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Predicting Operative Difficulties During Laparoscopic Cholecystectomy using Clinical and Radiological Criteria Based on Intraoperative Findings

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Abstract

Laparoscopic cholecystectomy (LC) being the gold standard treatment of symptomatic cholelithiasis preoperative prediction of the risk of conversion is an important aspect of planning laparoscopic surgery. It is important to predict difficult LC preoperatively during surgery rather than to avoid complications during surgery. This study aimed predicting operative difficulties during laparoscopic cholecystectomy using clinical and radiological criteria based on intraoperative findings. This prospective clinical study was conducted at El Zahraa University Hospital within two years duration, on one hundred fifty patients (N=150) presented to out-patients clinic suffering from gall bladder disease and scheduled for laparoscopic cholecystectomy. The results of this study showed that, the benefit of laparoscopic cholecystectomy over open surgery has been extensively accepted. However, many times it is challenging, and the surgeon has to face the difficulty that might lead to injury to adjacent structures leading to an increase in morbidity. Therefore, the preoperative estimate of a difficult LC is essential to predict the difficulty as well as for a better surgical plan. It also helps the surgeon in being better prepared to anticipate the intra operative difficulties that reached among the included patients with rate 1.3% and 21.3% respectively. This study concluded that, gender (male), past history of acute cholecystitis, gallbladder wall thickness (≥4–5 mm), fibrotic gallbladder, and adhesion at Calot's triangle are significant predictors for difficult LC. Moreover, an awareness about reliable predictors for difficult LC would be helpful for an appropriate treatment plan and application of the resources to anticipate difficult LC.

Keywords: Operative difficulties - Laparoscopic cholecystectomy - Radiological- Intraoperative

1. Introduction

Laparoscopic cholecystectomy has become the procedure of choice for the management of symptomatic gallstone disease. Advantages of laparoscopic cholecystectomy compared with open cholecystectomy are well described and

usually include decreased postoperative pain, shorter ileus, earlier oral intake, and earlier return to normal activities with better cosmesis [1]. “Difficult gallbladder” (DGB) is a term coined to denote a procedure with an increased surgical risk compared to standard cholecystectomies and has been associated with difficult dissection, altered anatomy and increased risk of bleeding [2]. Although, the LC is the most common operation performed these days, some of the intended LC require conversion due to several factors. Many times, it demands conversion to open cholecystectomy due to intraoperative complications for the safe ending of the procedure and takes more than anticipated time. However, current literature has mentioned a conversion rate of nearly about (2%–10%) [3]. It is reported with an incidence of up to 26% in large series and a conversion rate of up to 26.5% [4]. There are many risk factors which make laparoscopic surgery difficult like old age, male gender, attacks of acute cholecystitis with fever and leukocytosis, obesity, previous abdominal surgery, clinical signs of acute cholecystitis, and some specific ultrasonographic findings (i.e., thickened gall bladder wall, distended gall bladder, pericholecystic fluid collection, and impacted stone [5]. Preoperative complexity estimation helps surgeons decide whether to proceed with a minimally invasive approach or perform an open procedure [6]. The use of a predictive score of operative difficulty is thus of primary interest to identify high-risk procedures and could be helpful to improve patient counselling, optimize surgical planning and operating room efficiency, detect patients at risk of complications and change, when necessary, the operative technique. This study aimed to predicting operative difficulties during laparoscopic cholecystectomy using clinical and radiological criteria based on intraoperative findings.

2. Patients And Methods

This prospective clinical study was conducted within two years duration extended from November 2019 to November 2021, on one hundred fifty patients (N=150) presented to out-patients clinic suffering from gall bladder disease and scheduled for laparoscopic cholecystectomy.

2.1 Inclusion criteria

Patients from Age 18 to 70 undergoing laparoscopic cholecystectomy for various indications such as cholelithiasis, gall bladder polyps or porcelain gall bladder, will be included in this study.

2.2 Exclusion criteria

Patients under 18 years in age and patients over 70 years old, Pregnant female patients. Patients unfit for anesthesia, Patients with hemorrhagic blood diseases, obstructive mass in the gall bladder and patients presented with CBD stones.

2.3 All patients included in the study were subjected to

Full personal, clinical history and examination and full laboratory (CBC , liver enzymes and bilirubin) and radiological investigations with consideration of age, gender, BMI history of previous hospital admissions with acute cholecystits Abdominal scar and presence of gall bladder distension on radiological investigations with consideration of gall bladder wall thickness, Pericholecystic collection and Impacted stone in Hartmann’s pouch, Intraoperative findings will be documented regarding gall bladder appearance , Distension / Contraction of gall bladder , Access (easy or difficult), presence of sepsis and time taken to identify cystic artery and cystic duct. All patients were assessed according to Randhawa score giving points to each item in preoperative

clinical and radiological assessment and correlation to intraoperative findings regarding degree of adhesions, distension or contraction of gall bladder, ability to grasp the fundus of the bladder, stone impaction in Hartman's pouch and presence of severe sepsis or occurrence of intraoperative bleeding and injury to hepatic ducts or cystic duct. Time taken to identify cystic duct and cystic artery was also considered as well as total operative time. Primary end point: Presence of complication as results of difficult laparoscopic cholecystectomy in the form of severe sepsis, excessive bleeding or injury to hepatic or common bile duct. Secondary end point: Conversion from laparoscopic to open surgery**.**

2.4 Statistical analysis

Statistical analysis was conducted using SPSS 22nd edition, numeric variables were presented in mean ± Standard deviation, comparison of means was conducted using Mann Whitney U test between 2 groups and Kruskal Wallis test among >2 groups. Categorical variables were presented in frequency and percentages, and compared using Chi2 test, however paired comparison was conducted using McNamara test. Sensitivity analysis was conducted using ROC curve. Any p value <0.05 was considered significant.

Table 1: Preoperative Randhawa score (2009) was applied to all patients included in our study (6).

Scoring Factors			Score	Maximum Score
History	Age	≤50 years	0	1
		> 50 years	1	
	Gender	Male	1	1
		Female	0	
	History of hospitalization for acute cholecystitis	Yes	4	4
		NO	0	
Clinical parameters	BMI	<25	0	
		25-27.5	1	2
		>27.5	2	
	Abdominal scar	No	0	
		Infraumbilical	1	2
		Supraumbilical	2	
	Palpable gall bladder	Yes	1	
		No	0	1
Radiological parameters	Gall bladder wall thickness	Thin <4mm	0	
		Thick ≥ 4mm	2	2
	Pericholecystic collection	No	0	1
		Yes	1	
	Impacted stone in Hartmann's pouch	NO	0	
		Yes	1	1
Total maximum score				15

Score up to 5 predicted easy, 6–10 difficult and >10 a very difficult laparoscopic cholecystectomy.

The degree of operative difficulty was assessed based on the laparoscopic intra-operative findings using the scoring system introduced by Sugrue et.al. [8] **[TABLE 2].**

TABLE 2 -Intra-operative Grading system for Difficult Laparoscopic Cholecystectomy (Sugrue et.al.)[8]

Scoring factors		Score	Maximum score
Gall bladder appearance	Adhesions < 50% of gall bladder	1	3
	Adhesions burying the gall bladder	3	
Distension/ Contraction	Distended or Contracted shriveled Gall Bladder	1	
	Unable to grasp the gall bladder with atraumatic laparoscopic forceps	1	3
	Stone of 1 cm or > 1 cm impacted in the Hartman's pouch	1	
Access	BMI > 30	1	
	Adhesions from previous surgery limiting access	1	2
Severe Sepsis/ Complication	Bile or Pus outside gall bladder	1	1
Time to identify cystic artery and cystic duct > 90 minutes		1	1
Total score			10

3. Results

A total of 150 patients were included in our final analysis, all included patients were admitted to surgery department with primary diagnosis of calculary cholecystitis. We assessed the clinical and radiological findings that form a score for detection of intraoperative difficulty of laparoscopic cholecystectomy. Among the included patients 129 (86%) aged ≤50 years, while 21 (14%) were >50 years. 80.7% were females while 19.3% were males. History of hospitalization for acute cholecystitis was reported in 32 (21.3%) of cases. BMI tends to exceed i25 in most of the included patients 59.7% (BMI 25-27.5) and 30.7% (BMI >27.5). Previous abdominal operations were reported in 58.7% of cases (36% infra umbilical scars, 22.7% supra umbilical scars). Distended gall bladder was reported in 18% of cases by US examination, cases with distended gall bladder CT was done and malignant masses excluded. Using Ultrasound there was a Pericholecystic collection in 2%, impacted stone in Hartmann's pouch in10%of the included cases. Gall bladder appearance showed Adhesions <50% of gall bladder in 81.3% and Adhesions burring the gall bladder in 9.3% of cases. As well difficult access was reported in 20% of patients, besides 100% of patients consumed <90 minutes to identify cystic artery and duct intraoperative.

Table 3: Components of clinical and radiological difficulty scoring.

		Count	Column N %
Age	≤50 years	129	86.0%
	>50 years	21	14.0%
Gender	Female	121	80.7%
	Male	29	19.3%
History of hospitalization for acute cholecystitis	No	118	78.7%
	Yes	32	21.3%
BMI	<25	28	18.7%
	25-27.5	76	50.7%
	>27.5	46	30.7%
Abdominal scar	No	62	41.3%
	Infra umbilical	54	36.0%
	Supra umbilical	34	22.7%
Distended GB on US	No	123	82.0%
	Yes	27	18.0%
Gall bladder wall thickness	<4 mm	73	48.7%
	>= 4mm	77	51.3%
Pericholecystic collection	No	147	98.0%
	Yes	3	2.0%
Impacted stone in Hartmann's pouch	No	135	90.0%
	Yes	15	10.0%
Distension / Contraction	No	78	52.0%
	Distended or contracted gall bladder	72	48.0%
Access	Easy access	120	80.0%
	Difficult access	30	20.0%
Time to identify cystic artery and duct > 90 minutes	< 90 minutes	150	100.0%
	> 90 minutes	0	0.0%
Clinical and radiological score	Easy	82	54.7%
	Difficult	68	45.3%
	Very Difficult	0	0.0%

Table 4: Operative details and difficulty score.

		Mean	Standard Deviation
Time of surgery (mean ± SD)		50.8	26.8
Conversion to open	No	148	98.7%
	Yes	2	1.3%
Complications	No	118	78.7%
	Yes	32	21.3%
Difficulty	Easy	118	78.7%
	Difficult	29	19.3%
	Very Difficult	3	2.0%

Clinical and radiological score revealed that 54.7% should have an easy operation while Among the included patients had a mean operative time was 50.8 ± SD 26.8 minutes. Only 2 patients needed conversion from laparoscopy to open, while 21.3% experienced postoperative complications. 45.3% will experience difficult laparoscopic cholecystectomy.

Intraoperative difficulty score showed that 78.7% of the included patients had an easy operation, 19.3% were difficult and only 3 (2%) had very difficult operation.

3.1 Paired comparison

Paired comparison of intraoperative versus clinical and radiological scores for laparoscopic cholecystectomy difficulty showed that there was a concordance between intraoperative and clinical difficulty score with p value 0.69. It showed a sensitivity 95.1% in detecting difficult operation, specificity 89.7%, Positive Predictive Value 86.76%, Negative Predictive Value 96.34% and overall diagnostic accuracy 92.00%.

Table 5: Paired comparison of intraoperative versus clinical and radiological difficulty scores.

				Intraoperative Difficulty		
			Easy	Difficult		P value
		Count	Row N %	Count	Row N %	
Clinical difficulty score	Easy	79	96.3%	3	3.7%	0.69
	Difficult	9	13.2%	59	82.3%	

Table 6: Diagnostic indices of clinic-radiological score.

Statistic	Value	95% CI
Sensitivity	95.16%	86.50% to 98.99%
Specificity	89.77%	81.47% to 95.22%
Positive Likelihood Ratio	9.30	5.00 to 17.32
Negative Likelihood Ratio	0.05	0.02 to 0.16
Disease prevalence (*)	41.33%	33.36% to 49.65%
Positive Predictive Value (*)	86.76%	77.88% to 92.43%
Negative Predictive Value (*)	96.34%	89.70% to 98.76%
Accuracy (*)	92.00%	86.44% to 95.80%

Multivariate analysis showed that age, gender, history of hospitalization with acute cholecystitis, abdominal scars, gall bladder wall thickness and impacted stone in Hartmann's pouch are an independent risk factors for difficult laparoscopic cholecystectomy with p value 0.009, 0.003, 0.0001, 0.003, 0.0001 and 0.014 respectively.

Table 7: Multivariate analysis of intra-operative outcome with risk factors

			Intraoperative Difficulty			P value
			Easy	Difficult		
		Count	Column N %	Count	Column N %	
Age	<=50 years	106	89.8%	23	71.9%	0.009
	>50 years	12	10.2%	9	28.1%	
Gender	Female	101	85.6%	20	62.5%	0.003
	Male	17	14.4%	12	37.5%	
History of hospitalization for acute cholecystitis	No	102	86.4%	16	50.0%	0.0001
	Yes	16	13.6%	16	50.0%	
BMI	<25	24	20.3%	4	12.5%	0.17
	25-27.5	62	52.5%	14	43.8%	
	>27.5	32	27.1%	14	43.8%	
Abdominal scar	No	55	46.6%	7	21.9%	0.003
	Infra umbilical	43	36.4%	11	34.4%	
	Supra umbilical	20	16.9%	14	43.8%	
Distended GB by US	No	98	83.1%	25	78.1%	0.52
	Yes	20	16.9%	7	21.9%	
Gall bladder wall thickness	<4 mm	68	57.6%	5	15.6%	0.0001
	>= 4mm	50	42.4%	27	84.4%	
Pericholecystic collection	No	115	97.5%	32	100.0%	0.36
	Yes	3	2.5%	0	0.0%	
Impacted stone in Hartmann's pouch	No	108	91.5%	27	84.4%	0.004
	Yes	10	8.5%	5	15.6%	

3.2 Total leukocyte count correlations

There was a statistically significant difference of WBCs count among difficulty grades as all patients with TLC >10 10^3/CC had difficult operation using clinical and radiological score with p value 0.0001.

Table 8: Comparison of TLC between groups based on Clinical and radiological difficulty **score.**

			Clinical and radiological difficulty score				P value
			Easy	Difficult		Very Difficult	
		Count	Column N %	Count	Column N %	Count	Column N %	
WBC	<10 10^3/CC	82	100.0%	32	47.1%	0	0.0%	0.0001
	≥10 10^3/CC	0	0.0%	36	52.9%	0	0.0%	

There was a statistically significant difference in TLC based on the intraoperative difficulty score with p value 0.0001, as most of patients with difficult operation had higher TLC as well as, those who had a very difficult intraoperative score were all having high TLC ≥10 10^3/CC.

Table 9: Comparison of TLC between groups based on intraoperative difficulty score.

		Intraoperative Difficulty score						P value
		Easy		Difficult		Very Difficult		
		Count	Row N %	Count	Row N %	Count	Row N %	
WBC	<10 10^3/CC	103	87.3%	11	37.9%	0	0.0%	0.0001
	≥ 10 10^3/CC	15	12.7%	18	62.1%	3	100.0%	

Operative time was significantly correlated with TLC as higher TLC counts was significantly correlated to longer intraoperative time with p value 0.0001 and correlation coefficient 0.78.

Table 10: Spearman correlation test between operative time and WBCs count.

Spearman test	Correlation coefficient	P value
Operative time and WBCs count	0.78	0.0001

3.3 Incidence of complications

Incidence of complications in the form of severe sepsis, excessive bleeding, and bile leak, intra and post operatively were reported among the included patients with rate 1.3% and 21.3% respectively. Conversion to open occurred in 2 cases, one case due to excessive bleeding obscuring the field that could not be controlled laparoscopically, other case due to excessive adhesions that led to CBD injury which necessitated open surgery and repair of injury and complete cholecystectomy procedure. Conversion rate was not significantly associated with clinical and radiological score of difficulty with p value 0.11, however incidence of complications 7(4%) cases had intraoperative sepsis 10(7%) cases had intraoperative bleeding and 15(10%) cases had intraoperative bile leak, was significantly higher among patients with difficult category (3.7% in easy group versus 42.6% in difficult group) in clinical score with p value 0.0001.

Table 11: Intra and postoperative complications incidence based on clinical and radiological difficulty score.

		Clinical and radiological difficulty score						P value
		Easy		Difficult		Very Difficult		
		N	%	N	%	N	%	
Conversion to open	No	82	100.0%	66	97.1%	0	0.0%	0.11
	Yes	0	0.0%	2	2.9%	0	0.0%	
Complications	No	79	96.3%	39	57.4%	0	0.0%	0.0001
	Yes	3	3.7%	29	42.6%	0	0.0%	

Table 12: Intra and postoperative complications incidence based on intraoperative difficulty score.

				Difficulty				P-Value
			Easy	Difficult		Very Difficult		
		N	%	N	%	N	%	
Conversion to open	No	118	100.0%	29	100.0%	1	33.3%	0.0001
	Yes	0	0.0%	0	0.0%	2	66.7%	
Complications	No	118	100.0%	0	0.0%	0	0.0%	0.0001
	Yes	0	0.0%	29	100.0%	3	100.0%	

There was a statistically significant association between intraoperative difficulty and conversion to open as very difficult operations were converted to open with p value 0.0001, as well, all patients with postoperative complications were only categorized as intraoperative difficult and very difficult scores with p value 0.0001.

4. Discussion

Laparoscopic cholecystectomy (LC) being the gold standard treatment of symptomatic cholelithiasis preoperative prediction of the risk of conversion is an important aspect of planning laparoscopic surgery. It is important to predict difficult LC preoperatively so that senior surgeons can be requested to be present during surgery rather than less experienced junior surgeon prolonging the surgery which may lead to intraoperative complications. In preoperatively predicted to be conversion, early decision of conversion can be made so as to avoid unnecessarily prolonging the surgery and to prevent complications. Many studies have attempted form a scoring system to predict difficult LC, but most of them are complex, use large number of determining factors, and they are difficult to use in day today practice [6,7]. And many of these scoring systems cannot be applied preoperatively [7,8]. In most of the studies age was considered as a risk factor for conversion [9]. Our results on the clinical and radiological difficulty scoring cleared that, among the included patients 129 (86%) aged ≤50 years, while 21 (14%) were >50 years. We and Bhandari et al did not notice age to be associated with during laparoscopic cholecystectomy [10]. In our results 23 (71.90 %) have difficulties observed at the age < 50 year and 9 (28.10 %) have difficulties observed at age > 50 year and there is a significant difference among age incidences. Our results agreed with the results of (-Soltes M et al) where they mentioned different predictors for difficult LC such as age 60 or more, male gender, comorbid condition, past history of acute cholecystitis, previous abdominal surgery, gall bladder wall thickness ≥4–5 mm, contracted gall bladder, and impacted stone [9]. Likewise, the elderly population (age >60 years) has been defined as a predictor for difficult laparoscopic cholecystectomy in some studies [9]. In our study, age, BMI (obesity), presence of comorbidity has not been found as risk factors similar to other studies. Also, Bhandari et al. when analyzed the predictors of difficult LC in DLC, they found that gender (male), past history of acute cholecystitis, gall bladder wall thickness (≥4–5 mm), fibrotic gallbladder, and adhesion in the triangle of Calot were significant risk factors for difficult LC likewise reported in other studies [10]. These results disagreed with those of

(Nidoni et al.) where they observed that, the mean age in non-converted patients and converted patients are 44.1 years and 62.33 years respectively but statistically they were not different from each other (p=0.22, 95% confidence interval) [11]. Our results cleared that, 80.7% were females while 19.3% were males. History of hospitalization for acute cholecystitis was reported in 32 (21.3%) of cases. These results agreed with those of (Nidoni et al.) where they found that there was delayed presentation of symptoms by male as compared to female patients. The possible reason could be less attention to mild symptoms leading to presentation only after disease progression. This scenario has also been mentioned in other studies [9, 10]. The results of (Nardoni et al.) cleared that, male sex as an independent risk for cholecystitis is controversial [11]. Few series have shown it to be an independent risk factor [12,13,14,15]. However, (Yol S, et al) did not notice sex to be associated with difficulties [15]. In our study, male sex was found to be a risk factor for difficulties (p = 0.034, 95% confidence interval). Notably, Vivek et al. in their study reported that BMI (obesity) is an important predictor [16]. Our study cleared that, the BMI tends to exceed 25 % in most of the included patients 59.7% (BMI 25-27.5) and 30.7% (BMI >27.5). But in our study, we could not assess since none of our patients were obese instead, we found some malnourished patients in our study but that did not have any effect on determining the difficult LC. Regarding surgeon's experience, in our institution, LC is regularly performed by consultant surgeons, so we did not include the experience of the surgeon as a predictor. However, some studies maintained the operative inexperience of surgeons as a risk factor for difficult LC [17]. Previous abdominal operations were reported in 58.7% of cases (36% infra umbilical scars, 22.7% supra umbilical scars). Distended gall bladder was reported in 18% of cases by US examination. Using Ultrasound there was a Pericholecystic collection in 2%, impacted stone in Hartmann's pouch in 10%o of cases. Our results higher than that of (Alponat, et al), The overall conversion rate in our study was 6%. Alponat, et al., conducted a study which included 536 patients who underwent laparoscopic cholecystectomy [18]. The Overall conversion rate in their study was 7.81%. Tiwary KS et al., conducted a study on 200 patients undergoing laparoscopic cholecystectomy at Kathmandu medical college [19]. The conversion rate in their study was 4%. Gall bladder appearance showed Adhesions <50% of gall bladder in 81.3% and Adhesions burring the gall bladder in 9.3% of cases. As well difficult access was reported in 20% of patients, besides 100% of patients consumed <90 minutes to identify cystic artery and duct intraoperative. These results agreed with the results of (Yol S et al) where they reported that, the patients who required hospitalization for repeated attacks of acute cholecystitis carry more chances of difficult laparoscopic cholecystectomy and conversion. Possibilities are dense adhesions at Calot's triangle and gall bladder fossa. In our study also, it was found to be a significant factor for the prediction of difficult laparoscopic cholecystectomy. These cases required more time for dissection of Calot's triangle and dissection of the gall bladder from the liver bed. [12]. The results of the clinical and radiological score revealed that 54.7% should have an easy operation while 45.3% will experience difficult laparoscopic cholecystectomy. The operative details and difficulty score results cleared that, among the included patients had a mean operative time was 50.8 ± SD 26.8 minutes. Only 2 patients needed conversion, one case due toexcessive bleeding that obscured the field that could not be controlled laparoscopically, other

case due to excessive adesions that led to CBD injury which necessities open surgery and repair, from laparoscopy to open, while 21.3% experienced postoperative complications in th form of sepsis or bile leak that was managed conservatively. Intraoperative difficulty score showed that 78.7% of the included patients had an easy operation, 19.3% were difficult and only 3 (2%) had very difficult operation. While our results on the intraoperative versus clinical and radiological difficulty scores, cleared that, the paired comparison of intraoperative versus clinical and radiological scores for laparoscopic cholecystectomy difficulty showed that there was a concordance between intraoperative and clinical difficulty score with p value 0.69. It showed a sensitivity 95.1% in detecting difficult operation, specificity 89.7%, Positive Predictive Value 86.76%, Negative Predictive Value 96.34% and overall diagnostic accuracy 92.00%. The results of the diagnostic indices of clinic-radiological score cleared that, its sensitivity reached to 95.16 %, specificity 89.77 and the diseases prevalence reached to 41.33 %, their accuracy % reached to 92 %. These results agreed with those of (Bhandari T.R.et al) revealed that there was significantly high risk of difficulty and conversion in patients with previous history of more than 2 attacks of acute cholecystitis (p=0.03, 95% confidence interval). Similar result has been concluded in other studies as well [11].

Also, Sanabria et al., found in their study of 628 patients that patients with multiple attacks (ten or more) were significantly associated with conversion, but in our study, we found significance with a number of attacks more than two [20]. In our study mean number of attacks in easy, difficult and converted groups were 1.28, 2.33 and 3.66 respectively. Schrenk et al., reported in a study of 300 patients assessing 24 variables for conversion that patients with history of acute cholecystitis within the last 3 weeks were at increased risk of conversion [21].

The Multivariate analysis of intra-operative outcome with risk factors, showed that the age, gender, history of hospitalization with acute cholecystitis, abdominal scars, gall bladder wall thickness and impacted stone in Hartmann's pouch are an independent risk factors for difficult laparoscopic cholecystectomy with p value 0.009, 0.003, 0.0001, 0.003, 0.0001 and 0.014 respectively [18].

This results agreed with those of Sanabria et al regarding gall bladder wall thickness has been identified as a risk factor for conversion in almost all the studies. The thickness of gall bladder associated with conversion varies from study to study. It was 3mm [20, 22], 4mm [23]. In our study the critical gall bladder wall thickness was 3mm. Also, (Bhandari T.R.et al), reported that, the mean gall bladder wall thickness in easy, difficult and conversion group was 3, 3.6, 5.6 respectively [11].

Moreover, we found fibrosis of the gallbladder is associated with difficult LC similar to reported by (Stanisic, V et al) [24] The fibrotic gallbladder usually resulted from repeated episodes of attack of cholecystitis due to constant irritation of the gallbladder wall with gallstones. Chronic inflammation of gall bladder leads to pericholecystic adhesion and adhesions at the triangle of calot' that leads to difficulty in dissection during LC and this increased duration of surgery, increase the risk of bleeding and injuries to adjacent structures. So, adhesion at Calot's triangle is another important predictor described in a few studies [25,26,27] similar to our study.

While our results on the total leukocyte count correlations cleared that, there was a statistically significant difference of WBCs count among difficulty grades as all patients

with TLC >10 10^3/CC had difficult operation using clinical and radiological score with p value 0.0001.

Many studies have identified raised WBC as a risk factor for predicting conversion [13]. The comparison of TLC between groups based on intraoperative difficulty score cleared that, there was a statistically significant difference in TLC based on the intraoperative difficulty score with p value 0.0001, as most of patients with difficult operation had higher TLC as well as, those who had a very difficult intraoperative score were all having high TLC ≥10 10^3/CC.

These results agreed with those of [11] where they observed significantly more risk of conversion in patients having TLC >11000/ cumm. (p=0.037, 95% confidence interval). This can be probably attributed to persisting acute inflammation with edema of the gall bladder making surgery difficult. The mean TLC in converted group of our study was ≥ 10 10^3/CC /cumm compared to 10195/cumm in a study conducted by [18].

The operative time was significantly correlated with TLC as higher TLC counts was significantly correlated to longer intraoperative time with p value 0.0001 and correlation coefficient 0.78. Also, our results cleared that, there was a statistically significant association between intraoperative difficulty and conversion to open as very difficult operations were converted to open with p value 0.0001, as well, all patients with postoperative complications were only categorized as intraoperative difficult and very difficult scores with p value 0.0001.

In our study, we performed the preoperative ultrasonographic evaluation of patients scheduled for surgery. Preoperative ultrasonographic findings of gallbladder wall thickness is also a significant predictor for difficult LC in our study, similarly, reported by [28]. Some studies have highlighted the use of laparoscopic ultrasound during cholecystectomy and incorporate its benefit in difficult situations while the anatomy is not clear [29].

To manage the challenging situations of difficult laparoscopic cholecystectomy, many studies have recommended alternative procedure and advised to follow a safe cholecystectomy principle (Dili, A., Bertrand, C. [6, 30].

Besides, several approaches have been described for the management of difficult LC in the literature including laparoscopic subtotal cholecystectomy, fundus first or antegrade or other techniques [30]. Though we usually performed laparoscopic subtotal cholecystectomy being very loyal to conversion, this study could not make a single recommendation about these techniques to manage difficult LC sand this has been agreed about growing consensus in laparoscopic subtotal cholecystectomy and fundus first methods. We believe that this is one of the precise series clearly showing an association of different preoperative and intraoperative predictors with difficult LC. Regarding the limitations of our study, we acknowledge that this is a retrospective and single centered study. Hence, to endorse our findings, we recommend conducting appropriately designed prospective studies in our setting in the future [31].

Our study concluded that, many times it is challenging, and the surgeon has to face the difficulty that might lead to injury to adjacent structures leading to an increase in morbidity. Therefore, the preoperative estimate of a difficult LC is essential to predict the difficulty as well as for a better surgical plan. It also helps the surgeon in being better prepared to anticipate the intra operative difficulties. Also, gender (male), past history of acute cholecystitis, gallbladder wall thickness (≥4–5 mm), fibrotic gallbladder, and adhesion at Calot’s

triangle are significant predictors for difficult LC. Moreover, an awareness about reliable predictors for difficult LC would be helpful for an appropriate treatment plan and application of the resources to anticipate difficult LC.

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