

## Original Research Article

# Ultrasonography findings of appendicular wall thickness in acute appendicitis and recurrent appendicitis with pathological correlation

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### ABSTRACT

**Background:** Appendicitis is among most common cause for acute abdominal pain requiring operative management. This study is to establish relationship between wall thickness of acute appendicitis and recurrent appendicitis with its pathological outcome.

**Methods:** In this prospective study, 24 patients of acute appendicitis and 8 patients of recurrent appendicitis presenting as acute appendicitis were examined by High resolution Ultrasonography within 48 hrs of acute onset of symptoms following a detailed clinical examination. Alvarado scoring was done in all patients. Acute appendicitis and recurrent appendicitis were differentiated on the basis of clinical details and timeline of illness. Post operatively all specimens underwent gross and histopath examination and were divided into subgroups and tabulated as “early acute appendicitis”, “acute suppurative appendicitis” and “acute gangrenous Appendicitis”.

**Results:** Wall thickness of acute appendicitis and recurrent appendicitis (presenting with acute onset of symptoms) were tabulated. Patients with wall thickness of <3mm had statistically significant higher prevalence of acute gangrenous appendicitis on pathological correlation. Patients with recurrent appendicitis had higher incidence of wall thickness <3mm, consequently increased incidence of acute gangrenous appendicitis. The value of z was 6.0715. The value of p is <0.00001. The result was significant at p <0.01 according to SPSS 16, which correlates well with findings.

**Conclusions:** Wall thickness is an important indicator in the management of acute or recurrent appendicitis, wall thickness of <3mm or >3mm was decisive in patient management. Reduced wall thickness of appendix in patients with acute or recurrent appendicitis correlate with higher incidence of acute gangrenous appendicitis therefore are at higher risk of perforation and should be managed aggressively by surgical intervention to avoid complications.

**Keywords:** Acute Appendicitis, High resolution Ultrasonography, Histopathology, Recurrent appendicitis, Wall thickness

### INTRODUCTION

Appendicitis is one of the most common cause for acute abdominal pain requiring operative management. An individual lifetime risk of suffering from Appendicitis varies from 7-10%.<sup>1</sup> Appendectomy was the most

common operation performed on relatively emergency basis in our centre during this period. The accurate diagnosis of appendicitis relies on a combination of clinical findings (Alvarado scoring system) and imaging findings.<sup>2</sup> Alvarado scoring system fairly predicts appendicitis by minimizing negative appendectomies and can serve as a helpful adjunct to imaging.<sup>3</sup> Negative

Laparotomy, Acute appendicitis and perforated appendicitis have significant mortality and morbidity rates.<sup>4</sup> Appendicitis has dynamic disease progression, therefore early diagnosis and prompt management is imperative to reduce resultant morbidity and mortality. USG of abdomen has been the cornerstone of imaging for acute appendicitis with pathbreaking works of graded compression USG by Puylaert et al.<sup>5</sup> High resolution sonography of acute appendicitis by Monzer M. Abu-Yousef et al, USG detection of normal and abnormal appendix by Michel Rioux etc.<sup>6,7</sup>

**METHODS**

There were 32 patients with acute abdominal pain between 12 to 50 years of age suspected of acute appendicitis were examined by high resolution USG of abdomen as primary imaging modality over a period of two years from July 2017 to July 2019. USG of abdomen was performed by curvilinear probe (4 to 6 MHz) and linear probe (6 to 10 MHz) on GE Logiq P3 Pro ultrasound machine. Gross and Histopath examination was done in our lab following Appendectomy.

Real time Ultrasound was performed by two radiologist with experience of 10 to 15 years. Pathological correlation was done by two pathologist with experience of 5 to 10 years.

Wall thickness was measured in all patients of appendicitis and were tabulated separately for acute appendicitis and recurrent appendicitis. Patients under the umbrella of acute appendicitis had their first episode of acute appendicitis based on clinical findings (Alvarado score of 7 or more) and imaging features of high resolution USG. Patients grouped under recurrent appendicitis were the ones who previously had episode/episodes of appendicitis (clinically with Alvarado score of 7 or more and USG features of appendicitis) and had presented again with acute episode of appendicitis.

Wall thickness was measured of the near wall with minimum 2 cms length of uniform segment and preferably parallel to the beam.

**Inclusion criteria**

All patients with acute onset of pain up to 48 hrs duration, patients with Alvarado score of 7 or more. Patients with imaging features of appendicitis on USG.

**Exclusion criteria**

Patients below 12 years of age. Patients with Alvarado score less than 7.

USG is the first and usually the only imaging investigation done in our centre for suspected acute appendicitis. Imaging features of Acute appendicitis on

USG are enlarged appendix with diameter more than 6mm, with presence or absence of peri appendiceal inflammation, intraluminal collection, appendicolith/fecalith, peri appendiceal fluid and increased vascularity. In all the patients fulfilling the clinical and imaging criteria of acute or recurrent appendicitis, wall thickness of appendix was measured within 48 hrs of onset of symptoms and divided into two subgroups i.e. wall thickness >3mm and <3mm. On pathological basis they were divided into three subgroups as “early acute appendicitis” (catarrhal stage), “acute suppurative appendicitis” and “acute gangrenous Appendicitis”. Wall thickness and pathological outcome were tabulated separately for acute appendicitis and recurrent appendicitis presenting as acute appendicitis. Objective of the study was to correlate between wall thickness and its pathological outcome for patients of acute appendicitis and for patients of recurrent appendicitis presenting as acute appendicitis. “Acute gangrenous appendicitis” and “acute suppurative Appendicitis” with reduced wall thickness carry a higher risk of complications and thus need to be managed aggressively to reduce the associated mortality and morbidity.

**RESULTS**

Statistically 32 patients, 22(68.75%) male and 10(31.25%) female patients with clinical and radiological findings of acute appendicitis and recurrent appendicitis were evaluated for wall thickness and results were tabulated under different subgroup in (Table 1).

**Table 1: Sex wise distribution of total patient population and in subgroup of acute appendicitis and recurrent appendicitis.**

Total no. of patients	Acute appendicitis	Recurrent appendicitis
32(M-22, F-10)	24(75%) (M-14,F-8)	8(25%) (M-5,F-3)

**Table 2: Wall thickness of acute and recurrent appendicitis as >3mm and <3mm for subgroups of acute appendicitis and recurrent appendicitis/ acute on chronic appendicitis.**

Mean mural thickness	Acute appendicitis	Recurrent / Acute on chronic appendicitis
Wall thickness ≥3mm	20(83.33%)	2(25%)
Wall thickness <3mm	4(16.66%)	6(75%)

Among 24 patients of acute appendicitis 20 patients exhibited wall thickness of >3mm (Figure 1) and 5 patients exhibited wall thickness <3mm (Figure 3), and

these 5 patients had significant intraluminal collection (Table 1).

**Table 3: Correlation of wall thickness (>3mm and <3mm) and pathological correlation into subgroups of “early acute appendicitis”, “acute suppurative appendicitis” and “acute gangrenous appendicitis” for acute appendicitis.**

Mean mural thickness	Early acute appendicitis	Acute suppurative appendicitis	Acute gangrenous appendicitis
Wall thickness $\geq 3\text{mm}$	11(45.83%)	7(29.16%)	2(8.33%)
Wall thickness $< 3\text{mm}$	Nil	1(4.16%)	3(12.5%)

**Table 4: Correlation of mean wall thickness ( $\geq 3\text{mm}$  and  $< 3\text{mm}$ ) and pathological subgroups of “early acute appendicitis”, “acute suppurative appendicitis” and “acute gangrenous appendicitis” for recurrent appendicitis.**

Mean mural thickness	Early acute appendicitis	Acute suppurative appendicitis	Acute gangrenous appendicitis
Wall thickness $\geq 3\text{mm}$	Nil	1(12.5%)	1(12.5%)
Wall thickness $< 3\text{mm}$	Nil	1(12.5%)	5(62.5%)

Among 8 patients of recurrent or acute on chronic appendicitis 2 patients exhibited wall thickness of  $> 3\text{mm}$  (Figure 2) and 6 patients exhibited wall thickness  $< 3\text{mm}$  (Figure 4) (Table 2).

Among 4 patients of acute appendicitis with wall thickness of  $< 3\text{mm}$ , pathological correlation revealed 1 patient (4.16%) with Acute Suppurative Appendicitis and 3 patients (12.5%) with Acute Gangrenous Appendicitis (Table 3).

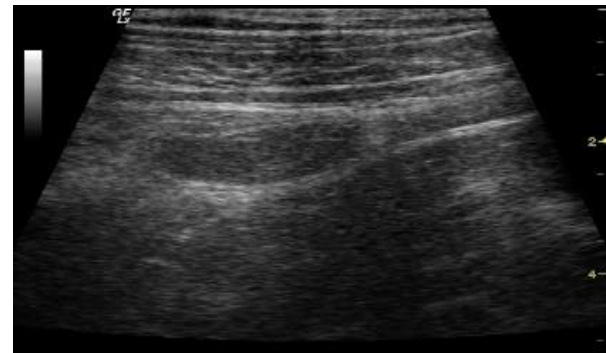
Among 6 patients of recurrent/acute on chronic appendicitis with wall thickness of  $< 3\text{mm}$ , pathological correlation revealed 1 patient (12.5%) with Acute Suppurative Appendicitis and 5 patients (62.5%) with Acute Gangrenous Appendicitis (Table 4).

There is a statistically significantly higher incidence of acute gangrenous appendicitis with wall thickness of  $< 3\text{mm}$ . Patients with recurrent appendicitis have higher incidence of wall thickness of  $< 3\text{mm}$  and consequently increased incidence of acute gangrenous appendicitis. The value of z was 6.0715. The value of p is  $< 0.00001$ .

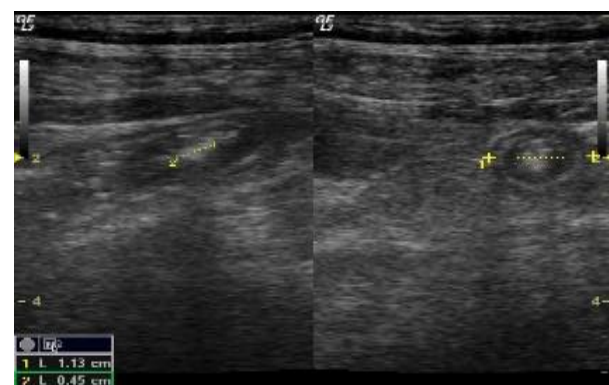
The result was significant at  $p < 0.01$  according to SPSS 16, which correlated with the findings.



**Figure 1: Acute appendicitis with thickened and edematous wall measuring more than 3mm in thickness.**



**Figure 2: Recurrent appendicitis with enlarged appendix and small intraluminal collection exhibiting wall thickness more than 3mm.**



**Figure 3: Acute appendicitis with small intraluminal collection and fecalith with irregularly thickened wall with thickness less than 3mm.**

**DISCUSSION**

Acute appendicitis is a common illness requiring surgical intervention; thus it is very relevant to promptly and accurately diagnose acute appendicitis in helping the surgeon to timely take up future course of management. Still there are 12-30% of patients undergoing unnecessary

appendectomy.<sup>8</sup> Clinical trial of migrating abdominal pain, right Iliac fossa tenderness and leukocytosis is absent in up to 50% of patients.<sup>9</sup> Alvarado score is a helpful tool to make a sound clinical impression and as a guide for further imaging work up and management.<sup>2,3</sup> High resolution USG has 95% accuracy, 89% sensitivity, 100% specificity, 89% positive predictive value and 91% negative predictive value. A meta-analysis between 1986 and 1994 showed an overall sonographic sensitivity of 85% and 92%.<sup>10</sup> Appendicitis is commonly caused by obstruction of its lumen, either by fecalith /fecal material, appendicolith, other mechanical aetiologies like lymphoid hyperplasia or intestinal parasites.<sup>11</sup>



**Figure 4: Recurrent appendicitis with appendicolith and intraluminal collection exhibiting wall thickness less than 3mm.**

Most common USG imaging features are non-compressible appendix with wall diameter greater than >6mm, thickened edematous walls, peri appendiceal inflammatory fat with probe tenderness.<sup>12</sup> There may or may not be intraluminal collection, fecalith/appendicolith, peri appendiceal collection and increased vascularity on color Doppler.<sup>12</sup> Wall thickness measured from lumen interface to serosa is >3mm in acute appendicitis.<sup>6</sup> In patients with luminal dilatation, most commonly following obstruction the wall thickness may be less than 3mm.

Pathology outcome varies with degree and duration of inflammation. When evaluated at the earliest stage, only a scant neutrophilic exudate may be found throughout the mucosa, submucosa, and the muscularis propria. Subserosa vessels are congested and there is a perivascular neutrophilic infiltration. There may be increased lymphoid reaction in the submucosa. The inflammatory reaction transforms the normal glistening serosa into a dull, granular, red membrane; this transformation signifies early acute appendicitis or the catarrhal stage of appendicitis. As the inflammation progresses, a prominent neutrophilic exudate generates a fibrinopurulent reaction over the serosa. There is abscess formation within the wall, along with ulceration and foci of suppurative necrosis in the mucosa. This stage is acute suppurative appendicitis. Further appendiceal compromise leads to large areas of hemorrhagic green

ulceration of the mucosa and green-black gangrenous necrosis through the wall extending to the serosa, creating acute gangrenous appendicitis stage. If left unattended this may lead to rupture and suppurative peritonitis.<sup>13</sup>

Among 24 patients of acute appendicitis, 20 patients had wall thickness of >3mm, 11 patients correlated with Catarrhal stage, 7 had Acute Suppurative Appendicitis showing mucosal ulceration on pathological correlation. 2 patients with acute gangrenous appendicitis had wall thickness of greater than or equal to 3mm, however on histopath correlation they had eccentric foci of wall thickness <3mm near its terminal end, this was involving the posterior wall and obscured by luminal collection on USG.

Among 24 patients of acute appendicitis, 4 patients had wall thickness of <3mm, one patient had acute suppurative appendicitis on pathological outcome showing large areas mucosal ulceration but the gangrenous changes were not evident, 3 patients with wall thickness <3mm had appendicolith causing obstruction and luminal dilatation with early gangrenous changes and impending rupture.

Among 8 patients of recurrent appendicitis, 2 patients had wall thickness of >3mm, one of these patient had acute suppurative appendicitis with mucosal ulceration. One patient had acute gangrenous appendicitis, this patient did not have any significant luminal collection and no increased intraluminal pressure, but there was vascular compromise likely secondary to recurrent episodes.

Among 8 patients of recurrent appendicitis, 6 patients had wall thickness of <3mm. 2 patients showed extensive deep ulceration involving the mucosa and submucosa on the fibrinopurulent background with neutrophil infiltration and few lymphocytes, correlating with suppurative appendicitis on the background of chronic appendicitis presenting as acute episode. Three patients showed fecalith/fecal collection, one patient had appendicolith, these patients had significant intraluminal collection causing obstruction with increased luminal pressure, leading to gangrenous changes on pathological correlation.

## CONCLUSION

There were 10 patients of acute appendicitis and recurrent appendicitis having wall thickness of <3mm had statistically significant higher prevalence of acute gangrenous appendicitis (70%) on pathological correlation. Overall 22 Patients had wall thickness of >3mm and only 10% patients had acute gangrenous appendicitis. Recurrent appendicitis had higher prevalence of wall thickness of <3mm (75%) as compared to acute appendicitis (10%). Reduced wall thickness of appendix in patients with acute or recurrent appendicitis are at higher risk of perforation and should



be managed aggressively by surgical intervention to avoid complications.

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## REFERENCES

1. Temple CL, Huchcroft SA, Temple WJ. The natural history of appendicitis in adults. A prospective study. *Annals of surgery*. 1995 Mar;221(3):278-81.
2. Blitman NM, Anwar M, Brady KB, Taragin BH, Freeman K. Value of focused appendicitis ultrasound and alvarado score in predicting appendicitis in children: can we reduce the use of CT?. *Am J Roentgenol*. 2015 Jun;204(6):W707-12.
3. Nema P, Jain AK. A clinical comparative study of different scoring systems in acute appendicitis. *Internat Surgery J*. 2016 Dec 13;3(1):184-8.
4. Velanovich V, Satava R. Balancing the normal appendectomy rate with the perforated appendicitis rate: implications for quality assurance. *Am Surgeon*. 1992 Apr;58(4):264-9.
5. Puylaert JB. Acute appendicitis: US evaluation using graded compression. *Radiology*. 1986 Feb;158(2):355-60.
6. Abu-Yousef MM, Bleicher JJ, Maher JW, Urdaneta LF, Franken Jr EA, Metcalf AM. High-resolution sonography of acute appendicitis. *Am J Roentgenol*. 1987 Jul 1;149(1):53-8.
7. Riou X M. Sonographic detection of the normal and abnormal appendix. *AJR. Am J Roentgenol*. 1992 Apr;158(4):773-8.
8. Wilson EB, Surgical evaluation of appendicitis in the new era of radiographic imaging. *Semin US, CT, MRI* 2003; 24:65-68.
9. Lee SL, Walsh AJ, Ho HS. Computed tomography and ultrasonography do not improve and may delay the diagnosis and treatment of acute appendicitis. *Arch Surgery*. 2001 May 1;136(5):556-62.
10. Orr RK, Porter D, Hartman D. Ultrasonography to evaluate adults for appendicitis: decision making based on meta-analysis and probabilistic reasoning. *Academic Emergency Med*. 1995 Jul;2(7):644-50.
11. Jones MW, Lopez RA, Deppen JG. Appendicitis. In *Stat Pearls and (Internet) and Treasure Island and (FL) and Stat Pearls* .2019;01:1-4
12. Mostbeck G, Adam EJ, Nielsen MB, Claudon M, Clevert D, Nicolau C, et al. How to diagnose acute appendicitis: ultrasound first. *Insights into imaging*. 2016 Apr 1;7(2):255-63.
13. Kumar V, Abbas AK, Aster JC. *Robbins basic pathology*. 16th ed. Philadelphia: Elsevier Saunders; 2016:583-9.

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