Original Article

Accuracy of Ultrasonography in Predicting Factors for Difficult Laparoscopic Cholecystectomy

Muhammad Raheem, Sajid Ali Shah, S H Waqar

ABSTRACT

Objective: To determine the accuracy of ultrasound in predicting difficult laparoscopic cholecystectomy, keeping preoperative findings as gold standard.

Methodology: A cross sectional study was conducted from July 2018 to January 2019 at Department of General Surgery, Pakistan Institute of Medical Sciences Islamabad. Adult patients with diagnosis of cholelithiasis were included in the study by consecutive sampling, who underwent laparoscopic cholecystectomy. Preoperative ultrasound parameters such as gallbladder wall thickness, size & number of gallstones, pericholecystic fluid, impacted stone and contracted gall bladder were studied. Intraoperative difficulty of laparoscopic cholecystectomy was determined by the criteria as procedure time more than 60 minutes, dissection at Calot's triangle more than 30 minutes and tear of gallbladder.

Results: A total of 150 patients were included in the study with mean age of 41.4+9.9 years. There were 29(19.3%) males and 121(80.7%) females with male to female ratio of 1:4. Preoperative ultrasonography (USG) findings such as gall bladder wall thickness >4mm, size of the stone ≥1 cm impacted gall stones, contracted gall bladder and presence of pericholecystic fluid were significantly (*p* value= 0.001) associated with difficult laparoscopic cholecystectomy.

Conclusion: In majority of the patients, preoperative ultrasonography is found as a good predictor of difficult laparoscopic cholecystectomy and should be used as a screening procedure.

KEYWORDS: Cholelithiasis, Laparoscopic cholecystectomy, Ultrasonography.

INTRODUCTION

The gold standard in the treatment of symptomatic gallstones is laparoscopic cholecystectomy, which is one of the most regularly performed surgical operations globally.[1] When compared to open cholecystectomy, literature demonstrates that laparoscopic cholecystectomy is safer and more successful in terms of hospital stay, morbidity, recovery time, and cosmesis.[2] It is associated to a 0.5% mortality rate and a 10% morbidity rate, respectively.[3] There are many factors that make the laparoscopic surgery difficult like obesity, previous surgery in that area, multiple stones that may lead to spillage of stone into the common bile duct, gall bladder wall thickness of more than 4mm and presence of pericholecystic fluid.[4] Ultrasonography is the investigation of choice in gallbladder or biliary disease. Preoperative abdominal ultrasonography is the most commonly used modality, as it is a low-cost, radiation-free, and non-invasive diagnostic approach.[5] It is the gold-standard for the identification of extrahepatic biliary disorders and gall stone disease, with a sensitivity and specificity of 84 percent and 99 percent, respectively.[6] Preoperative ultrasonography can help to determine surgical problems or even the likelihood of a laparotomy conversion,[4] despite that it is operator dependent. Actual rates of conversion from the laparoscopic cholecystectomy to open cholecystectomy recorded in the literature are highly diverse, ranging from 0% to 35%, despite the increase in surgical expertise.[7,8] Patients with a gall bladder wall thickness of more than 4 mm on ultrasonography are more likely to have a difficult operation or conversion to open , as well as a higher risk of bile duct injury or harm to the adjacent viscera,[9] while the accuracy of presence of pericholecystic fluid on ultrasonography, is another factor of difficult laparoscopic surgery.[10] The presence of multiple stones within the gall bladder on ultrasonography is another indicator of difficult laparoscopic surgery.[11] Surgeons can choose situations that are appropriate for their skills based on ultrasound

Dr. Muhammad Raheem *MBBS*
Postgraduate Resident
Pakistan Institute of Medical Sciences, ISB
Dr. Sajid Ali Shah *MBBS, FCPS*
Assistant Professor
Pakistan Institute of Medical Sciences, ISB
Dr. S H Waqar *MBBS, FCPS,*
Professor
Pakistan Institute of Medical Sciences, ISB

Correspondence:
Dr. S H Waqar
Email: drshwaqar@szabmu.edu.pk

findings, limiting operative complications and maximizing available operating time.

It would be beneficial to have some reliable predictors of laparoscopic cholecystectomy conversion or complications. Patients may be chosen for laparoscopic cholecystectomy and other high-risk operations with the potential for consequences. The aim of present study was to predict the diagnostic accuracy of ultrasonography in determining the factors that make laparoscopic cholecystectomy difficult. It might help the surgeon in better anticipation of the possible complications. Secondly it will help the surgeon in better explaining the procedure its complications and possible conversion to open cholecystectomy to the patient and his/her relatives before surgery. In this way patient can be mentally prepared and he/she can adjust their expectations accordingly.

METHODOLOGY

This cross-sectional validation study was conducted in Department of Surgery, Pakistan Institute of Medical Sciences, Islamabad, including 150 patients from July 2018 to June 2019. Sample size was calculated using WHO sample size calculator confidence level 95%**.** Patient of both genders with age above 20 years with a diagnosis of cholelithiasis who admitted for laparoscopic cholecystectomy were included using non-probable consecutive sampling technique in this study. Patients having CBD stones or any other CBD pathology, jaundice or abnormal liver function tests (LFTs), acute cholecystitis, abnormal coagulation profile, and patients who had previously undergone upper abdominal procedures were excluded from the trial.

Informed consent was obtained from all of the patients recruited once the hospital ethical committee approved the study (F.1-1/2015/ERB/SZABMU/263). Patients who fulfilled the inclusion criteria were selected from the OPD of General surgery department and admitted to the ward for laparoscopic cholecystectomy. History was taken in detail from the patients and a thorough examination was performed. Preoperative ultrasound was performed in all the patients by radiologist using the same probe (Aplio 500, Toshiba, Japan). Gallbladder wall thickness; number of gallstones, pericholecystic fluid, impacted stone and contracted gall bladder were the parameters studied on ultrasonography. The learning curve statistics do not apply to this study because the surgeon is experienced in laparoscopic surgery. Intraoperative findings were recorded on specifically designed proforma. Following criteria was set to objectively grade the operative findings as difficult laparoscopic cholecystectomy:

- Procedure time of more than 60 minutes (time taken from introduction of the Verses needle or trocar until the retrieval of the gallbladder)
- Gallbladder tear during dissection, resulting in bile and stone leakage.
- More than 30 minutes for dissection of gall bladder from the bed
- Calot's triangle took more than 30 minutes for dissection
- Any procedure that need conversion to the open

Statistical analysis: The data was examined using the SPSS version 24 computer-based statistical software. For the categorical variables like gender, number of gall stones, bladder wall thickness and presence of peri-cholecystic fluid, frequencies and percentages were determined. Mean and standard deviations were calculated from continuous numerical variables like age. Post stratification chi-square test was applied. P value less than 0.05 was considered statistically significant. Diagnostic efficacy indices like sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) of ultrasonography were measured and accuracy for the ultrasonography was calculated by using the following standard formulas:

Sensitivity = TP/TP+FN x 100

Specificity =TN/TN+FP x 100

Positive Predictive Value = TP/TP+FP x 100

Negative Predictive Value = TN/TN+ FN x 100

RESULTS

A total of 150 patients were included in the study who underwent laparoscopic cholecystectomy. The mean age was 41.4±9.9 years (range 20 – 65 years).

Table 1: Patients' Characteristics and Parameters (N=150)

Items	Statistics N (%)
Age (years)	
Mean ± SD	41.4±9.9
Median (Range)	42 (20 – 60)
Gender	
Female	121 (80.7)
Male	29 (19.3)
BMI (kg/m^2)	
<25	102 (68)
25 – 27.5	14 (9.3)
>27.5	34 (22.7)
Palpable gallbladder	
No	116 (77.3)
Yes	34 (22.7)
Operating time (minutes)	
Mean + SD	20.35 ± 17.62
Range	8.31 – 90.7
Conversion rate	07 (4.6)

There were 29 males (19.3%) and 121 females (80.7%), with male to female ratio was 1:4. (Table 1) Mean duration of surgery and postoperative hospital stay were 20.35 ± 17.62 minutes and 1.4 ± 0.5 days respectively. Table 1 showed patients' characteristics with conversion rate from laparoscopic surgery to open, while ultrasonographic findings are shown in Table 2.

Table 2: Preoperative Ultrasonography (USG) Findings of Study Population (n=150)

USG findings	N (%)
Peri-cholecystic fluid	7 (4.7)
Number of stones	
Single	08 (5.3)
Multiple	142 (94.7)
Gallbladder wall thickness	
<4mm	132 (88)
≥4mm	18 (12)
Impacted stone	20 (13.3)
Contracted Gallbladder	18 (12)
Size of the stone	
<1cm	122 (81.3)
≥1cm	28 (18.7)

As demonstrated in Table 3, preoperative ultrasound abnormalities such as gall bladder wall thickness >4mm, stone size ≥1 cm, contracted gall bladder, and presence of pericholecystic fluid were strongly linked with complicated laparoscopic cholecystectomy.

Table 3: Relation of Preoperative Ultrasonography Findings and Difficult Laparoscopic Cholecystectomy (n=150)

USG parameters	Findings	Laparoscopic Cholecystectomy			
		Difficult n (%)	Not difficult n (%)	Total n	P value
Gall bladder wall thickness	≤ 4mm > 4mm	18 (15.7) 31 (88.6)	97 (84.3) 04 (11.4)	115 35	.001*
Size of the stone	<1cm ≥1cm	30 (24.6) 20 (71.4)	92 (75.4) 08 (28.6)	122 28	.004*
Gall stone mobility	Mobile Impacted	99 (76.1) 20 (100)	31 (23.9) 0 (0.0)	130 20	.001*
Contracted gall bladder	No Yes	02 (1.5) 17 (94.4)	130 (98.5) 01 (5.5)	132 18	.001*
Pericholecystic fluid	No Yes	25 (20.3) 26 (96.3)	98 (79.7) 01 (3.7)	123 27	.001*

p-value less than 0.05 considered significant

Table 4: Diagnostic Accuracy of Ultrasonography Findings in Predicting Difficult Laparoscopic Cholecystectomy (n = 150)

USG findings	Diagnostic accuracy				
	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Gall bladder wall thickness (>4mm)	89.4	99.2	94.4	98.4	98
Size of the stone (≥1cm)	96.5	75	99.3	37.5	96
Gall stone mobility (Impacted)	40	100	100	76.9	80
Contracted gall bladder	65	97.5	92.9	84.5	86.7
Pericholecystic fluid	75	99.3	89.7	98.6	98

PPV=Positive Predictive Value, NPV=Negative Predictive Value, USG = Ultrasonography

The presence of the pericholecystic fluid on ultrasonography and gall bladder wall thickness of more than 4mm were the most reliable predictors of a difficult laparoscopic cholecystectomy, followed by the size of the stone and a contracted gall bladder, as shown in Table 4. Sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of gall bladder wall thickness of more than 4mm and pericholecystic fluid on ultrasonography were predictors of the difficult laparoscopic cholecystectomy showed 89.4%, 99.2%, 94.4%, 98,4%, 98% and 75%, 99.3%, 85.7%, 98.6%, 98% respectively; while number of gall stones on ultrasonography showed sensitivity 96.5%, specificity 75%, PPV 99.3% NPV 37.5% and 96% diagnostic accuracy.

DISCUSSION

Cholelithiasis is one of the most frequent digestive problems. Gallstones are typically asymptomatic (>80% of the time), and the prevalence of gallstones varies greatly around the globe.[12] Due to benefits of reduced postoperative morbidity, safety, and success, laparoscopic cholecystectomy has become the gold standard treatment for symptomatic gallstones.[13] It is now the most commonly performed operation by general surgeons. Currently, the laparoscopic cholecystectomies account for about 80% of cholecystectomies.[14] Aim was to determine if there were any pre-operative abdominal ultrasonographic parameters that could accurately predict the likelihood of difficulty and problems during laparoscopic cholecystectomy. When there was an acutely inflamed or gangrenous gallbladder, dense adhesions at Calot's triangle, fibrotic and contracted gall bladder, the surgeons encountered difficulties in laparoscopic cholecystectomy. Male sex, advanced age, obesity, acute cholecystitis attacks, previous abdominal surgery, and certain ultrasonographic abnormalities, such as thickening gall bladder wall, distended gall bladder, pericholecystic fluid collection, and impacted stone, are all risk factors that make laparoscopic operation difficult. Although generally safe and uneventful, laparoscopic cholecystectomy might be challenging at times. The majority of the country's novice laparoscopic surgeons use relatively basic instruments and infrastructure. It's also possible that senior laparoscopic surgeons won't be available. With increasing expertise, the selection criteria for laparoscopic cholecystectomy have gotten more lenient.

Old age has been identified as a substantial risk factor for the complicated laparoscopic cholecystectomy in some investigations[15] and choose the age of 50 years as cut off for this purpose. Because the majority of the patients in this study were under the age of 50, age had no bearing on intraoperative difficulties. This finding is in line with that of Gupta et al, while Saleem AA et al discovered a strong link between age higher than 50 years and surgical difficulty.[16,6]

Most of the patients (80.7%) in this study were females. The effect of estrogen and progesterone on biliary cholesterol levels and gallbladder motility has been linked to a higher prevalence of gallstones in women.[17] The connection between male sex and difficult cholecystectomy is debatable. According to several studies, male gender may be a risk factor for complicated cholecystectomy. Males may be detected late since cholelithiasis is thought to be mostly a disease of females. Due to frequent attacks of inflammation before diagnosis, it may result in substantial adhesions. Males had a considerably higher conversion rate than females, according to Nidoni et al ($p = 0.034$, 95 percent confidence interval). [18] The conversion rate from laparoscopic to open cholecystectomy varies between 7% and 35% globally.[19] In this study, the overall conversation rate was 4.6 percent; all cases had mostly comparable prognostic variables, such as palpable GB, pericholecystic collection, increased GB wall thickness, and a BMI of more than 25, while gender and age had no bearing on conversion. This finding is in consistent with Bourgouin et al (4.3%).[20] This low conversion rate may be attributed to the expertise of the operating surgeon. Several prediction models for a difficult LC have been presented but these are based on subjective assessment of difficulty made by surgeon that he encounters intraoperative. However, because these evaluations are based on a surgeon's experience and usual practice, they are difficult to transmit between institutions.[21] So findings of ultrasonography have been used as predictors for difficult laparoscopic cholecystectomy. Gall bladder has been identified in studies as a predictor of difficult surgery.[22] Gall bladder wall thickness is one of the most researched parameters, and it can be assessed with high precision using ultrasonography.[23] Gall bladder detachment from its bed is more difficult when the thickness of wall of the gall bladder is increased; thicker gall bladder walls make grasping and manipulating the gall bladder more difficult, as well as making dissection at Calot's triangle and the gall bladder bed more difficult.[6] In this study, we discovered a significant link (p 0.001) between the gall bladder wall thickness and the complex surgery which is comparable to other studies. The presence of pericholecystic fluid on ultrasonography was found to be a predictor for the difficult laparoscopic cholecystectomy in the study; this was present in 27 (18%) patients and in 26 cases, laparoscopic cholecystectomy was found difficult. Similar results were described by Chindarkar H et al and Nidoni et al in their studies.[2,18] Another important indicator that has a good predictive value is a stone impacted at the neck. Because of the distension of the gall bladder and the thick gall bladder wall, an impacted stone at the neck of the gall bladder causes some technical issues in the laparoscopic cholecystectomy. We found stone impacted in 20 (13.3%) patients and all were difficult on surgery. The impacted stone caused mucocele, which made it difficult to grasp the gallbladder's infundibulum for retraction during dissection, resulting in difficult operation. This result is in consistent with other studies.[24] Many studies have discovered a statistical link between the size of stones and the conversion of laparoscopic cholecystectomy to open cholecystectomy.[2] The same is found in the present study, but Jansen et al showed that stones larger than 20 mm were associated with a higher chance of conversion.[25] In this study, a 10 mm gall bladder calculus is used as a cutoff size. Twenty (71.4%) out of the 28 cases with calculi larger than 10 mm had difficult laparoscopic surgery, while the remaining eight (28.6%) did not. A much higher proportion of cases with a larger calculus had a higher likelihood of difficult surgery.

***Limitations*:** Major limitations of ultrasound are that it is operator dependent, experience of sinologist, difficulty in obese patients and difficulty with contracted gall bladder.

CONCLUSION

In the vast majority of instances, preoperative ultrasonography is an excellent predictor of difficulty in laparoscopic cholecystectomy and should be used as a screening technique. This can help the surgeon anticipate any potential problems during surgery, allowing for better pre-operative planning and patient counseling, and lowering overall morbidity and complications.

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***Authors' contribution*:**	
Dr. Muhammad Raheem	Study design and concept, the acquisition, analysis, or interpretation of data for the work; Drafting the manuscript revising critically for important intellectual content
Dr. Sajid Ali Shah	Study design and concept, data collection and analysis, or interpretation of data, manuscript writing, revising it critically for important intellectual content
Dr. S H Waqar	Study design, interpretation of data for the work; Drafting the manuscript or revising it critically for important intellectual content All authors participated in study design and writing manuscript and agree to be accountable for accuracy, integrity of all aspects of the work.

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