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Case Series

Preoperative Ultrasonographic Gallbladder Wall Thickness as a Predictor of Intraoperative Complications and Conversion in Laparoscopic Cholecystectomy: A Hospital-Based Case Series

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Abstract:

Background: Gallbladder wall thickening on preoperative ultrasonography (USG) has been proposed as a marker of difficult laparoscopic cholecystectomy (LC). We assessed its association with intraoperative complications and conversion to open surgery in acute cholecystitis.

Methods: This hospital-based case series included 44 patients with acute cholecystitis who underwent LC at HSK Hospital, Bagalkot, between August 2022 and February 2024. Preoperative gallbladder wall thickness (GWT) was grouped as <4.0 mm (Group I, n = 12), 4.0–4.9 mm (Group II, n = 27) and ≥5.0 mm (Group III, n = 5). Outcomes were major haemorrhage, bile leak, biliary injury, injury to other structures and conversion to open cholecystectomy.

Results: Mean age was 42.8 ± 10.9 years and 24 patients (54.5%) were men. Mean GWT was 4.03 ± 0.60 mm (range 3–6 mm). Ten patients (22.7%) had at least one intraoperative complication: bile leak in 9 (20.5%), major haemorrhage in 3 (6.8%) and hepatic artery injury in 1 (2.3%). One patient (2.3%) needed conversion because of a frozen Calot's triangle. No bile duct injury occurred. The complication rate rose from 0% in Group I to 29.6% in Group II and 40.0% in Group III (exact p = 0.076). Patients with complications had thicker walls than those without (4.50 ± 0.62 vs 3.89 ± 0.53 mm; p = 0.005). GWT discriminated patients with complications with an area under the ROC curve of 0.78; a cut-off of ≥4.5 mm gave 60% sensitivity and 85.3% specificity, and no complication occurred below 4.0 mm.

Conclusion: Increasing preoperative GWT is associated with a higher likelihood of intraoperative complications during LC for acute cholecystitis. A wall of 4.5 mm or more should alert the surgeon to a potentially difficult dissection and inform preoperative counselling.

Keywords: Laparoscopic cholecystectomy; Gallbladder wall thickness; Ultrasonography; Acute cholecystitis; Intraoperative complications; Conversion.

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Introduction

Laparoscopic cholecystectomy (LC) has replaced open cholecystectomy as the standard operation for symptomatic gallstone disease since the early 1990s. Compared with the open operation, it offers less postoperative pain, faster recovery, a shorter hospital stay and fewer wound complications [1]. It is among the most frequently performed abdominal operations, and large population-based audits show that, although outcomes are generally good, a measurable proportion of patients still experience intraoperative difficulty, complications and readmission [2]. When inflammation distorts the hepatocystic triangle, dissection becomes slower, bleeding more likely, and the risk of bile spillage, vascular injury and conversion to open surgery rises. Acute cholecystitis is the setting in which these difficulties are most common. The Tokyo Guidelines 2018 incorporate imaging findings, including gallbladder wall thickening, into the diagnostic criteria and severity grading of acute cholecystitis [3]. On ultrasonography (USG) the normal gallbladder wall appears as a thin echogenic line of 3 mm or less. Thickening beyond this reflects mural oedema and inflammation and, in longstanding disease, fibrosis [4]. Thickening is not specific: it also occurs in hepatitis, heart failure,

hypoalbuminaemia, adenomyomatosis and carcinoma. In a patient with gallstones and right upper quadrant pain, however, it is a practical marker of the inflammatory burden the surgeon will meet [4]. Safe LC depends on clear identification of the cystic duct and cystic artery. Strasberg and colleagues showed that most bile duct injuries arise from misidentification of structures and introduced the critical view of safety to prevent them [5]. A thick, oedematous or fibrotic wall is difficult to grasp and retract, obscures the planes in Calot's triangle and the gallbladder bed, and so threatens this view. It is therefore plausible that wall thickness measured before surgery could forecast intraoperative events.

Several studies support this idea. Al-Hilfi et al. found wall thickening to be the most sensitive sonographic indicator of technical difficulty and conversion [6]. Raman et al., in 874 patients, reported that conversion, complications and hospital stay increased stepwise with the degree of thickening [7]. Nidoni et al. identified wall thickness above 3 mm, together with pericholecystic fluid, leucocytosis and repeated attacks, as predictors of difficult LC [8]. Kania reported that a wall of 5 mm or more predicted conversion with high accuracy [9], and Qureshi et al. found that thickening above 4 mm predicted conversion with 88.5% sensitivity and 91.5% specificity [10]. In a prospective study of 1089 patients, Kokoroskos et al. showed that wall thickness independently predicted intraoperative events and outperformed symptom duration [11]. Balbaloglu and Tasdoven later combined wall thickness with inflammatory indices to improve the prediction of conversion [12].

The evidence is not uniform. Proposed thresholds range from 3 to 7 mm, and definitions of a difficult operation vary. Indian data are limited and largely from single centres [13,14], and at least one recent study found ultrasonographic assessment of little value for predicting difficult LC [15]. Most series also mix elective and acute cases, so the predictive value of wall thickness within acute cholecystitis, where some thickening is almost universal, is less clear.

We therefore studied patients with acute cholecystitis undergoing LC at a tertiary teaching hospital in north Karnataka. Our aim was to determine whether preoperative ultrasonographic gallbladder wall thickness is associated with intraoperative complications (major haemorrhage, bile leak, biliary injury and injury to other structures) and with conversion to open cholecystectomy, and to estimate how well it discriminates patients who develop these events.

Materials and Methods

Study Design and Setting: This was a prospective, hospital-based case series conducted in the Department of General Surgery, S. Nijalingappa Medical College and HSK Hospital and Research Centre, Bagalkot, Karnataka, from 1 August 2022 to 29 February 2024. The Institutional Ethics Committee on Human Subjects Research approved the study on 16 July 2022 (File No. SNMC/IECHSR/2021-22/A-54/1.1), and the protocol was registered with Rajiv Gandhi University of Health Sciences. Written informed consent was obtained from every participant in English or Kannada.

Participants: Consecutive patients aged 18–65 years admitted with a diagnosis of acute cholecystitis, with an abdominal ultrasound report, who were scheduled for LC and willing to participate were included. Patients were excluded if gallbladder wall thickness could not be measured, if they had choledocholithiasis or suspected gallbladder malignancy, or if they had a bleeding disorder.

Sample Size: Sample size was estimated with OpenEpi version 2.3.1 using the formula $n = [DEFF \times Np(1 - p)] / [(d^2/Z^2_{1-\alpha/2} \times (N - 1)) + p(1 - p)]$. Taking the proportion of patients with complications in the moderately thickened group as 83.3%, as reported by Sharath Chandra and Bose [13], with 12% absolute precision and a 95% confidence level, the minimum sample was 36. It was rounded up to 40, and 44 patients were finally enrolled.

Ultrasonographic Assessment: Abdominal USG was performed by the radiology department as part of routine work-up. Gallbladder wall thickness (GWT) was measured in millimetres on the anterior wall and recorded from the radiology report.

A wall of up to 3 mm was regarded as normal. For analysis, patients were grouped as Group I (<4.0 mm), Group II (4.0–4.9 mm) and Group III (≥5.0 mm), corresponding to mild, moderate and severe thickening.

Operative Technique: All operations were performed under general anaesthesia using the standard four-port technique. Pneumoperitoneum was created with carbon dioxide at 12–15 mmHg. The gallbladder fundus was retracted over the liver, and Calot's triangle was dissected to obtain the critical view of safety before the cystic duct and artery were clipped and divided. The gallbladder was separated from the liver bed with electrocautery and retrieved in a bag through the umbilical or epigastric port. Conversion to open surgery was at the operating surgeon's discretion.

Outcome Measures: Data were recorded prospectively in a structured proforma. The intraoperative outcomes were:

- Major haemorrhage: bleeding requiring additional haemostatic measures beyond routine cautery, as judged by the operating surgeon.
- Bile leak: leakage of bile during dissection, from a breach of the gallbladder wall or the cystic duct.
- Biliary injury: injury to the common bile duct or common hepatic duct.
- Injury to other structures: injury to any adjacent vascular or visceral structure.
- Conversion to open cholecystectomy, with the reason recorded.

A patient with any of these events was classified as having an intraoperative complication. Age and sex were recorded as baseline variables.

Statistical Analysis: Data were entered in Microsoft Excel and analysed with SPSS version 19.0 and Python (SciPy). Continuous variables are presented as mean ± standard deviation (SD) and median (range), and categorical variables as number (percentage). Proportions across the three GWT groups were compared with the chi-square test; because expected cell counts were small, exact p values from the Fisher–Freeman–Halton test (Monte Carlo, 20 000 permutations) are reported. Continuous variables across groups were compared with the Kruskal–Wallis test, and GWT between patients with and without complications with the Mann–Whitney U test. The discriminative ability of GWT was assessed with the area under the receiver operating characteristic curve (AUC), and sensitivity and specificity were calculated at 4.0, 4.5 and 5.0 mm. A two-sided $p < 0.05$ was considered significant.

Results

Forty-four patients were analysed. Intraoperative complications occurred only in patients with a wall of 4.0 mm or more, and patients who developed a complication had walls about 0.6 mm thicker than those who did not.

Table 1: Baseline characteristics of the study population (n = 44)

Characteristic	Value
Age, years, mean ± SD (range)	42.8 ± 10.9 (23–65)
Age 21–30 years, n (%)	5 (11.4)
Age 31–40 years, n (%)	18 (40.9)
Age 41–50 years, n (%)	11 (25.0)
Age 51–60 years, n (%)	5 (11.4)
Age ≥61 years, n (%)	5 (11.4)
Male / female, n (%)	24 (54.5) / 20 (45.5)
GWT, mm, mean ± SD (range)	4.03 ± 0.60 (3.0–6.0)
Group I, <4.0 mm, n (%)	12 (27.3)
Group II, 4.0–4.9 mm, n (%)	27 (61.4)
Group III, ≥5.0 mm, n (%)	5 (11.4)

The largest age group was 31–40 years (40.9%), and the male-to-female ratio was 1.2:1. Most patients (61.4%) had moderate thickening of 4.0–4.9 mm; only five (11.4%) had a wall of 5 mm or more.

Table 2: Age and sex by gallbladder wall thickness group

Variable	Group I (<4.0 mm), n = 12	Group II (4.0–4.9 mm), n = 27	Group III (≥5.0 mm), n = 5	p value
Age, years, mean ± SD	42.6 ± 14.7	41.4 ± 8.4	51.0 ± 11.4	0.288[a]
Female, n (%)	7 (58.3)	9 (33.3)	4 (80.0)	0.103[b]

[a] Kruskal–Wallis test. [b] Fisher–Freeman–Halton exact test.

Age and sex did not differ significantly between the groups, so neither is likely to explain differences in outcome. Patients in Group III were on average about nine years older.

Table 3: Intraoperative outcomes by gallbladder wall thickness group

Outcome	Group I (<4.0 mm), n = 12	Group II (4.0–4.9 mm), n = 27	Group III (≥5.0 mm), n = 5	Total, n = 44	Exact p value
Major haemorrhage, n (%)	0 (0)	2 (7.4)	1 (20.0)	3 (6.8)	0.342
Bile leak, n (%)	0 (0)	7 (25.9)	2 (40.0)	9 (20.5)	0.115
Biliary injury, n (%)	0 (0)	0 (0)	0 (0)	0 (0)	—
Injury to other structures, n (%)	0 (0)	0 (0)	1 (20.0)	1 (2.3)	0.111
Conversion to open, n (%)	0 (0)	0 (0)	1 (20.0)	1 (2.3)	0.111
Any intraoperative complication, n (%)	0 (0)	8 (29.6)	2 (40.0)	10 (22.7)	0.076

Every complication rose in frequency with wall thickness. Bile leak was the most common event (20.5%), followed by major haemorrhage (6.8%). The single injury to another structure was a hepatic artery injury, and the single conversion was required for a frozen Calot's triangle; both occurred in the same patient, who had the thickest wall in the series (6 mm). No bile duct injury occurred. The overall complication rate rose from 0% to 29.6% to 40.0% across the groups, a trend that approached but did not reach significance (p = 0.076), reflecting the small number of patients in Group III.

Table 4: Gallbladder wall thickness in patients with and without intraoperative complications

Group	n	GWT, mm, mean ± SD	Median (range), mm	p value
Any complication	10	4.50 ± 0.62	4.5 (4.0–6.0)	0.005[c]
No complication	34	3.89 ± 0.53	4.0 (3.0–5.0)	

[c] Mann–Whitney U test.

Treating wall thickness as a continuous measure gave a clearer result than the three-group comparison. Patients with a complication had significantly thicker walls (p = 0.005).

Table 5: Performance of gallbladder wall thickness cut-offs for predicting any intraoperative complication (AUC = 0.78)

Cut-off	Sensitivity, % (n/N)	Specificity, % (n/N)	PPV, %	NPV, %
≥4.0 mm	100 (10/10)	35.3 (12/34)	31.3	100
≥4.5 mm	60.0 (6/10)	85.3 (29/34)	54.5	87.9
≥5.0 mm	20.0 (2/10)	91.2 (31/34)	40.0	79.5

PPV, positive predictive value; NPV, negative predictive value.

GWT showed fair discrimination (AUC 0.78). A cut-off of 4.0 mm ruled out complications in this series (NPV 100%), whereas 4.5 mm offered the best balance of sensitivity and specificity.

Discussion

In this series of patients undergoing LC for acute cholecystitis, intraoperative complications were confined to patients with a gallbladder wall of 4.0 mm or more. Patients who developed a complication had significantly thicker walls than those who did not, and wall thickness discriminated them with an AUC of 0.78. These findings support the use of preoperative USG to anticipate a difficult dissection.

The direction of our results agrees with most published work. Raman et al. found that conversion and complications increased progressively from normal to severely thickened walls [7], and Sharath Chandra and Bose, in a south Indian series, reported the highest complication rate in the most thickened group [13]. Khan et al. likewise observed rising conversion and complication rates across four thickness categories in 350 patients [14]. Kokoroskos et al. showed that thickness independently predicted intraoperative events after adjustment for other factors [11].

Our proposed threshold of 4.5 mm lies between the 3 mm cut-off favoured by Nidoni et al., Ghazanfar et al. and Pathak and Zaidi [8,16,17] and the 5 mm threshold reported by Kania [9]. It is close to the 4 mm value that Qureshi et al. found most accurate for predicting conversion [10]. Because all our patients had acute cholecystitis and none had a wall under 3 mm, a higher threshold is expected: within an already inflamed population, the useful question is how much thickening, not whether it is present. Bile leak was the most frequent event (20.5%). In our proforma this captured leakage of bile during dissection, most often from a breach of an oedematous, friable wall, rather than a postoperative leak from the cystic duct stump or bile ducts.

Thick, inflamed walls tear more easily under traction, and Zaman et al. similarly reported bleeding (35.7%), adhesions (33.3%) and gallbladder perforation (7.8%) as common findings in thick-walled gallbladders [18]. Major haemorrhage (6.8%) also clustered in the thicker groups, consistent with the increased vascularity of an acutely inflamed gallbladder bed.

Our conversion rate of 2.3% is lower than the 5.5–8% reported by Al-Hilfi et al., Alamiri and Adwan and Jafary et al. [6,19,20]. The only conversion was for a frozen Calot's triangle in a patient with a 6 mm wall, who also sustained a hepatic artery injury. Krishnamurthy et al. showed that even in perforated gallbladders, experienced teams can complete most operations laparoscopically, using techniques such as retroinfundibular dissection to manage a frozen Calot's triangle [21].

Importantly, no bile duct injury occurred, which we attribute to the routine pursuit of the critical view of safety [5]. Conversion should be seen not as a failure but as a safe decision when this view cannot be achieved [5].

Not all studies agree. Khan et al. found no useful agreement between ultrasonographic and intraoperative difficulty [15], which may reflect

differences in scoring systems, operator experience and case mix. Population data also show that operative duration, fitness grade and prior emergency admissions influence outcomes [2], so wall thickness should be one part of a broader risk assessment that includes clinical and laboratory markers [8,12]. This study has limitations. The sample was small, particularly in Group III, which limited the power of group comparisons; the group trend did not reach significance even though the continuous analysis did. It was a single-centre series without multivariable adjustment. USG was operator-dependent, wall thickness varies across the gallbladder, and the interval between scan and surgery was not standardised. Intraoperative events were judged by the operating team without blinded assessment. Larger multicentre studies with standardised measurement and definitions are needed to validate the 4.5 mm threshold.

Conclusion

Preoperative ultrasonographic gallbladder wall thickness is associated with intraoperative complications during LC for acute cholecystitis. In this series no complication occurred with a wall below 4.0 mm, and a wall of 4.5 mm or more identified a group at substantially higher risk of bile leak, haemorrhage, vascular injury and conversion. Measuring and reporting wall thickness should be routine before LC; it helps the surgeon plan for a difficult dissection, allocate experienced staff, and give patients realistic information when obtaining consent.

References

1. Keus F, de Jong JA, Gooszen HG, van Laarhoven CJ. Laparoscopic versus open cholecystectomy for patients with symptomatic cholecystolithiasis. Cochrane Database Syst Rev. 2006;(4):CD006231.
2. CholeS Study Group, West Midlands Research Collaborative. Population-based cohort study of outcomes following cholecystectomy for benign gallbladder diseases. Br J Surg. 2016;103(12):1704-15.
3. Yokoe M, Hata J, Takada T, Strasberg SM, Asbun HJ, Wakabayashi G, et al. Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholecystitis (with videos). J Hepatobiliary Pancreat Sci. 2018;25(1):41-54.
4. Ahmed M, Nag HH, Meena P. Clinical approach to patients with thick wall gallbladder. Egypt J Radiol Nucl Med. 2023;54(1):184.
5. Strasberg SM, Hertl M, Soper NJ. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J Am Coll Surg. 1995;180(1):101-25.
6. Dawood Al-Hilfi A, Al-Jawher MH, Taha SA. The impact of the gallbladder wall thickness assessed by sonography on the outcome of laparoscopic cholecystectomy. Basrah J Surg. 2011;17(2):30-6.
7. Raman SR, Moradi D, Samaan BM, Chaudhry US, Nagpal K, Cosgrove JM, et al. The degree of gallbladder wall thickness and its impact on outcomes after laparoscopic cholecystectomy. Surg Endosc. 2012;26(11):3174-9.
8. Nidoni R, Udachan TV, Sasnur P, Baloorkar R, Sindgikar V, Narasangi B. Predicting difficult laparoscopic cholecystectomy based on clinicoradiological assessment. J Clin Diagn Res. 2015;9(12):PC09-12.
9. Kania D. Ultrasound measurement of the gallbladder wall thickness in the assessment of the risk of conversion from elective laparoscopic cholecystectomy to open surgery: Olkusz County experience. Pol Przegl Chir. 2016;88(6):287-307.
10. Qureshi TJ, Khan AU, Ashfaq A, Abid KJ. To determine the diagnostic accuracy of gallbladder wall thickness and presence of pericholecystic fluid in predicting the need for conversion of laparoscopic cholecystectomy to open cholecystectomy in patients with cholelithiasis. Pak J Med Health Sci. 2016;10(3):1031-4.
11. Kokoroskos N, Peponis T, Lee JM, El Hechi M, Naar L, Elahad JA, et al. Gallbladder wall thickness as a predictor of intraoperative events during laparoscopic cholecystectomy: a prospective study of 1089 patients. Am J Surg. 2020;220(4):1031-7.
12. Balbaloglu H, Tasdoven I. Can gallbladder wall thickness and systemic inflammatory index values predict the possibility of conversion from laparoscopy to open surgery? Niger J Clin Pract. 2023;26(10):1532-7.
13. Sharath Chandra BJ, Bose R. Study of the degree of gall bladder wall thickness and its impact on outcomes following laparoscopic cholecystectomy in JSS Hospital. Int Surg J. 2018;5(4):1417-21.
14. Khan I, Yadav P, Saran RK, Sharma S, Sharma AK. A study of the degree of gall bladder wall thickness and its impact on patients undergoing laparoscopic cholecystectomy. Cureus. 2023;15(5).
15. Khan HB, Ali A, Zahid MJ, Hamayun S, Haseeb A, Shiraz A, et al. Validating an ultrasonographical assessment tool for predicting difficult laparoscopic cholecystectomy in a tertiary care hospital. Cureus. 2024;16(1).
16. Ghazanfar S, Qureshi S, Raza SN, Quraishy MS. Prediction of difficult laparoscopic cholecystectomy on the basis of gallbladder

wall thickness. Ann Abbasi Shaheed Hosp Karachi Med Dent Coll. 2013;18(1):22-5.
17. Pathak P, Zaidi R. Role of gallbladder wall thickness in predicting laparoscopic operability prior to cholecystectomy: a retrospective analysis. Int Surg J. 2018;5(5):1885-8.
18. Zaman J, Imaduddin S, Razzak R. Frequency of difficult laparoscopic cholecystectomy in patients with thick walled gall bladder. Pak J Surg. 2015;31(3):165-8.
19. Alamiri MH, Adwan MK. Relation between gallbladder wall thickness, assessed by sonography, and difficulties in laparoscopic cholecystectomy. J Fac Med Baghdad. 2015;57(2): 114-8.
20. Jafary MF, Abdulrazaq AF, Kadum AN. Gall bladder wall thickness: sonographic accuracy and laparoscopic cholecystectomy conversion rate, evaluated by histopathology. Indian J Forensic Med Toxicol. 2020;14(4).
21. Krishnamurthy G, Ganesan S, Ramas J, Damodaran K, Khanna A, Patta R. Early laparoscopic cholecystectomy in acute gallbladder perforation: single-centre experience. J Minim Access Surg. 2021;17(2):153-8.