

Ultrasound findings in predicting difficult laparoscopic cholecystectomy

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Abstract

Background: Multiple technical intra-operative problems that raise the risk of complications and greatly lengthen the operating time are referred to as difficult laparoscopic cholecystectomy (LC).

Aim: to assess preoperative ultrasound (US) findings that indicate a difficult (LC) and the potential benefits for improvement of patient care.

Patients and method: 100 patients underwent LC over a period of 9 months. Of these, 74 were female and 26 were male. Abdominal US was performed 48 hours prior to the surgery. The gallbladder (GB) wall thickness, GB size, gallstone (GS) multiplicity, GS mobility, GB empyema, and presence of pericholecystic fluid are the six parameters that were examined by ultrasound. The surgical procedure was rated as easy or difficult based on some surgical parameters, these include the length of the procedure, the occurrence of intraoperative bleeding, and the presence of significant adhesions or inflammation surrounding the GB and the Calot's triangle that obscure the dissection planes. The results of the ultrasound and the operation were compared.

Results: According to the statistical analysis, all ultrasound parameters were significantly correlated with the degree of surgical difficulty. 21 of the patients had a difficult laparoscopic cholecystectomy; of them, 2 had an open procedure performed because of severe adhesion. When predicting a difficult laparoscopic cholecystectomy, the thick wall gallbladder > 3mm has the highest sensitivity (83.3%) and the presence of pericholecystic fluid or empyema has the highest specificity (100%).

Conclusion: preoperative ultrasound results can be useful in anticipating problems that may arise during LC and necessitate conversion to open cholecystectomy (OC).

Keywords: Ultrasound; Laparoscopic cholecystectomy; Difficult; Open cholecystectomy.

1. Introduction

Laparoscopic cholecystectomy became one of the most frequently performed procedures worldwide in general surgery, it has a, shorter hospital stay and provides a more comfortable postoperative period for the patient. In comparison to OC, LC offers not only patient satisfaction but also lower risk of problems, better cosmesis and shortens hospitalization period [1, 2, 3]. In situations where LC is dangerous, a surgeon may be forced to change from laparoscopy to open procedure [4]. The phrase (difficult cholecystectomy) describes multiple technical intra-operative problems that

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lengthen the operating time and raise the risk of complications [5, 6]. The majority of patients will benefit from the laparoscopic technique as well, but difficult cases have a higher chance of conversion and the consequent complications that could outweigh any benefits of the laparoscopic procedure, rendering it risky, expensive, ineffective, and potentially less effective than open cholecystectomy [7, 8]. The preparation and planning of management for patients with symptomatic cholelithiasis would greatly benefit from the availability of reliable predictive factors for difficult procedures, and consequently, conversion of laparoscopic cholecystectomy [9, 10]. It is not a complication to convert to an open procedure, and the patient should be informed of this possibility prior to surgery. With emergency operations, conversion rates are typically higher in most series. Reporting rates for elective cases vary from 1.5 to 15%, with most reporting rates being approximately 5% [11]. When significant anatomic structures are uncontrollably clear or no progress is being made, the decision to convert to OC should be taken. Generally speaking, the procedure should be changed to OC if the gallbladder-cystic duct junction cannot be found within 30 minutes of the start of the procedure [12].

Preoperative information regarding potential intraoperative complications, such as uncontrollable bleeding or unclear anatomy, will be especially beneficial if LC is converted to OC [13, 14]. It can be helpful to raise level of cautiousness and establish a criterion that could assess the risk for conversion preoperatively [15]. Accurately determining a patient's risk of conversion based on preoperative data would be beneficial because it could lead to better preoperative counseling, more efficient scheduling and use of the operating room, risk stratification for technical difficulty, and the appropriate assignment of resident assistance. It could also improve patient safety by reducing the amount of time needed for conversion and improve the mental preparation of both surgeons and patients [16, 17].

In more than 90% of patients with symptoms, gallstones can be reliably detected using ultrasonography. In 93% of patients, ultrasonography-based measurements of the gallbladder wall thickness are accurate to within 1 mm [17].

2. Patients and methods

The study is an analytical prospective study which was carried out at the Al-Imamain Al-Kadhmayain Medical City in Baghdad, Iraq, in the departments of surgery and diagnostic radiology through period of 9 months. This study involved one hundred patients, of which 74 were female and 26 were male. Patients with acute or chronic cholecystitis or gallstone disease who were scheduled for a laparoscopic cholecystectomy met the inclusion criteria. Patients with renal failure, pancreatitis, previous upper abdominal surgery, suspected cancer, with bleeding disorders, diabetes, and uncontrolled hypertension are the exclusion criteria.

A detailed clinical history and physical examination were carried out prior to the patient being taken for surgery, a full blood count, liver function tests, a chest X-ray, and other preanesthetic investigations were performed. The following details were obtained from patients who got ready for a laparoscopic cholecystectomy: age, sex, occupation; clinical presentation; prior medical and surgical history; family history and laboratory results.

One to two days before the procedure, an abdominal ultrasound was carried out with a high resolution ultrasound machine (3.5MHz, curvilinear probe, HD11/Philips medical system, Netherlands). Prior to the examination, the patients had a minimum 6-hour fast.

During suspended inspiration, the right subcostal area was the site of the first scan. In addition to scanning parallel to the GB's long axis, scans were also conducted perpendicular to it. Right lateral intercostal scans were carried out along the intercostal spaces when necessary. An additional alternative method involved placing the patients entirely on their left side, performing anterior subcostal scans, and, if stone impaction was suspected, positioning them upright. Every inch of the organ was carefully inspected to make sure no small calculus was overlooked. By using ultrasonography, the following parameters were examined: the size of GB, wall thickness, multiplicity and mobility of gallstones, gallbladder empyema as well as pericholecystic fluid's existence. Measurements beyond 3 mm were regarded as thickening of the wall, and this value was accepted as the threshold for calculating wall thickness. Gallbladder sizes are categorized using the GB short axis. The patient was scanned in supine, lateral decubitus, and upright positions to assess the mobility of the stone or stones (GS impaction at the GB's neck and the GB packed so densely with stones that the stones are immobile, regarding as immobile GS). The US parameters evaluated to predict the surgical result are displayed in Table (1).

Table 1 US parameters assessed to predict the surgical results

Ultrasound parameters		
GB wall thickness	Normal(≤ 3 mm)	Thick(> 3 mm)
GB size (short axis)	Normal (2-5 cm)	Abnormal (> 5 cm or < 2 cm)
Gall stones multiplicity	Absent	Present
Gall stones mobility	Mobile	Immobile
GB empyema	Absent	Present
Pericholecystic fluid	Absent	Present

The following are the parameters of surgical difficulty at LC:

- A prolonged operation lasting longer than thirty minutes, during which all the structures in Calot's triangle were identified and the cystic duct and cystic artery were ligated.
- Significant adhesions or inflammation obstructing the dissection planes around the GB and the Calot's triangle.
- The existence of bleeding during surgery.

When the procedure needed to be changed to an open cholecystectomy, the surgeon made that decision. The ultrasound results prior to surgery were compared to the results after surgery.

The statistical analysis was conducted utilizing SPSS. For the continuous variables, descriptive data was taken out, and for the other variables, frequencies were ascertained. After analyzing qualitative data, chi-square was ascertained. For quantitative data, the independent sample t-test was used, and P values of less than 0.05 were regarded as statistically significant.

3. Results

Of the 100 patients in the study, 74 were female and 26 were male (a female to male ratio of 2.85). The age distribution was 21–70 years old (mean 42.22 ± 1.15). All patients whose preoperative ultrasound had shown GS had GS discovered surgically; therefore, the ultrasound's sensitivity, specificity, and accuracy in diagnosing GS were 100%. Table (2) displays the frequency of ultrasound parameters that impact surgical difficulty.

Table 2 Frequency of US parameters that impact surgical difficulty (some patients have more than one parameter)

Ultrasound parameters	Patients	
	No.	%
Thick wall GB	23	23%
Abnormal GB size	16	16%
Multiple GS	9	9%
Immobile Gall stone	16	16%
GB empyema	2	2%
Pericholecystic fluid	8	8%

LC was easy for 79 (79%) patients; 61 (77.2%) females, 18 (22.8%) males, and difficult for 21(21%) patients; 13 (61.9%) female, male, 8 (38.1%) male. When it was thought necessary to spare patients unnecessary risks, LC was changed to OC. In two (9.5%) of our study's difficult cases (40 and 54-year-old females) the surgical approach was changed from LC to OC due to dense pericholecystic adhesions that were irremovable.

With a difficult surgical procedure, all ultrasound parameters in the current study seem to be statistically significant. Thick GB wall was a significant predictor of difficult LC. Of the 23 patients with GB wall thickness greater than 3mm, 15 (65.2%) had a difficult procedure; two of them had to have an open procedure. As a result, the sensitivity and specificity of wall thickness greater than 3mm in predicting difficulty were 83.3% and 90.2%, respectively. Figure 1 shows U/S image of a patient with GS and a thickened GB wall LC was difficult because it required a longer operation time due to difficulties in identifying the junction between the gallbladder and cystic duct.

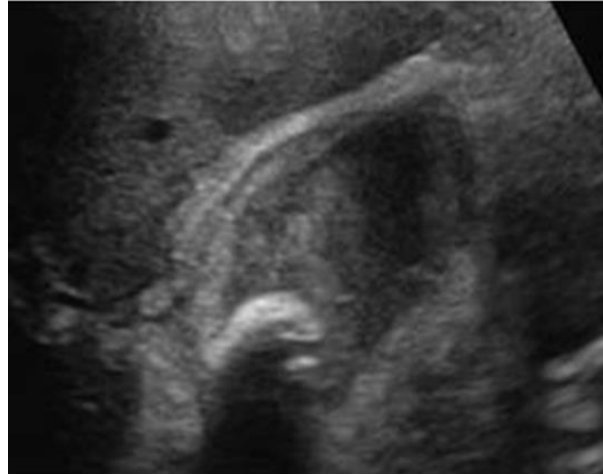


Figure 1 32-year-old male with thick GB wall (12mm in thickness) LC was difficult.

Of the 16 patients with abnormal GB size (dilated or contracted), 12 (75%) found LC difficult; one patient underwent conversion to OC. As a result, the sensitivity and specificity of abnormal GB size in predicting surgical difficulty were 66.6% and 95.1%, respectively.

The procedure proved to be difficult for five out of nine patients (55.6%) who had multiple GS, with a sensitivity of 27% and specificity of 95%, the patient in Figure 2 has GS multiplicity; the procedure was difficult.

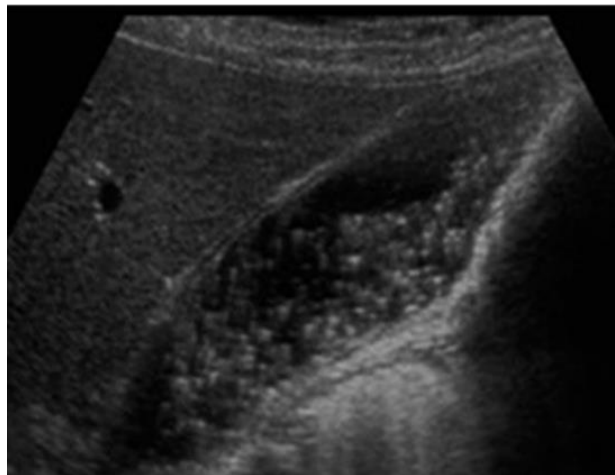


Figure 2 55-year-old female with multiple GS, LC was difficult.

Of the 16 patients with immobile gallstones, 11 (68.8%) experienced difficulty; thus, its sensitivity was 17.2% and its specificity was 98.2%.

The procedure was difficult in both patients (100%) when there were ultrasound features that suggested empyema (n=2) (one of them was converted to OC due to edema, adhesions, and distorted anatomy in the Calot's triangle area). Its sensitivity was 11% and its specificity was 100%.

A more difficult laparoscopic procedure was required when there was fluid present in the pericholecystic area. Of the 8 (100%) patients with pericholecystic fluid collection, the operation was difficult, and one of them converted to OC, so the sensitivity of pericholecystic fluid for surgical difficulties during LC was 44%, and its specificity was 100%. Out of the 69 (69%) cases that the ultrasound predicted to be easy, 68 (98.5%) were found to be actually easy, and 1 (1.5%) proved to be difficult according to figure 3.



Figure 3 67-year-old male with normal GB apart from a single stone, LC was difficult because of adhesion which couldn't be detected by ultrasound.

Table (3) illustrates the usefulness of ultrasound findings in predicting difficult LC.

Table 3 The usefulness of ultrasound findings in predicting difficult LC.

Ultrasound parameters	Difficult LC No. (%)	OC No. (%)	Sensitivity	Specificity	P value
Thick wall GB	15(65.2%)	2(13.3%)	83.3%	90.2%	0.000
Abnormal GB size	12(75%)	1(8.3%)	66.6%	95.1%	0.003
GS multiplicity	5(55.6%)	0(0%)	27%	95%	0.002
Immobile gall stone	11(68.8%)	0(0%)	17.2%	98.2%	0.01
Empyema	2(100%)	1(50%)	11%	100%	0.002
Pericholecystic fluid	8(100%)	1(12.5%)	44%	100%	0.000

4. Discussion

The current gold standard for treating symptomatic cholelithiasis is laparoscopic cholecystectomy. The most common difficult laparoscopic procedure that general surgeons perform worldwide, and one that may put the patient at serious risk, is the difficult gallbladder procedure. The surgeon should maintain a low threshold for conversion to open surgery and it should be viewed as a step in the patient's best interest rather than as an insult to the surgeon, even though the rate of conversion to open surgery and the rate of complications are low in experienced hands. The difficult gallbladder and conversion to open cholecystectomy can be determined by a number of preoperative factors [17].

Numerous conditions that were previously thought to preclude laparoscopic procedures (such as gangrenous gallbladder, GB empyema, bilio-enteric fistulae, obesity, pregnancy, ventriculo-peritoneal shunt, prior upper abdominal procedures, and cirrhosis) no longer preclude using the laparoscopic approach, but they still need special attention, patient preparation, and a careful risk-benefit analysis on the part of the surgeon. These contraindications have been disregarded as surgeons have gained substantial experience with the laparoscopic technique, and numerous reports of successfully completed cases are available [18, 19].

The best method for examining the GB and biliary tract is ultrasound, which is frequently used in the preoperative phase. Preoperative ultrasound and surgery have not, however, been shown to correlate well, and there have not been many studies on the factors influencing different surgical stages [20, 21]. Surgeons can choose cases that are suitable for their expertise based on radiological findings, to minimize operating time waste and operative complications. The criteria for what constitutes a difficult LC relates to the surgical team's experience [22].

We assessed the ability of preoperative ultrasound to predict technical difficulties in laparoscopic cholecystectomy procedures. According to the current study, US is a valid and accurate diagnostic test for GB disease.

In our study, we considered 3mm wall thickness as a threshold to predict surgical difficulties and we found that there is a statistically significant relationship between surgical difficulty and GB wall thickness like most of previous studies.

Ravindra et al [23] found that the critical gallbladder wall thickness for difficult laparoscopic cholecystectomy was 3mm. Tikka et al [24] found that preoperative ultrasonography findings of gallbladder wall thickness are significant predictor for difficult LC. Majeski et al [25] also used preoperative ultrasound measurements based solely on wall thickness. According to certain studies [21,26,27] the main factor behind switching from laparoscopic to open surgery was wall thickness. According to Ammoriet al [28] the operation time increased with wall thickness.

An ultrasound indicator of acute inflammation is the accumulation of pericholecystic fluid. V. Stanicic et al [29] found that pericholecystic fluid collection was a significant predictor of a number of operational difficulties. Teixeira J et al [30] stated that the combination of pericholecystic fluid collection with other ultrasound signs of acute inflammation such as edematous and thickened GB wall and Murphy's sign is an important predictor of operational difficulties and a risk factor for conversion. In our study, we found that the relationship between pericholecystic fluid and surgical difficulty was statistically significant, and it was more specific than wall thickness in predicting difficult LC.

The presence of immobile stones in the gallbladder was statistically significant in predicting surgical complications in our study. It was thought that the stone's immobilization was a result of the gallbladder's ongoing inflammatory process [31]. While the results of the study by Cho et al [32] conflicted with our findings, Ahmed et al [33] found that impacted gall bladder stones can be used as a predictor for the presence of intra-operative technical difficulties because it was associated with a higher incidence of bleeding which result in difficulties during dissection of cystic artery and duct also. This could be because some patients who had difficult procedures had multiple ultrasound parameters that predicted surgical difficulty in addition to stone immobility.

The current study found a statistically significant relationship between GB size and surgical difficulties, same results of Cho et al [32] which indicate that a larger GB volume increased the difficulty of dissecting adhesions from the GB and dissecting Calot's triangle. Jethwani et al [17] stated that one of the important variables influencing surgical difficulty and conversion to an open procedure was contracted GB. Mittalgodu et al [34] found that distended or contracted gallbladder were associated with subsequent difficulties during the surgery.

On the other hand, O. Kaya et al [35] determined that the gallbladder volume was not a parameter to determine surgical difficulty,

Empyema was found to be a significant indicator of surgical difficulty in multiple studies [36, 38]. The presence of GB empyema in this study was significantly hampered by edema, adhesions, and distorted anatomy in the Calot's triangle region.

According to numerous studies, the conversion rate from a laparoscopic procedure to an open one ranges from 2 to 15%. However, as laparoscopic procedures have improved and surgeons with greater experience have reduced this rate, so that it currently stands between 1 and 6% [39, 40]. The conversion rate in this study was 2 percent, which is consistent with the lowest values listed in the literature.

According to this study, the number of ultrasound parameters that influence surgical difficulty correlates with the rate of surgical difficulty; in patients with more than three ultrasound findings, or when the specificity of ultrasound in predicting technical difficulty reached 100%, the procedure was never simple. When there were more than two ultrasound parameters, the conversion rate was higher, which is consistent with a study by Grzegorz C. Wiket al [41].

On the other hand, in 11 patients with abnormal ultrasound parameters, LC was easy. This can be explained by the fact that surgical difficulty depends on the surgeon's learning curve stage. One patient with normal ultrasound parameters

experienced a difficult LC, which ultrasound could not predict. The main reason for the difficulty was severe adhesions around the gall bladder, which is a finding that ultrasound cannot show and is an intraoperative finding.

Dinkel et al [42] discovered that the most specific marker of technical issues during LC was pericholecystic fluid, while GB wall thickening was the most sensitive indicator on ultrasonography. Such difficulties might necessitate a laparotomy; our study also demonstrated that.

5. Conclusions

This study confirms the significant correlation between the risk of a difficult surgery and the preoperative ultrasound evaluation. Longer operation times are required for difficult LC, and there may be several useful applications for preoperatively predicting lengthy procedures for patients who are listed for LC. The presence of pericholecystic fluid and the thickness of the GB wall are the two most crucial parameters that ultrasonography can provide to predict difficult LC.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Written informed consent was obtained from each patient for their anonymized information to be published in this article.

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