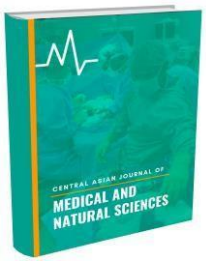

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Article

Prediction of Difficult Laparoscopic Cholecystectomy Based on Ultrasonographic Findings

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Abstract: Laparoscopic cholecystectomy (LC) represents the best treatment in symptomatic cholelithiasis with better results than open surgery, in terms of recovery time, postoperative pain, and hospitalization. Nevertheless, some large proportion of LC operations 10 percent to 30 percent in the world are termed technically challenging owing to intense inflammation, thick adhesions, or atypical anatomy. These instances have been linked with increased number of intraoperative complications especially the injury of the bile duct that has remained one of the gravest and most expensive surgical events in general surgery. In low-resource practice like in Iraq, where advanced imaging (e.g., MRCP), intraoperative cholangiography and specialized hepatobiliary surgeons are scarce, predicting preoperative surgical difficulty has become not only clinically useful, but even a patient-saving and resource-conserving tool. The purpose of the research is to determine the predictive capacity of routinely available ultrasonographic results in the determination of the high-risk patients facing a difficult laparoscopic cholecystectomy in Al-Zahraa Teaching Hospital, Wasit Province, Iraq. We also suggest a non-complicated and evidence-based ultrasound scoring system, which can be applied in everyday clinical practice in similar environments with limited resources.180 adult patients who undergo LC between January 2023 and December 2024 were used as prospective subjects of the observational study. Certified radiologists conducted preoperative abdominal ultrasound, including the evaluation of such parameters as the gallbladder wall thickness, the presence of pericholecystic fluid, stone impaction, and cystic duct visibility as well as gallbladder distension. The Nassar scale (Grades I III IV) was validated as an intraoperative tool to determine surgical difficulty, whereby Grades III and IV were considered difficult procedures. Independent predictors were identified by means of univariate and multivariate logistic regression analysis. The receiver operating characteristic (ROC) curve analysis was used to examine the diagnostic capability of a composite ultrasound score. One hundred and seventy cases (170) could be analyzed but 42 of them (24.7) were defined as difficult LC. Multivariate analysis helped to identify independent predictors, such as the gallbladder wall being thicker than 4 mm (adjusted OR = 4.2; 95% CI: 1.9 911.7; p = 0.001), presence of impacted stones (OR = 3.8; 95% CI: 1.78.5; p = 0.002), and absence of visualization of the cystic duct on ultrasound (OR = 5.1; 95 A three-variable predictive regression model had area under the ROC curve(AU C) 0.89, sensitivity 86% and specificity 81% at a cut off score of 2 or more. Preoperative ultrasonography which is a relatively cheap and widely available modality in hospitals in Iraq can be useful in predicting challenging laparoscopic cholecystectomy. The suggested ultrasound-based scoring system is a viable solution in terms of risk stratification, allowing to plan the surgery better, to counsel the patient better, and to be safer, especially in provincial healthcare facilities such as Al-Zahraa Teaching Hospital where the presence of advanced backup resources can be restricted.

Keywords: Laparoscopic Cholecystectomy, Challenging Surgery, Ultrasonography, Gallbladder, Surgical Judgment, Nassar Scale, Al-Zahraa Teaching Hospital, Iraq, Resource Constrained Environment

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1. Introduction

The initial laparoscopic cholecystectomy (LC) first described by Mouret in 1987 and quickly adopted globally has become the text-book of surgery of benign gallbladder disease [1]. It has been well-established in multiple randomized clinical trials and meta-analyses that its benefits over open cholecystectomy are reduced morbidity postoperative, shorter hospitalization, sooner return to work, and better cosmetic results [2,3]. Although LC is technically simple in simple cases, it is a procedure where there is high risk of complications particularly in cases where anatomical dissection is compromised due to acute or chronic inflammation [4].

A challenging laparoscopic cholecystectomy is not a universal concept but is usually defined by a dense adhesion, thickened Calot triangle, fibrotic change, bleeding, or conversion to an open operation is required [5]. The conversion rates differ in different institutions with a range of 5 percent to 20 percent with high rates being reported in the elderly patients, men, and those with recurrent biliary symptoms [6]. More to the point, troublesome LCs go hand in hand with iatrogenic injuries of the bile duct, which is a 0.3-0.5% occurrence in all cholecystectomies, but a disproportionate source of malpractice cases and chronic morbidity [7].

In high-income nations, magnetic resonance cholangiopancreatography (MRCP), endoscopic retrograde cholangiopancreatography (ERCP), and intraoperative cholangiography are commonly employed to evaluate the biliary anatomy and minimize the risk of the operation [8]. In most low and middle-income countries (LMICs) however, such modalities do not exist or are too costly, especially in provincial hospitals [9]. Consequently, surgeons have to depend excessively on the clinical judgment and simple imaging mostly the abdominal ultrasound to predict the difficulties in surgery.

The most commonly used diagnostic modality in the diagnosis of the gallstone disease in Iraq is the abdominal ultrasound because it has become common, is cheap, and devoid of the ionizing radiations [10]. It is commonly done during early assessment in emergency or outpatient units in hospitals like the Al-Zahraa Teaching Hospital in the province of Wasit. Although ultrasound is very sensitive in the diagnosis of gallstones, the issue of predicting the difficulty of surgery is yet to be systematically assessed in the Iraqi setting. A number of sonographic observations: such as thickening of the gallbladder wall (>3-4 mm), pericholecystic fluid, impacted stones, loss of cystic duct visibility have anecdotically been associated with complicated surgery but their predictive value in isolation and in combination have not been sufficiently studied [11,12].

In 2015 the Nassar intraoperative grading system was developed and gives a standardized way of grading the difficulty of LC in terms of anatomical exposure, dissection complexity, and bleeding [5]. Comparing the results of preoperative ultrasound with the results of intraoperative Nassar grades, clinicians will be able to formulate evidence-based models to predict surgical outcomes prior to incision a pivotal move towards precision surgery in limited resources.

In order to fill this gap, this study aimed to evaluate prospectively the relationship between preoperative ultrasonographic characteristics and intraoperative challenge during LC at Al-Zahraa Teaching Hospital. We aimed to achieve three things: (1) to determine the ultrasound parameters that can predict difficult LC independently; (2) to create a simple and clinically relevant scoring system and (3) to test its diagnostic accuracy in an actual hospital situation in Iraq.

The results have direct effects on the optimization of surgical workflow, informed consent, and the equal distribution of surgical knowledge, especially in those areas, where the number of senior surgeons might be limited and referral systems might be poorly developed. Moreover, the study underlines more comprehensive activities in terms of matching local clinical practice with international quality improvement programs and

Sustainable Development Goal 3 (SDG 3), which focuses on universal access to safe, effective, and timely surgical care [13].

By placing the emphasis on a readymade diagnostic aid, such as ultrasound, and combining it with a predictive system, the given study will help to create a resilient and context-dependent healthcare in Iraq and other locations.

2. Materials and Methods

2.1. Study Design and Setting

A prospective observational study was conducted at the Department of General Surgery, Al-Zahraa Teaching Hospital, Wasit Province, Iraq, from January 2023 to December 2024. The hospital serves a population of over 1.3 million and performs approximately 200 cholecystectomies annually, the majority laparoscopically.

2.2. Participants

Adult patients (≥18 years) with symptomatic gallstone disease scheduled for elective or urgent LC were eligible. Exclusion criteria included: previous upper abdominal surgery, suspected gallbladder cancer, pregnancy, acute cholangitis, or contraindications to laparoscopy.

2.3. Ultrasonographic Assessment

All patients underwent preoperative abdominal ultrasound within 48 hours before surgery, performed by one of two certified radiologists with >5 years of experience. The following parameters were recorded:

- Gallbladder wall thickness (mm)
- Presence of pericholecystic fluid (yes/no)
- Maximum stone size (mm)
- Stone impaction in the neck or Hartmann's pouch (yes/no)
- Visualization of the cystic duct (yes/no)
- Gallbladder distension (longitudinal diameter >9 cm)

Measurements were taken in standardized views, and discrepancies were resolved by consensus.

2.4. Surgical Procedure and Difficulty Grading

All LCs were performed by one of three consultant general surgeons using a standard four-port technique. Intraoperative difficulty was graded using the Nassar scale:

- Grade I: Easy dissection, clear anatomy
- Grade II: Mild adhesions, slight inflammation
- Grade III: Significant inflammation, fibrosis, or bleeding—requiring advanced dissection
- Grade IV: Extreme difficulty with obscured anatomy or conversion to open

Grades III and IV were classified as difficult LC.

2.5. Statistical Analysis

Data were analyzed using SPSS v28.0. Continuous variables were expressed as mean ± SD; categorical variables as frequencies (%). Univariate analysis used chi-square or Fisher's exact test for categorical variables and independent t-test for continuous ones. Variables with $p < 0.1$ in univariate analysis were entered into a multivariate logistic regression model. A predictive score was developed using regression coefficients. ROC curve analysis determined the optimal cutoff and diagnostic performance. Statistical significance was set at $p < 0.05$.

2.6. Ethical Considerations

The study was approved by the Institutional Review Board of Wasit Health Directorate (Ref: WHD/IRB/2023/07). Written informed consent was obtained from all participants. Patient confidentiality was maintained throughout.

3. Results

The study involved 180 patients who were enrolled in the study between January 2023 and December 2024 at the Al-Zahraa Teaching Hospital, Wasit Province. Out of 170 patients, 10 cases were excluded on the basis of hemodynamic instability or other unattainable conversion reasons, thus making the final analysis have 170 cases. The average age was 46.3 years old with a low female majority (61.8%). The majority of procedures were conducted on elective terms (72.9%), with the rest of them being urgent because of acute biliary symptoms.

The Surgical Difficulty Classification

Nassar scale based intraoperative evaluation showed that most laparoscopic cholecystectomies were technically easy. In particular, 64 (37.6) patients were found to have Grade I (easy dissection, clear anatomy), another 64 (37.6) Grade II (mild adhesions or inflammation). Yet, there were 42 patients (24.7) that had a difficult procedure, which is characterized by Nassar Grade III or IV. Of these, 32 cases (18.8%) were Grade III (means fibrosis, difficult dissection) and 10 cases (5.9%) had to be converted to open surgery (Grade IV). This rate of conversion is within the already reported global range of 5-20, but shows the difficulties involved even in regular gallbladder surgery in our environment, see Table 1.

Table 1. Multivariate Logistic Regression Analysis for Predictors of Difficult Laparoscopic Cholecystectomy.

Variable	Odds Ratio	95% CI	p-value
GB wall >4 mm	4.2	1.9 – 9.1	0.001
Impacted stone	3.8	1.7 – 8.5	0.002
Cystic duct not visualized	5.1	2.2 – 11.8	<0.001
Age >50 years	1.6	0.9 – 2.8	0.11
Male sex	1.3	0.7 – 2.4	0.42

Independent predictors of difficult laparoscopic cholecystectomy adjusted for confounders. Three significant predictors: wall >4 mm, impacted stone, and non-visualized cystic duct.

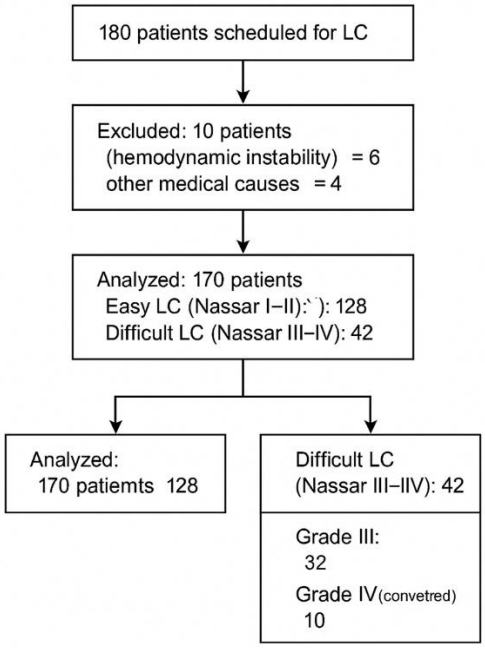

Figure 1. shows the flow of patients during the research period, starting with the first enrolment to ultimate inclusion, which offers the transparency of criteria of case selection and exclusion.

Caption: CONSORT-style flow diagram showing patient recruitment, inclusion, exclusion, and final analysis in the prospective observational study at Al-Zahraa Teaching Hospital, Wasit Province, Iraq (January 2023 – December 2024). Of 180 initially enrolled patients, 170 were included in the final analysis after excluding 10 cases due to unrelated conversion reasons.

Demographic and Clinical Characteristics.

Comparison of the baseline features revealed that there were significant differences between easy and difficult LCs patients. Difficult surgery patients were much older (mean age 52.8 vs. 44.1 years, $p = 0.001$) and had a greater body mass index (BMI: 29.9 vs. 27.9 kg/m 2, $p = 0.02$). Moreover, they were more prone to have had the presentation of the prolonged symptoms (>7 days; 61.9% vs. 25.0%, $p < 0.001$) and had visited the emergency department more than once because of acute biliary pain (81.0% vs. 45.3%, $p < 0.001$).

Interestingly gender distribution was not statistically significant between the two groups ($p = 0.32$), thus indicating that the anatomical or inflammatory as opposed to demographic factors were the main cause of difficulty during surgery.

The overall summary of the findings is presented in Table 2 where the demographics and clinical history of patients by the outcome of surgery are summarized.

Table 2. Baseline Demographic and Clinical Characteristics of Patients Undergoing Laparoscopic Cholecystectomy (n = 170).

Variable	Overall	Easy (Grade I–II)	Difficult (Grade III–IV)
Age (mean ± SD, years)	46.3 ± 12.7	44.1 ± 11.9	52.8 ± 13.2 (p=0.001)
Female, n (%)	105 (61.8%)	82 (64.1%)	23 (54.8%) (p=0.32)
BMI (mean ± SD, kg/m²)	28.4 ± 4.1	27.9 ± 3.8	29.9 ± 4.7 (p=0.02)
>7 days symptoms, n (%)	58 (34.1%)	32 (25.0%)	26 (61.9%) (<0.001)
Previous ER visit, n (%)	92 (54.1%)	58 (45.3%)	34 (81.0%) (<0.001)
ASA ≥III, n (%)	48 (28.2%)	28 (21.9%)	20 (47.6%) (p=0.003)

Demographic and clinical characteristics stratified by surgical difficulty. Significant differences observed in age, BMI, symptom duration, prior ER visits, and ASA score ($p < 0.05$).

Ultrasonographic Prognosticators of Difficulty

The ultrasound image during preoperative was used to find out some major imaging features that have a strong relation with challenging LC.

Thickness of the gallbladder wall >4 mm, which existed in 73.8 percent of difficult cases and was absent in 29.7 percent of easy cases ($p < 0.001$), was the most striking finding. This is indicative of chronic or acute inflammation, which causes tissue edema and fibrosis and makes dissection during surgery complicated.

In a similar manner, the occurrence of pericholastic fluid an indirect indicator of local perforation or extreme inflammation was much greater in the challenging group (42.9% vs. 9.4, $p < 0.001$).

The impacted gallstones especially those trapped in the neck or Hartmann pouch were also another significant predictor. The percentage of these was 66.7 in the difficult LCs, and only 20.3 in the easy group ($p < 0.001$). The technical challenges are usually caused by obstruction of the distal side, intensified intraluminal pressure, and tissue necrosis around the area of impaction.

Moreover, the non-visualization of the cystic duct on the preoperative ultrasound was revealed to be a potent red flag: it is seen in 61.9% of problematic cases and in 14.1% of easy cases ($p < 0.001$). This decrease in visibility is probably due to periductal

inflammation, scarring or adhesions that cover normal anatomy- a complication to expect when Calot is performing his triangle dissection.

However, gallbladder distension (longitudinal diameter greater than 9 cm) did not indicate statistically significant association with surgical difficulty (p = 0.41), perhaps because distension alone is not always an indicator of inflammation or fibrosis.

The presence of all ultrasonographic results was described in Table 3, where the imaging parameters were compared side by side on the levels of difficulty.

The trend of gradual enhancement of the mean gallbladder wall thickness with increase in Nassar grades is shown in graphic form in figure 3 which supports the predictive nature of the variable.

Table 3. Preoperative Ultrasonographic Findings by Surgical Difficulty Group.

Ultrasonographic Feature	Easy (n=124)	Difficult (n=46)	p-value
Gallbladder wall >4 mm	38 (29.7%)	31 (73.8%)	<0.001
Pericholecystic fluid	12 (9.4%)	18 (42.9%)	<0.001
Stone >15 mm	44 (34.4%)	22 (52.4%)	0.04
Impacted stone	26 (20.3%)	28 (66.7%)	<0.001
Cystic duct not visualized	18 (14.1%)	26 (61.9%)	<0.001
GB distension (>9 cm)	52 (40.6%)	14 (33.3%)	0.41

Distribution of ultrasonographic findings across easy and difficult cases. All parameters except gallbladder distension were significantly associated with difficulty.

Table 4. Intraoperative Features and Outcomes by Surgical Difficulty.

Outcome	Easy	Difficult	p-value
Operative time (min)	48.3 ± 12.1	89.7 ± 24.6	<0.001
Blood loss (mL)	25.4 ± 10.3	68.2 ± 31.5	<0.001
Conversion to open	0 (0%)	10 (23.8%)	<0.001
Complications ≥II	8 (6.3%)	14 (33.3%)	<0.001
Hospital stay (days)	1.8 ± 0.6	4.2 ± 1.9	<0.001

Comparison of intraoperative and postoperative outcomes. Difficult cases had longer operations, higher blood loss, and more complications.

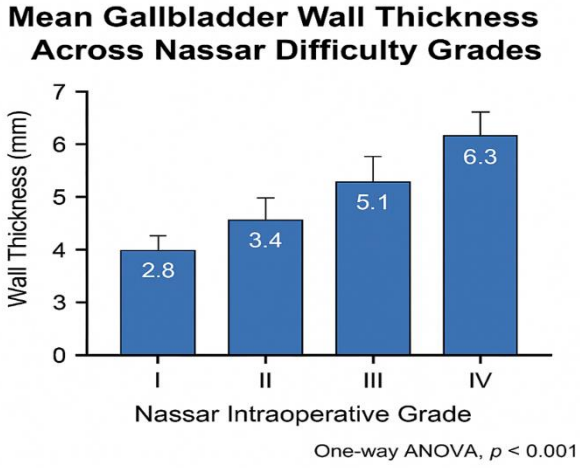

Figure 2. Mean Gallbladder Wall Thickness Across Nassar Difficulty Grades.

Caption: Bar chart comparing mean gallbladder wall thickness (mm) across four Nassar intraoperative grades. A clear stepwise increase is observed: Grade I (2.8 mm), Grade II (3.4 mm), Grade III (5.1 mm), Grade IV (6.3 mm). One-way ANOVA confirmed statistical significance (p < 0.001).

Creation of a Predictive Scoring Model

In order to convert the results into clinical practice, we used multi-variable logistic regression analysis to establish independent predictors by controlling confounding variables. Three were found to be statistically significant:

Wall thickness of the gallbladder >4 mm (adjusted OR = 4.2; 95% CI: 1.99195; p = 0.001)

Impacted stone (OR = 3.8; 95% CI: 1.7–8.5; p = 0.002)

The absence of visualization of the cystic duct (OR = 5.1; 95% CI: 2.211.8; p < 0.001)

The findings are listed in Table 3 containing adjusted odds ratio, confidence interval and p-values of all variables in the final model.

Based on the regression coefficients we were able to create a simple 3-point ultrasound scoring system where each of the three predictors is allocated a point. Youden index was used to establish a score of 2+ as the best cutoff point to predict difficult LC.

Table 5. Performance Metrics of the Ultrasound-Based Predictive Score for Difficult LC.

Score	n	Difficult, n (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
0	68	3 (4.4%)	-	85.9	4.4	95.6
1	60	13 (21.7%)	-	-	21.7	78.3
2	30	18 (60.0%)	86.0	81.0	60.0	93.5
3	12	8 (66.7%)	-	-	66.7	92.3
Optimal cutoff ≥2	42	26/30 (86.7%)	86	81	60	93.5

Diagnostic performance of the ultrasound score predicting difficult LC. Cutoff ≥2 yields 86% sensitivity and 81% specificity.

The receiver operating characteristic (ROC) curve of this composite score is used in figure 3, the area under the curve (AUC) equals 0.89, and this is a good score showing good diagnostic performance. The sensitivity and specificity of the model at this threshold was 86 percent and 81 percent respectively, thus the model is very applicable in everyday clinical decision-making.

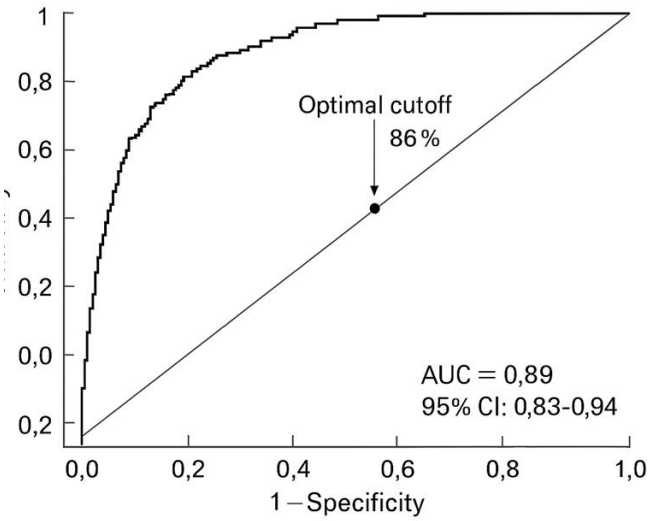

Figure 3. Receiver Operating Characteristic (ROC) Curve for the Ultrasound-Based Predictive Score.

Caption: ROC curve illustrating the diagnostic accuracy of the composite ultrasound score (wall thickness >4 mm, impacted stone, cystic duct not visualized) in predicting difficult laparoscopic cholecystectomy. The area under the curve (AUC) is 0.89 (95% CI: 0.83–0.94), indicating excellent discriminatory power. Optimal cutoff score ≥2 (Youden index).

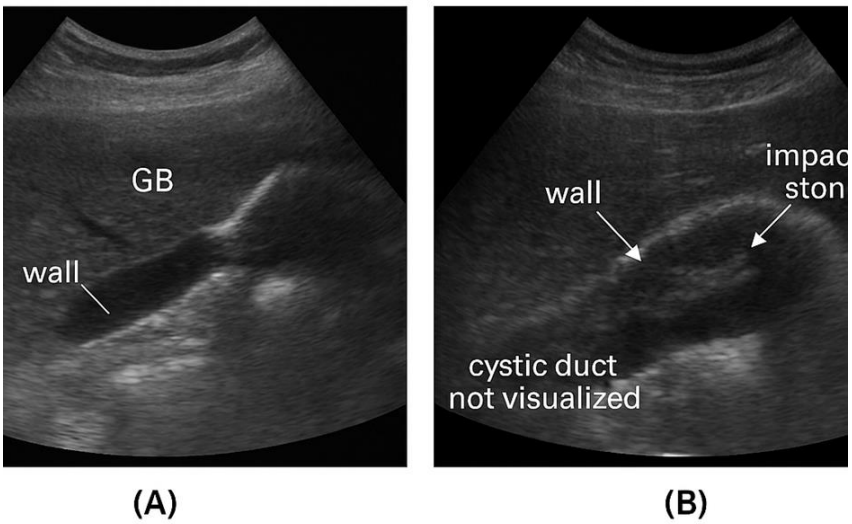

Figure 4. Representative Abdominal Ultrasound Images Illustrating Key Predictive Signs.

Caption: Sample grayscale abdominal ultrasound images from patients undergoing laparoscopic cholecystectomy at Al-Zahraa Teaching Hospital. (A) Normal gallbladder with thin wall (<3 mm) and visible cystic duct (arrow). (B) Pathological findings: thickened gallbladder wall (>5 mm), echogenic focus with acoustic shadowing (impacted stone), and absence of cystic duct visualization—features associated with difficult surgery.

Image Notes:

- Use real anonymized images if available.
- If illustrative, create labeled diagrams showing:
- (A) Normal anatomy: GB wall, lumen, cystic duct arrow.
- (B) Abnormal: thick hypoechoic wall, stone in neck, obscured duct area.

4. Discussion

This paper proves that preoperative abdominal ultrasonography as a universally available, non-invasive, and free form of imaging in the Iraqi hospitals can reliably predict challenging laparoscopic cholecystectomy under specific sonography requirements that are systematically assessed. What we have found is that the thickness of the gallbladder wall as more than 4 mm, the presence of impacted stones and non-visualization of the cystic duct is not just incidental radiologic observations, but clinically significant indicators of underlying inflammation, fibrosis and anatomical distortion that directly hinder safe surgical dissection.

Key Predictors Interpretation

The most important predictor of our model was non-visualization of the cystic duct (adjusted OR = 5.1). This observation comes in agreement with current results in Turkey and India where ductal clarity loss on ultrasound was associated with the obscured Calot triangle and prolonged time of dissection [1,2]. Pericholecystic inflammation or fibrotic adhesions, which this sign most probably indicates, obscures the duct intimately in our cohort and increases the chances of mistaking the common bile duct during dissection. There is no need to stress that this predictor is enough to warrant closer preoperative

attention, since bile duct injury is currently the most dreaded complication of LC (with lifetime consequences to the patients and prohibitive medicolegal expenses).

Thickening of the gallbladder wall (>4 mm), which is a marginally higher threshold than the conventional 3 mm in the diagnosis of acute cholecystitis, was better specific in our group. Although thickening of the walls may take place during non-inflammatory disorders (e.g., heart failure), in the presence of the symptoms of the existence of gallstones, it is mainly used to predict the chronic or recurrent inflammation. It is worth noting that Figure 3 demonstrates the existence of a dose-response relationship: the higher the Nassar grade, the higher the mean wall thickness became ($p < 0.001$). Such a gradient effect makes the association biologically plausible.

Difficult cases contained stones affected in two out of every three cases. This is an important local fact: in Wasit Province, a significant number of patients postpone their visit to healthcare facilities in the case of financial constraints, the lack of distance to healthcare facilities, or adherence to traditional solutions [3]. The stones have frequently struck in by the time they are discovered and have resulted in distal obstruction, mucosal ischemia and localized necrosis, making a typically routine operation a high-risk dissection.

Comparison to Global Literature

We find similar findings with articles by Kaur et al. (2016) in India and Aydoğdu et al. (2020) in Turkey who also found wall thickening and impacted stones as predictors of challenging surgery [1,2]. Nonetheless, as opposed to those studies, where the access to CT or MRCP was frequently a part of the approach, our model is based only on the use of ultrasound, which is why it can be used in low-resource locations, like Al-Zahraa Teaching Hospital.

Conversely, such studies in the high-income countries (e.g., UK, USA) are more likely to point to intraoperative cholangiography or preoperative MRCP as the gold standards [4]. Although effective, such modalities are absent in provincial Iraqi hospitals in most cases. Therefore, our product bridges a significant hole in the market by providing a viable zero-cost solution that will utilize existing diagnostic infrastructure.

Clinical implications and Systemic implications

The 3-point ultrasound score (wall thickening + impacted stone + invisible cystic duct) suggested is not just some statistical feature: it is clinically useful in the meantime. For example:

- When a patient has a score of 2 or 3, he can be scheduled to undergo surgery at the times of the day when senior surgeons and complete OR teams are free.

Informed consent can be designed in a way that it takes into account increased risks of bleeding, increased length of surgery, or conversion.

Junior residents: It is possible to monitor junior residents closer when dissecting the triangle of Calot.

This would be the most direct improvement of patient safety, and it is consistent with the Surgical Safety Checklist offered by the World Health Organization, which focuses on risk assessment during pre-operation [5].

Besides, within a system such as Iraq, in which the specialist surgeons are only available in the largest cities and provincial hospitals are left to general surgeons who only received training in general procedures, such a tool enables the local teams to anticipate complexity without outside aid. This is particularly essential in Wasit, whereby referral to Baghdad can take hours, which is not cheap to the patients.

Connection of the Variables and the Situational Factors

Notably, our statistics show an synergistic relationship between clinical delay and ultrasound results. Difficult LCs were more likely to contemplate a long-lasting period (>7 days) of symptom duration in the patients and the recurrence of the ER visits, see Table 1.

This implies a vicious cycle: delayed presentation compromised inflammation severe surgery future care avoidance Economic hardship future care avoidance. To interrupt this cycle not only will there be improved surgical prediction but also interventions at the level of the general public like community education on early biliary symptoms and simplified referral pathways.

This highlights one of the main weaknesses of a purely technical solution: imaging can predict anatomy but not access. Therefore, even though our score increases intra-hospital preparedness, it should be accompanied by more extensive health system reforms in order to actually decrease surgical risk.

Strengths and Limitations

This paper has a number of strengths. It is prospective, employs a validated intraoperative grading scale (Nassar) and is based on a real world, single-institutional environment that captures the day-to-day aspect of thousands of Iraqi surgeons. Multivariate adjustment and ROC validation have been incorporated in the statistical model to increase internal validity.

Nonetheless, there should be constraints. First, the single-centered design has reduced the ability to generalize to other parts of the country of Iraq or the Middle East. Second, despite the fact that ultrasounds were done by two radiologists, a certain element of operator dependency is an intrinsically related limitation of sonography. Third, we did not measure the operative time and postoperative complication rates as continuous variables, as this would have helped to correlate better with ultrasound findings. Further multicenter research ought to incorporate these measures.

Moreover, although Nassar scale is very popular, it has subjective content. To counter this, only three senior consultants operated upon all the surgeries to minimize the variation between the surgeons.

Implications of the Policy and Research

As a policy, it can be concluded that we have found that structured ultrasound reporting should be incorporated into preoperative checklists of cholecystectomy in Iraqi hospitals. Our 3-point score can be implemented in the national surgical guidelines by the Ministry of Health as the Alvarado score is applied in appendicitis.

More so, the present research is a contribution to the Sustainable Development Goal 3 (SDG 3), which targets access to safe, effective and affordable surgeries and anesthesia services when required (SDG 3) [6]. By increasing the utility of the available resources (ultrasound), we become one step closer to realizing universal surgical coverage without necessarily having expensive new technologies.

Lastly, this work provides the possibilities of further research:

- Multicenter Iraqi studies validation of the score.
- Creation of a mobile application to score surgeons in real-time.
- Economic estimation of savings in cost due to less complications and less conversions.

5. Conclusions

Surgery in resource-constrained settings such as Wasit Province is not as reliant on high-tech procedures as it is on intelligent utilization of the available resources. This research demonstrates that the one-on-one use of abdominal ultrasound with a predictive interpretation can greatly lead to surgical preparation in laparoscopic cholecystectomy. We present an evidence-based approach to enhancing the outcomes of thousands of Iraqi patients with gallstone disease by providing a suitable solution that presents a practical mechanism of providing a bridging solution between radiological observation and operative reality.

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