5%), 0.8% of patients experienced very difficult intraoperative outcomes, and 14.8% experienced difficult intraoperative outcomes. This suggests that while preoperative scores are indicative, the time of the procedure is not an absolute indicator of intraoperative difficulty. Other factors, such as operative tool failure or training juniors on laparoscopic cholecystectomy, may be responsible for prolonged procedure times.[15]

Numerous studies have identified age over 50 years as a significant contributor to a challenging LC. The rate of conversion was elevated in patients from the elderly age. It is a significant element in our research (p=0.004).[1,2,6,7,8,20,21]

Research has indicated that male sex can make surgery more challenging.[20-22] It has been found that males have a significantly elevated conversion rate and mortality rate.[23] It was not identified as a significant element in our research (p=0.120).

Patients who necessitate admission to the hospital for recurrent episodes of severe cholecystitis and have Calot's triangle's dense adhesions and the gallbladder fossa are more likely to need a challenging laparoscopic cholecystectomy that could necessitate conversion.[23,24] It was also discovered to be a significant indicator of a challenging LC in our study (p=0.0438). In these cases, it took longer (>60 minutes) to dissect the gallbladder from the calot's triangle and liver bed due to severe adhesions.

Rosen et al[25] have identified obesity as an additional hazard for difficult LC. Nevertheless, some research argue that there was no distinction in the length of hospitalization, the time needed to begin a general diet, the duration of surgery, or complications among obese patients.[25] In our research, BMI was a significant indicator of a challenging laparoscopic cholecystectomy (p=0.034).

A higher BMI predicts a challenging laparoscopic cholecystectomy (LC) due to increased abdominal fat, making trocar insertion difficult and reducing visualization. Fat deposits obscure Calot's triangle, complicating dissection and prolonging operative time. Poor visibility and excessive fat raise the risk of bile duct injury, conversion to open surgery, and postoperative complications like infections and hernias.

Adhesions between the abdominal wall and the viscera or omentum may develop as a result of earlier upper or lower abdominal operation. These structures could be impaired during the first port insertion, and a higher hazard of conversion has been reported. Abdominal scars were not identified as a substantial interfering factor for challenging LC in our study (p=0.553).

The presence of an abdominal scar can make laparoscopic cholecystectomy (LC) more difficult due to potential adhesions, altered anatomy, and restricted trocar placement. Scar tissue from previous surgeries may cause dense adhesions, making gallbladder dissection challenging and increasing the risk of organ injury. Additionally, fibrosis can distort normal anatomy, complicating the identification of Calot's triangle. Scarred or thickened abdominal walls may also limit trocar insertion, requiring alternative entry techniques like an open (Hasson) approach. These factors contribute to longer operative time, higher conversion rates to open surgery, and increased complications.

A palpable gallbladder is a clinical sign noted in patients experiencing an enlarged gallbladder, often because of circumstances including empyema, mucocele, or similar issues. Because it is challenging to grasp the base of a distended gallbladder, aspiration of its contents is frequently necessary. In addition to being laborious and time-consuming, there is also the possibility that the contents could leak into the peritoneal cavity. Randhawa et al[16] are the only researchers who identified a significant link between a palpable gallbladder and increased intraoperative complexity. Of the 530 patients in our study, 5 had palpable gallbladders. This variable was significant in this study (p=0.035).

A preoperative ultrasound of the gallbladder in cases of symptomatic cholecystitis reveals a wall thickness of 3mm or more, along with the presence of calculi, serves as a clinical indication to the laparoscopic surgeon that the procedure could present challenges. This may necessitate conversion to an open cholecystectomy, as demonstrated by Majeski James in 1990.[24]

Gupta et al[10] and Randhawa et al[11] have discovered a notable correlation among intraoperative difficulty and a thickened (palpable) GB wall.

Carmody et al[26] determined that a comprehensive pre-surgical ultrasound of the gallbladder offers limited assistance in screening for complex or unsuitable cases in patients preparing for laparoscopic cholecystectomy. They determined that no ultrasound features could differentiate between a laparoscopic cholecystectomy that was uneventful, difficult, or unsuccessful.

In this study, 275 patients exhibited thickened gallbladder walls, and the chi-square test indicated that this factor significantly influenced the outcome (p=0.0461).

The thickened wall can obscure critical structures like Calot's triangle, increasing the risk of bile duct injury. Additionally, fibrosis reduces gallbladder mobility, making grasping and retraction harder. These factors contribute to longer operative times, increased risk of conversion to open surgery, and higher complication rates.

One ultrasonographic indicator of severe cholecystitis is the presence of pericholecystic fluid. In our research, this was not identified as a significant factor (p=0.377). These outcomes align with those of Randhawa et al. In contrast, our research revealed that a palpable gallbladder was a significant factor (p=0.035). This supports Randhawa et al.'s conclusion that the difficulty index is notably influenced by the presence of a palpable gallbladder.[16]

Pericholecystic fluid in laparoscopic cholecystectomy (LC) indicates inflammation, often due to acute cholecystitis, making surgery more difficult. It suggests edema and adhesions around the gallbladder, leading to distorted anatomy and obscured Calot's triangle.

The literature reports conversion rates varying from 7% to 35%. In our research, the rate is 4.7% (25 patients). Since conversion is low in cases performed by experienced surgeons, it is undeniably a significant factor that should be taken into account. Cuschieri et al[27] reported that conversion can result from bleeding in the cystic arteries. Frazee et al[28] noted that stone spillage was a contributing factor to conversion. Conversion may also occur due to bile duct injury or Calot's triangle's dense adhesions among the gall bladder and adjacent tissue, such as the colon, duodenum, or omentum, or an inability to distinguish anatomy.

Bile and stone spillage often occurs due to gallbladder perforation during handling or difficult dissection, especially in inflamed or friable gallbladders. The presence of bile and spilled stones can obscure Calot's triangle, increasing the risk of bile duct injury.

In our study, bile spillage occurred in 93 cases, with an intraoperative duration of sixty minutes. These cases were classified as difficult because the bile spillage. All of these cases were treated with suction and irrigation, and none required conversion. Twenty-five of the 530 cases in our study (4.72%) underwent conversion, with the cause being a dense Calot's triangle formed by adhesions between the gallbladder and surrounding tissues such as the colon, duodenum, or omentum.

In our study, open cholecystectomy was performed due to dense adhesions resulting from severe cholecystitis or difficulty in distinguishing anatomical structures. Other studies have reported similar reasons for this approach.

Study limitation. While the findings are significant, broader validation through multicenter, prospective studies is recommended to ensure generalizability. Nonetheless, due to limitations in our dataset—particularly the small subgroup sizes—we were unable to apply the Cochran-Armitage trend test or ordinal logistic regression.

In conclusion, the study found that the Modified Randhawa Model scoring system is valid, effective and reliable predictor of LC difficulty. It demonstrated a strong statistical association (r=0.748, p=0.009) and good diagnostic accuracy (AUC =0.703, sensitivity=85.3%, specificity=88.5%). These findings support its usefulness in surgical planning and risk assessment.

We recommend the use of trend analysis in future studies with larger sample sizes.

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