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Original Research Article

Prospective Evaluation of Gallbladder Wall Thickness and Ultrasonographic Parameters for the Diagnosis of Acute Cholecystitis: A Histopathological Correlation Study

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Abstract

Background: Acute cholecystitis is a common surgical emergency, and ultrasonography is the primary imaging modality for diagnosis. Gallbladder wall thickening and other sonographic features may aid in diagnosis, but their diagnostic accuracy varies across studies.

Objective: To prospectively evaluate gallbladder wall thickness and ultrasonographic parameters in predicting acute cholecystitis and correlate findings with histopathology.

Methods: This prospective observational study included 56 adult patients with clinically suspected acute cholecystitis. Ultrasonographic parameters assessed included gallbladder wall thickness, pericholecystic fluid, gallstones, sonographic Murphy's sign, and mural hyperemia. Histopathology served as the reference standard. Diagnostic performance was evaluated using sensitivity, specificity, positive predictive value, and negative predictive value.

Results: Acute cholecystitis was confirmed histopathologically in 44 (78.6%) patients. Gallbladder wall thickening (>3 mm) was observed in 92.9% and demonstrated high sensitivity (97.7%) but low specificity (25.0%). Pericholecystic fluid showed high specificity (92.3%), while sonographic Murphy's sign had high sensitivity (93.0%). Combining wall thickening, pericholecystic fluid, and Murphy's sign improved diagnostic accuracy, with sensitivity and specificity of 94.5% and 83.3%, respectively.

Conclusion: Ultrasonography is an effective first-line modality for diagnosing acute cholecystitis. Gallbladder wall thickness combined with pericholecystic fluid and sonographic Murphy's sign significantly enhances diagnostic accuracy.

Keywords: Acute cholecystitis; Gallbladder wall thickness; Ultrasonography; Sonographic Murphy's sign; Pericholecystic fluid; Histopathology; Diagnostic accuracy.

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Introduction

Acute cholecystitis is a frequent cause of acute abdominal pain and remains one of the leading indications for emergency abdominal surgery worldwide. The condition most commonly results from obstruction of the cystic duct by gallstones, leading to gallbladder inflammation and, in severe cases, complications such as empyema, gangrene, or perforation. Early and accurate diagnosis is therefore crucial to reduce morbidity, prevent complications, and optimize surgical outcomes.[1]

Ultrasonography (USG) is widely accepted as the first-line imaging modality in suspected acute cholecystitis because of its non-invasive nature, wide availability, and favorable diagnostic performance. [2] Gallbladder wall thickening is one of the earliest and most commonly described ultrasonographic signs of acute cholecystitis. A wall thickness greater than 3–3.5 mm is generally considered abnormal and has been strongly associated with gallbladder pathology. [3] However, gallbladder wall thickening is not specific to acute cholecystitis and may also be observed in systemic conditions such as liver cirrhosis, cardiac failure, renal dysfunction, and hepatitis. Consequently, reliance on wall thickness alone may result in diagnostic uncertainty and potential misclassification. [4]

Previous prospective and retrospective studies have demonstrated that the diagnostic accuracy of ultrasonography improves when gallbladder wall thickness is interpreted in conjunction with additional sonographic features, including

pericholecystic fluid, gallbladder distension, gallstones, and a positive sonographic Murphy's sign. These parameters have also been associated with disease severity and operative difficulty in acute cholecystitis. [5] Nevertheless, considerable variability exists in the proposed diagnostic criteria and cutoff values for gallbladder wall thickness, with thresholds ranging from 3.5 mm to more than 5 mm reported in the literature. [6]

Given these inconsistencies, there is a need for prospective studies that correlate ultrasonographic findings with definitive intraoperative and histopathological outcomes to establish reliable diagnostic thresholds and improve clinical decision-making. The present study was designed to prospectively evaluate gallbladder wall thickness and other ultrasonographic features in predicting acute cholecystitis and to correlate these findings with surgical and histopathological results. Identifying the most predictive sonographic parameters may facilitate early diagnosis, assist in surgical planning, and reduce complications associated with delayed or inaccurate diagnosis.

Materials and Methodology

Study Design and Setting: This prospective observational study was conducted in the Studies were done in the Micro Health Lab – DM WIMS Urban Health Centre and St. Joseph's Hospital, Mananthavady, in collaboration with the Department of General Surgery, over a 12-month period from January 2025 to December 2025. The study aimed to evaluate the diagnostic role of gallbladder wall thickness and other ultrasonographic features in predicting acute cholecystitis and to correlate these findings with intraoperative and histopathological outcomes.

The study protocol was approved by the Institutional Ethics Committee of Wayanad Institute of Medical Sciences and written informed consent was obtained from all participants in accordance with the Declaration of Helsinki. [7]

Study Population: A total of 56 adult patients (≥18 years) presenting with clinical suspicion of acute cholecystitis were included. Inclusion criteria were right upper quadrant abdominal pain, localized tenderness, fever, and a positive clinical Murphy's sign.

Patients with chronic liver disease, renal failure, congestive cardiac failure, hepatitis, hypoalbuminemia, prior cholecystectomy, obstructive jaundice, or poor sonographic visualization were excluded.

The sample size was calculated using a single proportion formula for diagnostic studies. Assuming an expected ultrasonographic sensitivity of 90%, precision of 8%, and a 95% confidence level, yielding a minimum required sample size of 54; therefore, 56 patients were enrolled.

Ultrasonographic Evaluation: Ultrasound examinations were performed using a high-resolution ultrasound system (GE LOGIQ P9, GE Healthcare, USA) with a 3.5–5 MHz curvilinear transducer. Patients were examined after at least six hours of fasting in supine and left lateral decubitus positions. Gallbladder wall thickness was measured at the anterior wall in the longitudinal plane, avoiding artifacts. A wall thickness >3 mm was considered abnormal.

Additional sonographic parameters assessed included gallbladder distension (transverse diameter >4 cm), gallstones, pericholecystic fluid, and sonographic Murphy's sign. Color Doppler imaging was used to evaluate mural hyperemia, and adjacent hepatic parenchymal changes were documented.

Diagnostic Criteria and Reference Standard: Acute cholecystitis was suspected when at least two ultrasonographic criteria (wall thickening, gallstones, pericholecystic fluid, positive sonographic Murphy's sign) were present in conjunction with clinical findings. The final diagnosis was confirmed by intraoperative findings and histopathological examination of the resected gallbladder specimen, which served as the reference standard.

Histopathological Correlation: All patients underwent laparoscopic or open cholecystectomy based on clinical indications. Resected specimens were examined histopathologically for features of acute cholecystitis, including mucosal ulceration, neutrophilic infiltration, vascular congestion, and wall edema, and for chronic changes such as fibrosis and lymphocytic infiltration. Histopathological findings were correlated with preoperative ultrasonographic parameters.

Blinding and Bias Control: The radiologist performing ultrasonography was blinded to histopathological findings, and the pathologist was blinded to ultrasound results to minimize interpretation bias.

Statistical Analysis: Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Associations between ultrasonographic findings and histopathological diagnosis were assessed using the chi-square test. Diagnostic performance of ultrasonographic parameters was assessed using sensitivity, specificity, positive predictive value, and negative predictive value, using histopathology as the reference standard. A p-value <0.05 was considered statistically significant. This study

followed the principles of the STARD 2015 guidelines.[8]

Results

Patient Characteristics: A total of 56 patients with clinical suspicion of acute cholecystitis were included in the study. The mean age of the study population was 46.2 ± 12.4 years (range, 22–74 years). Female patients constituted 55.3% of the cohort, with a female-to-male ratio of 1.24:1. The majority of patients belonged to the 41–60-year age group.

Right upper quadrant abdominal pain and tenderness were present in all patients. Fever was reported in 42 patients (75.0%), vomiting in 33 (58.9%), and jaundice in 5 (8.9%). A positive clinical Murphy's sign was elicited in 45 patients (80.3%).

Ultrasonographic Findings and Association with Histopathology: Gallbladder wall thickening (>3 mm) was observed in 52 patients (92.9%). Histopathological examination confirmed acute cholecystitis in 44 patients (78.6%), chronic cholecystitis in 10 patients (17.9%), and normal gallbladder in 2 patients (3.5%). Among patients with gallbladder wall thickening, 43 (82.7%) had acute cholecystitis, whereas 9 (17.3%) had chronic or normal histology. Among the four patients with normal wall thickness, one (25.0%) had acute cholecystitis and three (75.0%) had chronic or normal histology. Gallbladder wall thickening was significantly associated with histopathologically confirmed acute cholecystitis ($p < 0.001$) (Table 1).

Ultrasonographic Predictors of Acute Cholecystitis: Pericholecystic fluid was present in 26 of 44 acute cholecystitis cases (60.4%) compared with 1 of 12 non-acute cases (7.7%) ($p < 0.001$). Sonographic Murphy's sign was positive in 40 acute cases (93.0%) versus 3 non-acute cases (25.0%) ($p < 0.001$). Gallstones were more frequent in acute cases (88.6%) compared with chronic or normal cases (58.3%) ($p = 0.038$). Mural hyperemia on color Doppler was observed in 63.6% of acute cases and 8.3% of non-acute cases ($p < 0.001$) (Table 2).

Diagnostic Performance of Ultrasonographic Parameters: Gallbladder wall thickness >3 mm demonstrated very high sensitivity (97.7%) but low specificity (25.0%) for diagnosing acute cholecystitis. Pericholecystic fluid showed high specificity (92.3%), while sonographic Murphy's sign demonstrated high sensitivity (93.0%). Combining gallbladder wall thickening, pericholecystic fluid, and sonographic Murphy's sign improved diagnostic performance, with sensitivity and specificity of 94.5% and 83.3%, respectively (Table 3).

Table 1: Association between gallbladder wall thickness on ultrasonography and histopathological diagnosis

Gallbladder Wall Thickness	Acute Cholecystitis (n = 44)	Chronic/Normal (n = 12)	Total (n = 56)	p-Value
Thickened (>3 mm)	43 (82.7%)	9 (17.3%)	52 (92.9%)	< 0.000*
Normal (≤3 mm)	1 (25.0%)	3 (75.0%)	4 (7.1%)	
Total	44 (78.6%)	12 (21.4%)	56 (100%)	
*:Chi-square test				

Table 2: Ultrasonographic features in patients with acute and non-acute cholecystitis

Ultrasonographic Feature	Acute Cholecystitis (n = 44)	Chronic/Normal (n = 12)	p-value
Gallbladder wall thickening (>3 mm)	43 (97.7%)	9 (75.0%)	<0.001*
Pericholecystic fluid	26 (60.4%)	1 (7.7%)	<0.001*
Sonographic Murphy's sign	40 (93.0%)	3 (25.0%)	<0.001*
Gallstones	39 (88.6%)	7 (58.3%)	0.038*
Mural hyperemia (Color Doppler)	28 (63.6%)	1 (8.3%)	<0.001*
*:Chi-square test			

Table 3: Diagnostic performance of ultrasonographic parameters for acute cholecystitis

Ultrasonographic Parameter	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Gallbladder wall thickness >3 mm	97.7	**25.0**	82.7	75.0
Pericholecystic fluid	60.4	92.3	96.3	46.4
Sonographic Murphy's sign	93.0	76.9	93.0	76.9
Wall thickness + Murphy's sign + pericholecystic fluid	94.5	83.3	94.5	83.3
*Diagnostic performance calculated using histopathology as the reference standard.				

Discussion

The present prospective study evaluated the diagnostic role of gallbladder wall thickness and other ultrasonographic parameters in predicting acute cholecystitis, with histopathology used as the reference standard. The findings confirm the clinical relevance of ultrasonography as the first-line imaging modality in suspected acute cholecystitis and highlight gallbladder wall thickening, pericholecystic fluid, and a positive sonographic Murphy's sign as important predictors of acute inflammation. [9]

In the current study, gallbladder wall thickening greater than 3 mm was observed in the majority of patients and showed a significant association with histopathologically confirmed acute cholecystitis. This finding is consistent with previous studies that have reported gallbladder wall thickening as one of the earliest and most sensitive sonographic signs of acute cholecystitis. However, gallbladder wall thickening demonstrated very high sensitivity but relatively low specificity in the present study, indicating that although it is a useful screening marker, it should not be used as a standalone diagnostic criterion. Gallbladder wall thickening can also be seen in systemic conditions such as hepatic dysfunction, cardiac failure, renal disease, and hypoalbuminemia, which underscores the need for cautious interpretation. [10,11]

Pericholecystic fluid and sonographic Murphy's sign were significant supportive findings in this study. Pericholecystic fluid showed high specificity for acute cholecystitis, while sonographic Murphy's sign demonstrated high sensitivity, reinforcing their complementary diagnostic roles. The combination of multiple ultrasonographic parameters improved diagnostic performance, supporting the concept that a multimodal ultrasonographic approach provides better diagnostic accuracy than reliance on a single imaging feature. These observations are in agreement with previous reports showing that combining ultrasonographic criteria enhances diagnostic sensitivity and specificity. [12,13]

Although computed tomography and magnetic resonance imaging are useful in detecting complications and differentiating acute from chronic cholecystitis, ultrasonography remains the most widely used initial imaging modality because of its non-invasive nature, rapid availability, and cost-effectiveness. In resource-limited settings, ultrasonography plays a crucial role in early diagnosis and guiding surgical decision-making. [14,15] It is important to recognize potential diagnostic pitfalls, as gallbladder wall thickening is not pathognomonic for acute cholecystitis and may occur in systemic venous congestion, liver cirrhosis, heart failure, and renal disorders. Therefore, gallbladder wall thickness should always be interpreted in conjunction with clinical findings and additional ultrasonographic features to avoid misdiagnosis and unnecessary surgical intervention.16

The present findings corroborate earlier studies reporting improved diagnostic performance when multiple ultrasonographic parameters are combined. Emerging imaging-based approaches and pattern recognition algorithms for gallbladder wall characterization may further refine diagnostic accuracy in the future, emphasizing the evolving role of imaging biomarkers in biliary pathology. [17,18]

This study has certain limitations. It was conducted at a single center with a relatively small sample size, which may limit the generalizability of the results. Interobserver variability among radiologists was not assessed, and advanced imaging techniques such as contrast-enhanced ultrasonography were not evaluated. Larger multicenter studies with standardized imaging protocols are warranted to validate these findings and establish robust diagnostic criteria.

Conclusion

Gallbladder wall thickening, pericholecystic fluid, and a positive sonographic Murphy's sign are important ultrasonographic predictors of acute cholecystitis. Gallbladder wall thickening showed high sensitivity but low specificity, while pericholecystic fluid was highly specific. Combining multiple ultrasonographic parameters improved diagnostic performance. Ultrasonography remains an effective first-line imaging modality for suspected acute cholecystitis.

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