DIAGNOSTIC ACCURACY OF PREOPERATIVE ULTRASONOGRAPHY FOR THE PREDICTOR OF DIFFICULT LAPAROSCOPIC CHOLECYSTECTOMY IN PATIENTS UNDERGOING IT FOR SYMPTOMATIC CHOLELITHIASIS AT TERTIARY CARE HOSPITAL KARACHI

Original Research

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ABSTRACT

Objective: To determine the diagnostic accuracy of preoperative ultrasonography for the prediction of difficult laparoscopic cholecystectomy in patients undergoing it for symptomatic cholelithiasis at Tertiary Care Hospital, Karachi.

Study Design and Setting: Cross-section validation study. The study was conducted at the Department of Surgery, JPMC, Karachi over a period of six months after approval of the synopsis (08-02-21 till 08-08-21).

Methodology: After obtaining verbal consent, patients' data were prospectively collected. 230 patients fulfilled the diagnostic requirements. Frequency and percentages were used to represent qualitative variables, whereas mean and standard deviation were the only descriptive statistics used to convey quantitative data. Calculations were made for sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy.

Results: A total of 230 patients were included in this study. Mean age, duration of surgery, height, weight, and BMI in our study were 42.23±8.57 years, 1.41±0.40 hours, 165.62±8.23 cm, 68.34±8.23 kg and 24.85±3.34 kg/m2 respectively. 124 (53.9%) were male and 106 (46.1%) were female. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of preoperative ultrasonography for the prediction of difficult laparoscopic cholecystectomy by taking intraoperative findings as the gold standard was found to be 88.2%, 85.8%, 91.4%, 81.1%, and 87.3% respectively.

Conclusion: Preoperative ultrasonography is a good indicator of the difficulty of a laparoscopic cholecystectomy in most situations, thereby it should be utilized as a screening tool. It can assist the surgeon in developing an understanding of the challenges that he might encounter with a certain patient.

Keywords: Laparoscopic Cholecystectomy (LC), Open Cholecystectomy (OC), Ultrasonography, Diagnostic Accuracy.

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INTRODUCTION

Laparoscopic cholecystectomy (LC) is the most frequently done laparoscopic procedure globally and is considered the gold standard for removing the gall bladder in patients with symptomatic gall bladder disease [1]. Due to extensive adhesions in the Calot's triangle, gallbladder empyema, constricted gallbladder, Mirrzi's syndrome, prior upper abdominal surgeries, and acute cholecystitis, LC can prove challenging in cases with deformed anatomy [2]. Of them During laparoscopic (LC) procedures, the surgeon may encounter dense adhesions and anatomic anomalies that might potentially need an open cholecystectomy (OC). The problematic gallbladder and conversion to OC may be determined with the use of several preoperative criteria [3]. Several studies have shown conversion rates ranging from 1.5% to 35% [4]. On the other hand, the literature also indicated a conversion rate of 8.33% for tough situations and 2% for the whole.

Approximately majority of the research has found that GB wall thickness is a risk factor for problematic LC. A study found that difficulties during LC were substantially correlated with a GB wall thickness of more than 4 mm. Acute inflammation and edema of the GB wall might burst, releasing contaminated bile, and stones can further obstruct vision of the operational region, making the procedure more challenging [5–6]. According to Randhawa et al., there is no statistically significant correlation between impacted stone and LC difficulties. That the detection of dilated CBD by ultrasonography might help anticipate technical issues during LC [7]. Similar outcomes, in which ultrasound findings are useful in anticipating problematic LC and conversion risk, have been reported by Daradkeh et al. and Cho et al. In a validation of the Randhawa and colleagues' rating method, Gupta et al. assigned a score ranging from 0 (easy) to 15 for the most difficult gallbladder [Table 01] [8–9]. According to Lal and colleagues, a difficult cholecystectomy is defined as one that lasts more than 90 minutes, requires more than 20 minutes to rip the gallbladder, and more than 20 minutes to dissect the gallbladder and any adhesions. However, according to Gupta's scoring methodology, there are only two operative characteristics described: an impacted stone and an ultrasonographically thickened (≥4 mm) GB wall [10]. With a positive predictive value of 78.8%, a score of 5 accurately identified problematic LC with a sensitivity of 80.7% and specificity of 91.7%. Patients at high risk may be notified and scheduled accordingly based on this grading system [11].

Table 1: Criteria for Easy or Difficult Laparoscopic Cholecystectomy

Easy	Difficult
• Time taken <60 min	• Time taken >60 min
• Absence of biliary leakage	• Presence of biliary leakage
• No injury to duct or artery	• Injury to duct or artery
• No conversion to open cholecystectomy	• Conversion to open cholecystectomy[103-118]

Based on clinical history, it is exceedingly difficult to predict preoperatively whether LC would be simple or difficult [12]. The most popular noninvasive, secure, and very reliable screening method for cholecystitis and cholelithiasis is ultrasonography [13]. Additionally, it can assist surgeons in gaining an understanding of potential challenges that may arise during surgery for that specific patient. Surgeons might choose situations that are suitable for their expertise based on ultrasound results, with the goal of avoiding surgical time wastage and operative problems [14]. To help the surgeon and the patient prepare psychologically, specific preoperative parameters can accurately predict, based on ultrasonographic results, the likelihood of conversion to open surgery and the risk of specific problems [15]. According to research by Siddiqui et al., the prevalence of difficult laparoscopy is 27.6%, and the sensitivity and specificity of ultrasonography for predicting the likelihood of difficult laparoscopic cholecystectomy are 80.7% and 91.7%, respectively [16]. Lal et al. discovered that ultrasonography had a positive predictive value of 80.95% for difficult laparoscopic cholecystectomy cases and 61.90% for open cholecystectomy conversion cases. Apart from the standard diagnostic variables, ultrasonography can accurately anticipate operational issues in over 50% of patients. Both patients and surgeons would benefit from the identification of preoperative sonological factors that

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might indicate the risk for potential conversion [10]. As a result, a high correlation between challenging lap cholecystectomy and preoperative ultrasonography was discovered.

The purpose of this study is to ascertain the diagnostic accuracy of preoperative ultrasonography in predicting the difficulty of laparoscopic cholecystectomy in patients undergoing the procedure for symptomatic cholelithiasis. This is because local data are scarce and the prevalence of various diseases varies globally based on lifestyle, diet, socioeconomic status, and cultural background information. It is yet unknown how preoperative ultrasonography might help anticipate possible intraoperative challenges and problems. The information gathered from this study will be useful in determining how well ultrasonography predicts probable problems and difficulties that may arise during a laparoscopic cholecystectomy. Hence reducing the risk of surgical problems for patients and enhancing surgical results.

MATERIAL AND METHODS

This cross-sectional validated study was carried out at the Department of Surgery of Jinnah Post Graduate Medical Center, Karachi over the period of six months (Feb-Aug 2021). **Approved by JPMC Karachi under Ref: F.2-81/2024GENL/28/JPMC.** Patients from the age 20 to 60 years of either gender having ASA ≤ 2 undergoing laparoscopic cholecystectomy for symptomatic cholelithiasis were included in the study. Non-consented, history of abdominal surgery within past two years, history of hypo/hyperthyroidism, history of Hepatitis C, B or HIV Infection, history of congestive heart failure, asthma, chronic liver disease, chronic renal failure, chronic obstructive pulmonary disease, and stroke, or pregnant patients assessed by history and confirmed by dating scan were all excluded from the data collection. By taking the frequency of difficult laparoscopy 27.6% with a sensitivity 80.7%, and specificity 91.7% [17], 230 patients were targeted for data collection. On 95% confidence interval, the margin of error d=10% for sensitivity and d=10% for specificity was marked. Non-probability consecutive sampling techniques were used for data sampling.

Table 2: Scoring of Preoperative Ultrasonography Findings.

Ultrasound parameters	Score
GB wall thickness ≥4 mm	2
Transverse diameter of GB ≥5 cm	2
Presence of impacted stones	2
CBD diameter >6 mm	2
Presence of pericholecystic collection	1
Number of stones >1	1
Liver size ≥15.5 cm	1

Patients presenting with Fever labeled by temperature ≥ 37.5oC for ≥ 24 hours, Pain labeled by tenderness under right costal margin (VAS ≥ 4) for ≥ 24 hours, and/or CBC showing white blood cell (leukocyte) count of more than 11000cells/microliter was used to label symptomatic cholelithiasis. Preoperative ultrasonography was taken on seven sonographic findings as shown in [Table 02]. A cut-off value ultrasound score of ≥ 5 was taken to predict difficult laparoscopic cholecystectomy out of a total ultrasound score 11.

The entire duration of surgery for all patients undergoing laparoscopic cholecystectomy was ≥90 minutes, which included the insertion of the Verres needle, the extraction of the gallbladder, and the closure of the trocar insertion site. Additionally, the total time spent dissecting the Calot's triangle was ≥20 minutes, and the total time spent removing the gallbladder from the gallbladder bed was ≥20 minutes. Patients who experienced spillage of bile and stone, gallbladder tears, or conversion to open cholecystectomy, or severe

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bleeding during surgery that resulted in tachycardia exceeding 100/min and a drop in blood pressure of more than 10 mm Hg were classified as difficult patients. a history of diabetes mellitus with documentation, and at least six months of treatment for hypertension, diabetes, and hypertension. Smoking was defined as the history of 10 to 20 cigarettes per day for the last 5 years. Patients with BMI ≥ 30kg/m2 were labeled as obese.

Patients with difficult laparoscopic cholecystectomy and an ultrasound score of ≥ 5 were marked "True Positive", Patients without difficult laparoscopic cholecystectomy and an ultrasound score of ≤ 5 were marked "True Negative", Patients without difficult laparoscopic cholecystectomy and an ultrasound score of ≥ 5 were marked "False Positive", and Patients with difficult laparoscopic cholecystectomy and an ultrasound score of ≤ 5 were marked as "False Negative". The percentage of positives that are correctly classified as having the disease (True Positive/True Positive + False Negative x 100) was used to test sensitivity. The percentage of negatives that are correctly classified as not having the condition (True Negative/True Negative + False Positive x 100) was used to determine specificity. The percentages of true positive outcomes (True Positive/True Positive + False Positive x 100) in diagnostic tests and statistics were considered positive predictive values. The percentages of genuine negative outcomes (genuine Negative/True Negative + False Negative x100) in diagnostic tests and statistics were considered to have negative predictive values. The formula used to calculate diagnostic accuracy was Total Positive + Total Negative / Total Patients x 100.

The institutional ethical review committee's approval was obtained before the study was carried out. All patients gave their informed consent before being assigned to a sample or having their data used in research. To gather demographic data, a brief history was recorded. A wall-mounted scale was used to measure each participant's height in meters, a weighing machine was used to measure each participant's weight to the closest kilogram, and a BMI calculation was made at the time of admission. Sonography was performed by radiologists with over ten years of experience after overnight fasting. Both the supine and left lateral decubitus postures were used to assess the patient. In the presence of the researcher, a single, highly skilled surgeon with over 10 years of expertise will execute a laparoscopic cholecystectomy. A typical four-puncture method with two 5 mm and two 10 mm ports was used to carry it out. Additionally, selective intraoperative cholangiography was carried out in patients suspected of having a CBD stone or damage. There were installed drains. Following surgery, each patient had routine postoperative treatment and follow-up care. The intraoperative findings were noted by the researcher as per the operational definition and were labeled as difficult laparoscopic cholecystectomy.

Data was analyzed on SPSS Version 20. Mean and standard deviation was calculated for continuous variables. Frequency and percentages were calculated for categorical ordinal variables. Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy of the ultrasonography were calculated by taking intraoperative findings of laparoscopic cholecystectomy as the gold standard. Stratification was done with regard to *"age, gender, diabetes mellitus type II, hypertension, smoking status, and obesity status"*. Post-stratification sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy were calculated.

RESULT

Out of 230 patients minimum age of the patient was 20 while the maximum age of the patients was 60 years. The mean age in our study was 42.23±8.57 years where a high ratio of patients fell in 41 to 60 years of age (75.65%). Whereas the mean duration of surgery, height, weight, and BMI in our study was 1.41±0.40 hours, 165.62±8.23 cm, 68.34±8.23 kg, and 24.85±3.34 kg/m2 respectively. Out of 230 patients, 124 (53.9%) were male and 106 (46.1%) were female. There were more non-diabetic type II patients (74.8%) as compared to diabetic (25.2%). Non-hypertensive patients (87.8%), and non-smokers (77.8%) were found highest in number during data collection. 59.6% of patients were obese included in the study as per the inclusion criteria. 145 (63%) had difficult laparoscopic cholecystectomy as per intraoperative findings. The same ratio was observed in patients who had difficult laparoscopic cholecystectomy as per ultrasonography i.e. 140 (60.9%) had difficulty while 90 (39.1%) had no difficulty.

With respect to age in stratification of difficulty, the highest ratio of patients from the age of 41-60 years falls in the category of 100 true positive patients and 55 true negatives. Male and females of 74 and 54 respectively were observed as true positive, and 40 true negative male patients were observed on the difficulty level of cholecystectomy. Non-diabetic patients of true positive and true negative (98 and 55 patients) were mostly observed. Similarly, true positive (113) and true negative (65) non-hypertensive patients, and true positive (105) and true negative (55) non-smoker patients were stratified when observing the difficulty of cholecystectomy on the basis of intraoperative and ultrasound findings. True positive (87) obese patients, True positive (41) non obese were observed [Table 02].

Table 3: stratification of study parameters with diagnostic accuracy of preoperative ultrasonography for the prediction of difficult laparoscopic cholecystectomy by taking intraoperative findings as the gold standard.

DIFFICULT LAPAROSCOPIC CHOLECYSTECTOMY ON ULTRASONOGRAPHY	DIFFICULT LAPAROSCOPIC		CHOLECYSTECTOMY ON INTRAOPERATIVE FINDINGS	
Age	**20-40 years (n=56)**		**41-60 years (n=174)**	
	Present	Absent	Present	Absent
Present	28[a]	06[b]	100[a]	06[b]
Absent	04[c]	18[d]	13[c]	55[d]
Gender	**Male (n=124)**		**Female (n=106)**	
	Present	Absent	Present	Absent
Present	74[a]	06[b]	54[a]	06[b]
Absent	04[c]	40[d]	13[c]	33[d]
Diabetes Mellitus Type II	**Diabetic (n=58)**		**Non Diabetic (n=172)**	
	Present	Absent	Present	Absent
Present	30[a]	06[b]	98[a]	06[b]
Absent	04[c]	18[d]	13[c]	55[d]
Hypertension	**Hypertensive (n=28)**		**Non-Hypertensive (n=202)**	
	Present	Absent	Present	Absent
Present	15[a]	02[b]	113[a]	10[b]
Absent	03[c]	08[d]	14[c]	65[d]
Smoking Status	**Smoker (n=51)**		**Non Smoker (n=179)**	
	Present	Absent	Present	Absent
Present	23[a]	06[b]	105[a]	06[b]
Absent	04[c]	18[d]	13[c]	55[d]
Obesity Status	**Obese (n=93)**		**Non Obese (n=93)**	
	Present	Absent	Present	Absent
Present	87[a]	06[b]	41[a]	06[b]
Absent	04[c]	40[d]	13[c]	33[d]

[a]*True Positive,* [b]*False Positive,* [c]*False Negative,* [d]*True Negative*

On stratification of diagnostic accuracy of preoperative ultrasonography for the prediction of difficult laparoscopic cholecystectomy by taking intraoperative findings as gold standard; 128 patients were true positive, 73 were true negative, 12 were false positive, and 17 were false negative. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of preoperative ultrasonography for the prediction of difficult laparoscopic cholecystectomy by taking intraoperative findings as gold standard was found to be 88.2%, 85.8%, 91.4%, 81.1%, and 87.3% respectively. All variables showed excellent sensitivity, specificity, positive

predictive value, negative predictive value, and diagnostic accuracy of preoperative ultrasonography for the prediction of difficult laparoscopic cholecystectomy by taking intraoperative findings as the gold standard. Male and obese patients had 94.8% and 95.6% accuracy of sensitivity. 41-60 years of age, non-diabetic, and non-smoker showed an accuracy of specificity of about 90.1%. Both males and females of age 41-60 years, non-diabetic, non-hypertensive, and obese revealed the highest accuracy of post-predictive value. Non-smoker and obese patients had the most negative productive value accuracy i.e., 94.8 and 90.9 respectively. The highest diagnostic accuracy was observed among male and obese patients. [Table 03].

Table 4: Diagnostic accuracy, sensitivity, specificity, positive predictive value, the negative predictive value of preoperative ultrasonography for the prediction of difficult laparoscopic cholecystectomy by taking intraoperative findings as the gold standard.

	SENSITIVITY	SPECIFICITY	POSITIVE PREDICTIVE VALUE	NEGATIVE PRODUCTIVE VALUE	DIAGNOSTIC ACCURACY
Age					
20-40 years	87.5%	75%	82.3%	81.8%	82.1%
41-60 years	88.4%	**90.1%**	**94.3%**	80.8%	89%
Gender					
Male	**94.8%**	86.9%	**92.5%**	90.9%	**91.9%**
Female	80.5%	84.6%	**90%**	71.7%	82%
Diabetes Mellitus Type II					
Diabetic	88.2%	75%	83.3%	81.8%	82.7%
Non Diabetic	88.2%	**90.1%**	**94.2%**	80.8%	88.9%
Hypertension					
Hypertensive	83.3%	80%	88.2%	72.7%	82.1%
Non Hypertensive	88.9%	86.6%	**91.8%**	82.2%	88.1%
Smoking Status					
Smoker	85.1%	75%	79.3%	81.8%	80.3%
Non Smoker	88.9%	**90.1%**	86.7%	**94.8%**	89.3%
Obesity Status					
Obese	**95.6%**	86.9%	**93.5%**	**90.9%**	**92.7%**
Non Obese	75.9%	84.6%	87.2%	71.7%	79.5%

DISCUSSION

There were 230 patients in total in our research. In this study, the average age, length of surgery, height, weight, and BMI were 42.23±8.57 years, 1.41±0.40 hours, 165.62±8.23 cm, 68.34±8.23 kg, and 24.85±3.34 kg/m2, in that order. There were 106 (46.1%) females and 124 (53.9%) males. Using intraoperative findings as the gold standard, *"the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy"* of preoperative ultrasonography were found to be 88.2%, 85.8%, 91.4%, 81.1%,

and 87.3%, respectively, for the prediction of difficult laparoscopic cholecystectomy. In a study where 26/97 cases were predicted to be difficult on USG, but only 18/26 (69.23%) cases were actually found to be difficult, there was a significant correlation between preoperative USG prediction and difficulty in LC. This resulted in a positive predictive value (PPV) of approximately 70% for difficult cases on LC and a p-value <0.001. In this study, contracted GB was found to be the most important USG Parameter for predicting problematic LC, with a p-value <0.001. With the highest PPV of the four USG measures, it was 92.3%. Additionally, there was a strong association (p-value = 0.030) between conversion to OC and preoperative USG prediction. The sensitivity, specificity, PPV (prediction of difficult LC on USG) and NPV (prediction of easy LC on USG) of USG for the prediction of difficult LC were 56.3%, 87.7%, 69.2% and 80.3% respectively [18].

According to another study, there was a significant correlation between the conversion of the procedure to an open cholecystectomy and the ultrasonographic parameters. This finding demonstrated that pre-operative ultrasonography is, in most cases, a reliable indicator of the difficulty of a laparoscopic cholecystectomy and should therefore be used as a screening procedure. When all four criteria were taken into account, the PPV of ultrasonography was 91.67%. The prediction's sensitivity was 78.57%. Additionally, the ultrasonographic prediction's specificity was 97.22%. [19] According to Lal et al., ultrasonography had an 80.95% positive predictive value for complicated laparoscopic cholecystectomy cases. Additionally, 61.90% was the positive predictive value for the prediction of conversion to an open cholecystectomy [20–21]. According to research by Dinkel et al., wall thickening's sensitivity, specificity, accuracy, and positive predictive value as a gauge of technical issues were, respectively, 66.7%, 94.1%, 84.2%, and 85.3% [22].

According to one piece of research, detecting challenging LC accurately required a score of >5, which had a sensitivity of 80.7% and a specificity of 91.7%. In 78.8% of tough and 92.6% of easy scenarios, the prediction was correct. The US results for dilated CBD, impacted stones, thicker GB walls, and distended GB were determined to be statistically significant. The conversion risk of LC to OC may be accurately predicted by this local grading system. High-risk patients might be properly planned, educated, and given the option to switch to open cardiology (OC) sooner if difficulties were predicted [23]. The laparoscopic cholecystectomy procedure was found to be more difficult than predicted by Prakash V et al. in 35% of cases. Of these, 3 cases had a difficult laparoscopic procedure (sensitivity & specificity: 100% & 67%), and 1 patient needed to convert to an open procedure (sensitivity & specificity: 100% & 65.7%). Difficult laparoscopic cholecystectomy can be predicted with meticulous preoperative USG by an expert radiologist, which may aid in appropriate preoperative planning and counseling to lower overall difficulties and morbidity [24].

CONCLUSION

Preoperative ultrasonography should be utilized as a screening method since it is generally a good predictor of the difficulties of laparoscopic cholecystectomy. The majority of challenging gallbladder cases may now be handled laparoscopically because to advancements in technology and increased laparoscopic experience. Preoperative risk variables can be used to forecast the likelihood of challenging gallbladder and OC conversion. Surgeons may find it useful to have an understanding of the various challenges that might arise with that specific patient. It is found that preoperative ultrasonography, in particular, affected the GB stone in the neck and thickened the GB wall. Preoperative assessment of a challenging laparoscopic cholecystectomy might aid in appropriate patient counseling and preoperative preparation to lower overall complications and morbidity.

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AUTHORSHIP

All authors have contributed their substantial work in form of data collection, data compilation, data analysis, study literature search, and writing the manuscript equally.

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CONFLICT OF INTEREST

The authors have no financial or non-financial ties to any organization or institution with an interest in the manuscript's subject or materials.

AUTHOR CONTRIBUTION

Author	Contribution
Sadia Lateef*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Nimra Aslam	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Rakhshanda Najam Siddiqi	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Tashaba Qaiser Faizi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
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