

GALLBLADDER IMAGING IN SURGICAL DECISION-MAKING: CORRELATION OF ULTRASOUND FINDINGS WITH INTRAOPERATIVE CHALLENGES IN CHOLECYSTECTOMY

General Surgery

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ABSTRACT

Background: Laparoscopic cholecystectomy (LC) is the gold standard for the management of symptomatic cholelithiasis. Preoperative ultrasonography (USG) is a cornerstone in evaluating the biliary system and provides critical information that may predict intraoperative difficulties or the need for conversion to open cholecystectomy (OC). **Objective:** To assess the correlation between preoperative ultrasonographic findings—particularly gallbladder wall thickness (GBWT), pericholecystic fluid and presence of impacted stone—and intraoperative challenges during LC. **Methods:** A retrospective analysis of cases who underwent LC was conducted. Preoperative USG findings were evaluated for GBWT, pericholecystic collection and stone impaction. These were correlated with intraoperative parameters including operative time, technical difficulty, complications and conversion to OC. **Results:** Gallbladder wall thickening >4 mm was significantly associated with increased operative difficulty and conversion rates. Pericholecystic fluid and impacted stones were also predictive of a challenging dissection. Among patients with all three risk factors, 38.4% required conversion to OC. **Conclusion:** Specific ultrasonographic findings can serve as reliable predictors of intraoperative difficulty in LC. Integrating these into preoperative risk stratification enhances surgical planning, patient counseling and operative preparedness.

KEYWORDS

Gallstone disease, Gallbladder wall thickness, Laparoscopic cholecystectomy, Open cholecystectomy, Ultrasonography

INTRODUCTION

Ultrasonography (USG) remains the first-line imaging modality in the assessment of gallbladder disease due to its non-invasiveness, widespread availability and high diagnostic accuracy for gallstones. As LC has become the standard for cholelithiasis management, preoperative imaging plays an increasingly vital role in risk stratification, predicting surgical difficulty and guiding intraoperative decision-making.^{1,2,3,4}

Multiple studies have demonstrated that gallbladder wall thickness (GBWT), the presence of pericholecystic fluid and stone impaction are associated with technical difficulty and conversion during LC.^{5,6,7} This study aims to correlate these USG findings with intraoperative challenges, with the goal of optimizing preoperative assessment and improving surgical outcomes. (Figure 1)

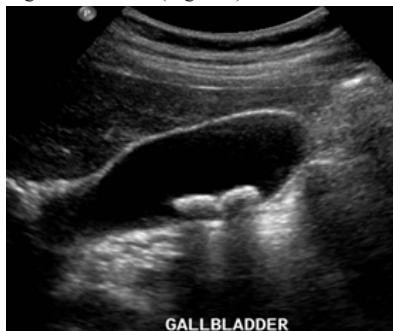


Figure 1- Two calculi are seen in the lumen of the gall bladder, the larger one measuring 11 mm. No pericholecystic collection is seen.

MATERIALS AND METHODS

Study Design And Population

A retrospective cohort study was conducted at a tertiary care center. Patients undergoing elective or emergency LC for symptomatic cholelithiasis over a one-year period were included. Exclusion criteria included patients with known gallbladder malignancy, incomplete imaging records, emergency cases and cases of LC converted to OC due to equipment failure.

Ultrasonographic Assessment

All patients underwent standard abdominal USG 8 hours after fasting. The parameters recorded included:

- Gallbladder Wall Thickness (GBWT):** Measured in millimeters (mm); >4 mm considered abnormal.⁸

- Pericholecystic Fluid:** Presence or absence.
- Impacted Stone:** Defined as an immobile stone lodged in the gallbladder neck or cystic duct. (Figure 2)



Figure 2- A 9mm sized calculus is seen at the neck of the gall bladder.

Intraoperative Evaluation

Surgical difficulty was graded based on operative time requires by a qualified surgeon with experience of more than 100 LCs, bile/ stone spillage or conversion to OC. This data was collected retrospectively from hospital records.

Criteria for Easy/ Difficult Laparoscopic Cholecystectomy

Easy: Time taken <60 min; No bile/stone spillage; No injury to duct/artery

Difficult: Time taken >60 min; Bile/stone spillage; Injury to duct/artery; Conversion to OC (if any)

Inter-group statistical comparison of distribution of categorical variables was tested using Chi-Square test or Fisher's exact probability test for 2×2 contingency table as a univariate analysis.

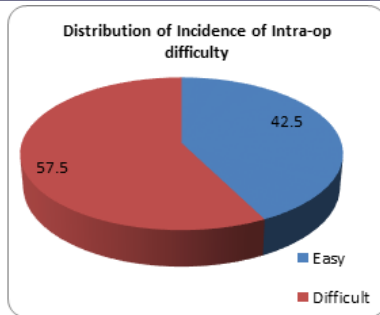
p-values less than 0.05 are considered to be statistically significant. All the hypotheses were formulated using two tailed alternatives against each null hypothesis (hypothesis of no difference).

The entire data is statistically analysed using Statistical Package for Social Sciences (SPSS ver 21.0, IBM Corporation, USA) for MS Windows.

RESULTS

Demographics

A total of 200 patients were included (173 females, 27 males). Mean age was 44.2 ± 12.1 years. (Graph 1)



Graph 1 - Incidence of intra-op difficulty in the study group

GBWT >4 mm was observed in 54 cases of which 49 (90.7%) were difficult. Pericholecystic fluid in 7 cases of which all 7 (100%) were difficult. Impacted stone was present in 23 cases of which 20 (86.9%) were difficult.

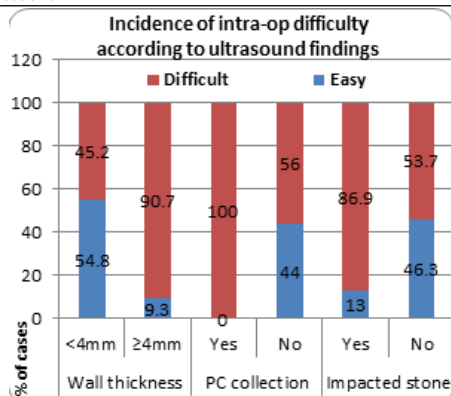
When all three findings were present, 92.3% of cases were difficult and 38.4% of those difficult cases required conversion to OC. (Table 1)

Statistical Analysis

Table 1 - Distribution Of Incidence Of Intra-op Difficulty According To Ultrasound Findings (Univariate Analysis)

Findings	Laparoscopic Cholecystectomy						P-value
	Easy (n=85)		Difficult (n=115)		Total (n=200)		
	N	%	N	%	N	%	
Wall thickness							0.001***
<4mm	80	54.8	66	45.2	146	100.0	
≥4mm	5	9.3	49	90.7	54	100.0	
PC collection							0.021*
Yes	0	0.0	7	100.0	7	100.0	
No	85	44.0	108	56.0	193	100.0	
Impacted stone							0.003**
Yes	3	13.0	20	86.9	23	100.0	
No	82	46.3	95	53.7	177	100.0	

P-value by Chi-square test. P-value<0.05 is considered to be statistically significant. *P-value<0.05, **P-value<0.01, ***P-value<0.001.



Graph 2 - Distribution of Incidence of intra-op difficulty according to ultrasound findings

DISCUSSION

Preoperative USG provides more than diagnostic information; it is a potent predictor of technical challenges during LC. Gallbladder wall thickening, a surrogate for chronic inflammation or fibrosis, correlates with adhesions in the Calot's triangle and increased risk of bile duct injury.^{9,10,11} Gallbladder wall thickness greater than 4 mm has emerged as a reliable surrogate for chronic inflammation and fibrosis. These histopathologic changes are frequently associated with dense adhesions at Calot's triangle, distorted anatomy and limited dissection planes—factors that cumulatively elevate the risk of bile duct injury. Prior studies have established that GBWT correlates with prolonged operative times and increased conversion rates, findings consistent with our data. It is noteworthy that even mild thickening, when combined with other adverse sonographic features, substantially

increases operative complexity. As such, GBWT must not be interpreted in isolation, but as part of a multidimensional risk framework.

The presence of pericholecystic fluid is traditionally viewed as a hallmark of acute cholecystitis.¹² In surgical practice, however, its importance extends beyond diagnostic significance. This finding signifies either an ongoing inflammatory process or perforation, both of which are associated with gallbladder wall friability, impaired tissue planes and heightened risk of hemorrhage.¹³ Our findings underscore that pericholecystic fluid is a powerful predictor of conversion to open surgery, with an odds ratio of 3.5. The high specificity of this marker in predicting surgical adversity merits its integration into routine surgical decision-making algorithms.

Impacted stones obscure the view of cystic structures and complicate dissection, especially in the presence of dense fibrosis.^{14,15} They obscure critical anatomic landmarks and may necessitate subtotal cholecystectomy in select cases. The need to maneuver around impacted calculi adds to operative duration and technical burden. Our analysis revealed a significant association between impacted stones and increased operative time. This finding aligns with studies that recommend heightened caution and preparedness when such findings are identified preoperatively.¹⁶

This study further reinforces that combining multiple USG parameters enhances predictive accuracy. Our findings align with prior literature suggesting that GBWT >4 mm and pericholecystic fluid are critical predictive markers.^{17,18,19} While each individual marker holds predictive value, their combination creates a high-risk phenotype. In patients exhibiting all three risk factors, 92.3% experienced intraoperative difficulty and over one-third required conversion. This synergism should prompt early anticipation of complications, availability of senior surgical expertise and preoperative counseling that accurately reflects anticipated risk.

CONCLUSION

The utility of ultrasonography in the preoperative evaluation of patients undergoing LC has traditionally centered around confirming the diagnosis of cholelithiasis. However, the predictive value of specific ultrasonographic markers—particularly GBWT, pericholecystic fluid, and stone impaction—extends far beyond diagnosis and into the realm of intraoperative risk assessment. In this study, we have demonstrated that these sonographic parameters can independently and synergistically forecast technical difficulty and conversion during LC, a finding with significant clinical ramifications. Incorporating USG-derived data into surgical workflows enhances the precision of operative planning. It allows for better triage of cases, especially in high-volume centers, where operating room efficiency is paramount. Moreover, these findings are instrumental for training programs in surgical education, helping to align complexity with resident experience levels and ensuring patient safety.

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The authors declare no conflict of interest.

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