Preoperative Anticipation of Difficult Laparoscopic Cholecystectomy with a Suggested Scoring System

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Abstract: The objective of this study is to evaluate the risk factors that can predict difficult laparoscopic cholecystectomy (LC) and the possibility of conversion to open cholecystectomy (OC) in our setup. Furthermore, the study aims to suggest a scoring system that can be used preoperatively to identify high-risk patients who would benefit from preparation for LC. Such a system could prove beneficial to both the patient and the surgeon, facilitating enhanced preparation for intraoperative risk and the potential for conversion to open cholecystectomy. The prospective study was conducted at the third surgical unit of Baghdad Teaching Hospital, Medical City, between January 2015 and January 2016. The study sample consisted of 130 patients with a history of gallstone disease. All patients were admitted to the hospital one day prior to the scheduled surgical procedure. At the time of admission, the following information was obtained from the patients and recorded in a special questionnaire form prepared for patients who were admitted for elective laparoscopic cholecystectomy (LC). Age, gender, and body mass index (BMI) were calculated as weight (in kilograms) divided by squared height (in metres). Among the 130 patients who underwent laparoscopic cholecystectomy (LC), males comprised 21 (16.2%), and females were 109 (83.8%). Regarding the history of admission for acute cholecystitis, it was noted that 44 (33.8%) Previous hospitalisation for conservative treatment of acute cholecystitis was noted in 130 patients, while 86 (66.2%) patients had no history of any admission. Of the 130 patients with cholecystolithiasis on sonography, the sonographist diagnosed 112 (86.2%) patients with GB wall thickness < 4 mm, while 18 (13.8%) patients had GB wall thickness ≥ 4 mm. A thickness of ≥4 mm was recorded as the cut-off point for defining the duration of the operation. The time of operation was recorded from the insertion of the first port until the removal of the last port. The results demonstrated that 78 patients (60%) had an operation time of <60 min, while 46 patients (35.4%) had an operation time of 60–120 min. Only six patients (4.6%) had prolonged surgery for >120 minutes. The duration of the surgical procedure for all patients ranged from 30 to 140 minutes. The application of this scoring system revealed that the majority of patients with a total score of 4 or above would experience a challenging surgical procedure, whereas those with a score below four would undergo an easier surgery. As illustrated in Table 9, there was a notable correlation between preoperative scoring and intraoperative outcomes, with a p-value of less than 0.001.

Keywords: Preoperative, Anticipation, Laparoscopic Cholecystectomy, Patients, BMI.

INTRODUCTION

Minimal access surgery represents a convergence of contemporary technology and surgical innovation, with the objective of achieving surgical therapeutic outcomes while minimising somatic and psychological trauma [Darzi, A. *et al*., 2013; Gadacz, T. R, 2000]

Laparoscopic cholecystectomy (LC) is a minimally invasive surgical procedure in which the gallbladder (GB) is removed. Mouret introduced laparoscopic cholecystectomy in France in 1987, and it has subsequently become the standard treatment, superseding open cholecystectomy (OC) [Selmani, R. *et al*., 2013]. LC has become the gold standard for the treatment of symptomatic gallbladder disease due to its association with reduced postoperative pain, fewer intra-abdominal adhesions, shorter hospitalisation periods, and favourable cosmetic outcomes [Bulbuller, N. *et al*., 2006] .It must be acknowledged that a significant number of patients present with characteristics that render laparoscopic cholecystectomy unsuitable and necessitate conversion to open surgery. A number of relative contraindications, such as morbid obesity, previous upper abdominal surgery, and acute cholecystitis, have been proposed as criteria for determining whether a patient is a suitable candidate for laparoscopic cholecystectomy [Kama, N. A. *et al*., 2001]. Despite the growing expertise and technological advances, the conversion rate remains variable, ranging from 1.5% to 19% in different centres worldwide [Kumar, S. *et al*., 2007]. The laparoscopic approach may be rendered difficult by various problems encountered during surgery. These include difficulties in accessing the peritoneal cavity, creating a pneumoperitoneum, dissecting Calot's triangle and the gall bladder, or extracting the excised gall bladder.

It is crucial to be aware of the various clinical radiological parameters and specific predictors that can assist in predicting the difficulty of LC.

The crucial step in cholecystectomy is the clear identification of the cystic duct and artery. This

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can be challenging in certain situations, particularly in the presence of dense adhesions or a severely inflamed gallbladder, which can increase the risk of common bile duct (CBD) injury. Despite this, the incidence of common bile duct injury in laparoscopic cholecystectomy remains relatively low. Where this paper aims to evaluate the risk factors that can predict difficult LC and the possibility of conversion to OC in our set up. Suggesting a scoring system preoperatively to identify high-risk patients to prepare for LC. This could help the patient as well as the surgeon in being better prepared for the intra-operative risk and the risk of conversion to open cholecystectomy.

PATIENTS AND METHODS

The prospective study was conducted at the third surgical unit of Baghdad Teaching Hospital, Medical City, between January 2015 and January 2016. The study sample comprised 130 patients with a history of gallstones. All patients were admitted to the hospital one day prior to the scheduled surgical procedure. Abdominal ultrasound was performed on all patients, and a comprehensive range of investigations were conducted, including complete blood count (CBC), renal function tests (RFT), liver function tests (LFT), random blood sugar (RBS), bleeding profile, virology screening, blood group, electrocardiogram (ECG), and chest X-ray (CXR). For each patient, weight and height were recorded, and the body mass index (BMI) was calculated accordingly.

Inclusion criteria:
- All patients admitted for elective laparoscopic cholecystomy were diagnosed with symptomatic cholelithiasis.

- All patients who were seen by a specialist anaesthesiologist prior to surgery were deemed fit for general anaesthesia (GA.(

Patients were excluded from the study if they met any of the following criteria:
- Laparoscopic cholecystectomy in conjunction with other surgical procedures conducted during the same operative session.
- Any patient who had developed jaundice in the recent past prior to the surgical procedure.
- Any technical or equipment deficiencies that occur during the course of the operation.
- In the event that a patient develops anaesthetic complications during the course of the operation, the following procedures shall be undertaken:
- Any patient with a history of upper abdominal surgery.

DATA COLLECTION

At the time of admission, the following information was obtained from the patients and recorded in a special questionnaire form prepared for patients who were admitted for elective laparoscopic cholecystectomy (LC:(Age, Gender, Body mass index (BMI) was calculated as weight (in kilograms) divided by squared height (in metres) (Table).

Previous history of admission for acute cholecystitis (in which the cases were treated conservatively initially and subsequently underwent surgery after a minimum of six weeks had elapsed .(Previous history of jaundice or ERCP intervention. Gall bladder wall thickness (either < 4 or ≥ 4 mm) which was determined through a preoperative ultrasound examination conducted by a specialist radiologist.

Table 1: Classification of the weight status according to the body mass index

BMI	Weight Status
< 18.5	Underweight
18.5 - < 25	Normal
25.0 - < 30	Overweight
30.0 - < 35	Obese
35.0 - < 40	Severely obese
≥ 40	Morbid obese

We used a standard laparoscopic cholecystectomy technique. We didn't use nasogastric intubation during surgery unless we needed to. Once the patient was anaesthetised and positioned, we used a Veress needle to enter the peritoneal cavity.

We used a 30-degree camera through a 10 mm port. We did a standard procedure through a four-port technique. An assistant recorded the time of operation. All the operations were done by the same surgical team.

At the time of surgery, the surgical difficulties and intraoperative findings were recorded as follows and were used as parameters for operative difficulties:

➢ The operative time was recorded as the interval between the insertion of the first port to create CO_2 pneumoperitoneum and the removal of the last port.
➢ The degree of difficulty encountered when accessing the peritoneal cavity was classified as either easy or difficult. In the former case, the insertion of the umbilical port was successful on the first attempt. In the latter case, multiple attempts were required, or an open method was employed.

➢ The occurrence of either bleeding or bile leakage. (In instances where bleeding was observed to be pulsatile or obscuring the operative field, or in cases of perforation of the GB and spillage of stone (s) and bile during the release of adhesions.
➢ Difficult dissection of the gallbladder bed or Calot's triangle. This was defined as the presence of dense adhesions involving either the omentum, duodenum, transverse colon or a frozen Calot's triangle.
➢ Conversion to open cholecystectomy. This was classified as either a yes or no response.

Table 2: Our criteria to classify the degree of difficulties of laparoscopic cholecystectomy

Degree of Difficulty	Our Criteria
Easy	Time taken < 60 min And no bile spillage And no injury to a duct or an artery
Difficult	Time taken ≥ 60 min And /or bile/stone spillage And/or injury to a biliary duct And/or bleeding or an injury to the artery And /or conversion to OC

Statistical Analysis

• Each patient is assigned a serial identification number. The data were analysed using Statistical Package for Social Sciences (SPSS) version 20.
• The categorical data is presented as frequency and percentage tables.
• The Chi-square and Fisher's exact tests were used to assess the association between categorical data with univariate odds calculation.
• The continuous variables were presented as averages, standard deviations, and ranges.
• Binomial logistic regression was used to calculate the adjusted multivariate odds ratios for risk factors.
• Receiver operator curves were used to assess predictive values (sensitivity and specificity) as well as calculating cutoff values.
• A P-value of less than 0.05 was used as the alpha level of significance.

RESULTS

One hundred and thirty patients were admitted to the third surgical ward, Baghdad Teaching Hospital, for elective LC for gallstones were included in the study:

A. Pre-Operative Risk Factors Incidence:

The most vulnerable patients affected by gallstones and underwent LC were between (30-49 y) comprising 66 (50.8%) patients, followed by (50-69 y) age group 33 (25.4%) patients. While old age group ≥ 70 y comprised only one patient (0.8%). The ages were ranging from 17 to 70y (Table 3).

Among the 130 patients in which LCs were done, males comprised 21(16.2%) and females were 109 (83.8%) (Table 3).

Also, table (3) shows that 62 (47.7%) patients were having a BMI between 25 and < 30, followed by 29 (22.3%) patients with a BMI ranging between 30 and <35, four (3.1%) patients had their BMI ≥40, and only one (0.8%) patient had BMI < 18.5. The BMI of all patients was ranging from 18.37 to 52.69.

Table 3: Number and percentage of patients, according to sociodemographic characteristics

Variable	Number	%
Age groups		
<30y	30	23.1%
30-49y	66	50.8%
50-69y	33	25.4%
≥ 70y	1	0.8%
Mean ± standard deviation (Range)	40.1 ± 13.2 Y	(17 – 70) Y
Gender		
Male	*21*	*16.2%*
Female	*109*	*83.8%*
BMI (kg/m2)		
<18.5	1	0.8%
18.5 - <25	18	13.8%
25 - <30	62	47.7%
30 - <35	29	22.3%
35 - <40	16	12.3%
40 & above	4	3.1%
Mean ± standard deviation (Range)	29.75 ± 5.2	(18.37-52.69)

Table 4: Number and percentage of patients, according to admission for acute cholecystitis, history of ERCP, and gall bladder wall thickness

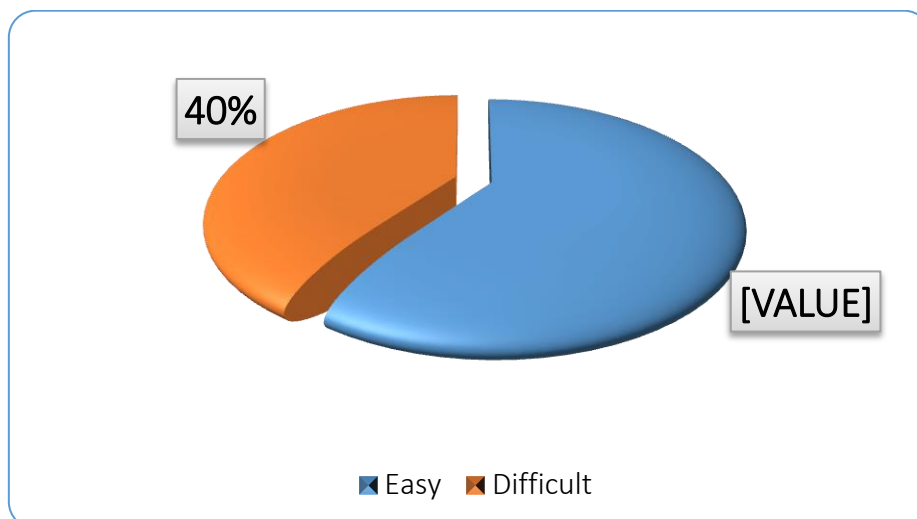| Risk factors	Number of patients	%
Admission for acute cholecystitis		
No	86	66.2%
Yes	44	33.8%
History of ERCP		
Negative	121	93.1%
Positive	9	6.9%
Gall bladder wall thickness		
< 4	112	86.2%
4≥	18	13.8%

Figure 3: Percentage of patients, according to operative outcomes, n = 130

In this research, the incidence of individual difficulty categories was assessed, and it was noted that 36 (28%) patients experienced bleeding or bile leak mainly after attempts to peel the gall bladder off its bed or stone (s) being spilt into the peritoneal cavity with difficulties in retrieving the

stones, and in the present study none sustained injury to the CBD. Furthermore, it was also established that among the 36 (28%) patients, some had dense adhesions, resulting in difficult dissection as a result of the ill-defined identity of the anatomy of the Calot's triangle. There was also difficulty in accessing the peritoneal cavity in 12 (9%) patients. In six (5%) patients, the decision for a change to OC was made (Table 5).

Table 5: Frequency of occurrence of each type of difficulty

Type of difficulties	Number	%
Bleeding and bile leak	36	28%
Difficult Calot's dissection	36	28%
Difficult access to the peritoneal cavity	12	9%
Conversion to open	6	5%

The time of operation was recorded from the insertion of the first port until the removal of the last port, and it was found that 78 (60%) patients had an operation time of < 60 min, while 46 (35.4%) patients were having operation time 60-120 min, and only six (4.6%) patients had prolonged surgery for > 120 min. The time of operation for all patients was ranging from 30 to 140 min (Table 6).

Table 6: Frequency of patients, according to operation time

Duration of LC (min)	Number of patients	%
<60 min	78	60.0%
60 - 120 min	46	35.4%
> 120 min	6	4.6%
Total	**130**	**100.0%**
Mean ± standard deviation (range) minutes	61.9±24.1	(30-140)

When analyzing the intraoperative outcome in relation to preoperative risk factors, as well as their impact on the difficulty level of LC, we discovered that age is not a significant factor when it comes to LC difficulties (p=0.568), whereas patient BMI levels of 30 and above do have a significant bearing on the operative procedure, approximately increasing the risk by about 12 times, adjusted multivariate odd ratio (AOR) = 12.10, p <0.001. (Table7)

Table 7: Univariate and multivariate analysis of per-operative outcome with risk factors

Risk factors	Per-operative outcomes No. (%)		p-value	Odds ratio	
	Difficult N=52	Easy N=78		Univariate	Multivariate AOR
Age groups					
<50 years	37 (71.2%)	59 (75.6%)	0.568	Reference	Reference
≥ 50 years	15 (28.8%)	19 (24.4%)	NS	1.29	1.52
Gender					
Female	37 (71.2%)	72 (92.3%)	0.001**	Reference	Reference
Male	15 (27.8%)	6 (7.9%)		4.86	5.75
Body mass index (kg/m2)					
<25 kg/m2	2 (3.8%)	17 (21.8%)	<0.001**	Reference	Reference
25- < 30 kg/m2	19 (36.5%)	43 (55.1%)		3.76	2.24
≥30 kg/m2	31 (59.6%)	18 (23.1%)		14.64	12.10
Admission for acute Cholecystitis					
No	23 (44.2%)	63 (80.8%)	<0.001**	Reference	Reference
Yes	29 (55.8%)	15 (19.2%)		5.3	1.96
History of ERCP					
Negative	44 (84.6%)	77 (98.7%)	0.006**	Reference	Reference
Positive	8 (15.4%)	1 (1.3%)		14	3.29
Gall bladder wall thickness					
< 4	36 (69.2%)	76 (97.4%)	<0.001**	Reference	Reference
≥ 4	16 (30.8%)	2 (2.6%)		5.95	2.53
NS=not significant, * moderately significant 0.01 < p ≤ 0.05, **Strongly significant p ≤ 0.01					

The area under the curve (AUC) for per-operative difficulties was analyzed with an aim to strike a balance between the validity indicators of each of the tested parameters in striving to achieve the highest sensitivity and specificity as well as accuracy in distinguishing the cases that were really difficult from the easy ones. This area under the receiver operator curve (ROC) is also referred to as the probability of correctly identifying a difficult case among all other easy cases and of randomly choosing two cases, one easy and one difficult. As depicted in figure (4).

specific AUC for the current study, the precision of detecting correctly difficult cases was 84.8% with 95% CI (78.3% - 91.2%). figure (4)
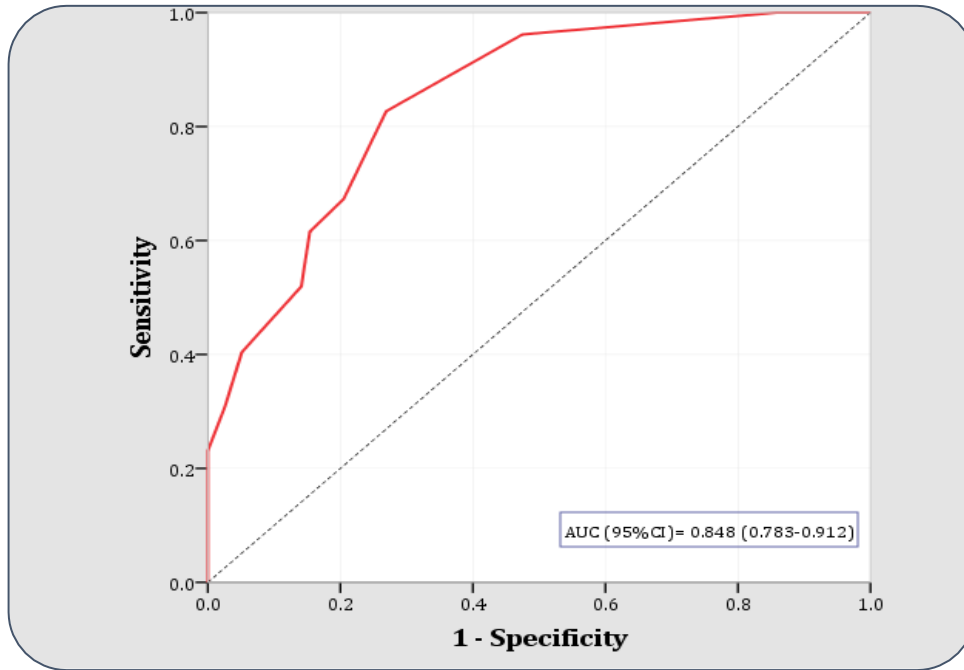
Figure 4: Receiver operator curve and its area under the curve for predicting the operative outcome based on preoperative score

From the receiver operator curve, a scoring system was suggested. The system is based on the relative importance of each predicting factor; accordingly, we gave a relative weight for each factor according to the observations in this study (Table 8).

Table 8: Relative weight of different predicting factors

Predicting factor		Relative weight (point)
Gender	Male	2
	Female	0
BMI	≥30	3
	25-< 30	1
	< 25	0
ERCP	Yes	1
	No	0
GB wall thickness	≥ 4	1
	< 4	0
Attack of cholecystitis	Yes	1
	No	0

Applying this scoring system, it was found that most of the patients with a total score of 4 or more would have a difficult surgery, while those with a score of less than four would have an easy surgery. As shown in table (9) that displays a significant association between preoperative scoring and intraoperative outcome p value < 0.001; as cut off value was 4, we found 9 (17.3%) difficult cases and 57(73.1%) easy cases had a score < 4, while 43 (82.7%) difficult cases and 21(26.9%) easy

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cases with score ≥ 4. this score system has sensitivity 82.7% and specifity 73.1%.

Table 9: Relation between operative scoring and outcome

Score	Per-operative outcomes No. (%)		Total No. (%)	p-value
	Difficult	*Easy*		
<4	9 (17.3%)	57 (73.1%)	66 (50.8%)	<0.001*
≥4	43 (82.7%)	21 (26.9%)	64 (49.2%)	
Total	**52 (100%)**	**78 (100%)**	**130 (100%)**	
Chi-square test, *Significant p ≤ 0.01, Sensitivity= 82.7%, Specificity= 73.1%				

DISCUSSION

Laparoscopic cholecystectomy has become the gold standard for patients with symptomatic gallbladder disease. Nevertheless, there are still some situations where the procedure cannot be performed because of technical factors, and open surgery becomes necessary. Surgeons should be able to preoperatively identify those patients [Elsebae, M. M. A]. There has been a plethora of literature published on the subject in recent years trying to study the risk factors for laparoscopic cholecystectomy [Habib, F. A]. Published apparently novel randomized controlled trials on the subject try measuring physical and emotional outcomes. In this respect, this study is in those studies extending one step further by using indeed the clinical evaluation of the patient, assessment of the ultrasound gall bladder and biliary system, and incorporation of these components into a scoring system in order to forecast the behavior of structure post-LC. In this study, it was also observed that nearly all of the patients who underwent laparoscopic cholecystectomy were of the age range (30-49 y), and it was found that increasing age did not contribute significantly to the rate of difficulties experienced while performing laparoscopic cholecystectomy. This observation concurs with the study done by Gabriel, R. *et al*., [2009], where the age group in which difficult laparoscopic cholecystectomy was most common was from (31- 40 y) and advancing age did not appreciably increase the chances of converting the operation from laparoscopic to open cholecystectomy. In the contrary, the reports of several other studies contradict with these findings, as reported by Pavlidis, T.E. *et al*., [2007] and Alexandros Polychronidis *et al*., who considered advanced age was a significant parameter of increasing the occurrence of difficulties and risk of conversion to OC probably due to longer history of gallstone and increased number of cholecystitis attacks, in which Repeated inflammation results in a shrunken gallbladder with dense adhesions to surrounding structures

Laparoscopic cholecystectomy has become the gold standard for patients with symptomatic gallbladder disease. Nevertheless, there are still some situations where the procedure cannot be performed because of technical factors, and open surgery becomes necessary. Surgeons should be able to preoperatively identify those patients [Elsebae, M. M. A. *et al*., 2006]. There has been a plethora of literature published on the subject in recent years trying to study the risk factors for laparoscopic cholecystectomy [Habib, F. A. *et al*., 2001]. Published apparently novel randomized controlled trials on the subject try measuring physical and emotional outcomes. In this respect, this study is in those studies extending one step further by using indeed the clinical evaluation of the patient, assessment of the ultrasound gall bladder and biliary system, and incorporation of these components into a scoring system in order to forecast the behavior of structure post-LC. In this study, it was also observed that nearly all of the patients who underwent laparoscopic cholecystectomy were of the age range (30-49 y), and it was found that increasing age did not contribute significantly to the rate of difficulties experienced while performing laparoscopic cholecystectomy. This observation concurs with the study done by Gabriel, R. *et al*., [2009], where the age group in which difficult laparoscopic cholecystectomy was most common was from (31-40 y) and advancing age did not appreciably increase the chances of converting the operation from laparoscopic to open cholecystectomy. In the contrary, the reports of several other studies contradict such findings, as reported by Pavlidis, *et al*., [2007] and Alexandros Polychronidis, *et al*., (21), who held that older age was an important risk factor for the development of difficulties and the likelihood of conversion to OC because of prolonged duration of gallstones and more episodes of cholecystitis, in which results in a fibrosed gallbladder that is reduced in size and sticks to adjacent organs bottom making it difficult to operate.

Conversely, the current study revealed that male gender was a significant risk factor for difficult laparoscopic cholecystectomy, with a higher incidence of complications observed in males compared to females. These findings align with those of numerous other studies, including the work of Gharaibeh, *et al*., [2001] which demonstrated that male patients tend to have longer operation times and higher conversion rates compared to females. Yol, S. *et al*., [2006] posited that males were more prone to difficulties due to the presence of higher numbers of macrophages and mast cells in their pericholecystic fibrosis. Additionally, the tissue collagen levels in the submucosal area of the gallbladder wall and in peri cholecystitis tissue were observed to be significantly higher in males than in females. Furthermore, the number of eosinophils was found to be six times higher in males than in females.

However, in some series, male sex was not identified as an independent predictor of conversion to open cholecystectomy, contrary to the findings of Al-Mulhim AA's study [Al-Mulhim, A. A. *et al*., 2008], which did not find male sex to be a predictive factor of difficult cholecystectomy.

The prevalence of obesity has increased gradually in all Western countries and has reached pandemic proportions, primarily due to an increase in the consumption of fat-rich diets and a sedentary lifestyle [Sidhu, R. S. *et al*., 2007]. LC in obese patients is technically more demanding due to the following factors: (1) An increased difficulty in inserting the Veress needle, introducing the most lateral subcostal port, and closing fascia; (2) the obscure anatomy of Calot's triangle due to the fatty omentum; (3) an inability to sufficiently retract the gallbladder fundus and the enlarged fatty liver; (4) the bulky transverse colon, leading to difficult manipulation of the instruments [Ammori, B. J. *et al*., 2001; Chang, W. T. *et al*., 2009; Simopoulos, C. *et al*., 2005; Unger, S. W. *et al*., 1992] In this study, it was observed that the majority of patients who underwent laparoscopic cholecystectomy had a body mass index (BMI) between 25 and <30 kg/m². Of these patients, 62 (47.7%) experienced significant difficulties, with the prevalence of these difficulties increasing in proportion to the BMI, particularly in cases where the BMI exceeded 30 kg/m². This finding is in accordance with the conclusions of Rosen, M. *et al*., Pavlidis, T.E. *et al*., who identified obesity as a significant risk factor for difficult LC, in addition to the increased risk of conversion to OC. Conversely, Stephen

Wise Unger, *et al*., [1992] Asserted that laparoscopic cholecystectomy is a safe and effective treatment for obese patients and should be the procedure of choice for those patients, avoiding the complications of prolonged bed rest and wound complications, which are common in these patients .

Previous episodes of acute cholecystitis typically result in the formation of scar tissue and fibrosis within the gallbladder, leading to the development of dense fibrotic adhesions that can impede laparoscopic dissection of Calot's triangle and the gallbladder from the liver bed.

The present study found that a history of admission to the hospital for the conservative management of acute cholecystitis was significantly associated with an increased rate of difficulty during laparoscopic cholecystectomy. This result is analogous to that reached by Nachnani, J. *et al*., (7), who identified the presence of a previous attack of acute cholecystitis as one of the most significant and independent predictors of difficult laparoscopic cholecystectomy. Similarly, Ghara Ibeh, *et al*., (2001) demonstrated the safety and feasibility of laparoscopic cholecystectomy in both acute and chronic cholecystitis despite a higher rate of conversion in the former than in the latter .

The incidence of cholecystitis complicating ERCP is estimated to be between 0.2 and 0.5%. The risk appears to be correlated with the presence of stones in the gallbladder and possibly the filling of the gallbladder with contrast during the examination (30).

Among the 130 patients included in the current study, only 9 (6.9%) had a history of ERCP intervention for obstructed jaundice.

CONCLUSION
The evaluation of preoperative clinical and ultrasonic factors that contribute to the possibility of encountering intraoperative difficulty during laparoscopic cholecystectomy (LC) for gallstones demonstrated that male gender, body mass index (BMI) ≥ 30, and history of acute cholecystitis, endoscopic retrograde cholangiopancreatography (ERCP) intervention, and gallbladder (GB) wall thickness ≥ 4 are statistically significant predictive factors. Furthermore, the development of a scoring system for predicting the difficult LC operation is a feasible and practical approach that could potentially reduce the complications of LC and facilitate the management of challenging cases.

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