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## ORIGINAL ARTICLE

# Ultrasonography Is Still A Useful Diagnostic Tool In Acute Appendicitis

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### ABSTRACT

**Aim:** The aim of the study was to evaluate the role of ultrasonography in the diagnosis of acute appendicitis and to study the correlation between clinical signs, laboratory investigations and ultrasonographic findings in the evaluation of the diagnosis of acute appendicitis.

**Methods:** A total number of 100 patients (52 men and 48 women) over a period of 2 years, with the clinical suspicion of appendicitis, were subjected to abdominal ultrasonographic examination. Ultrasound positive cases were subjected to surgery. The accuracy of ultrasonography in the diagnosis of appendicitis was compared with clinical diagnosis, laparotomy findings and histopathological examination reports.

**Results:** Out of 100 cases that underwent ultrasonography, 58 cases were sonographically positive for appendicitis and 3 cases were appendicular masses. Right iliac fossa tenderness, rebound tenderness and Rovsing's sign were the cardinal signs. The Murphy's triad of symptoms holds good in the diagnosis of appendicitis in the present study. The overall specificity of ultrasound was 88.09% and the sensitivity was 91.37% in the diagnosis of acute appendicitis.

**Conclusion:** Acute appendicitis is a common indication for emergency abdominal surgery. Ultrasonography is still a useful tool in the diagnosis of acute appendicitis in spite of sophisticated investigations like CT abdomen and laparoscopy; thus, reducing the cost of treatment and preventing negative laparotomies.

**Key Words:** Appendix, Appendicitis, Ultrasound in appendicitis, Sensitivity, Specificity.

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### Introduction

Acute appendicitis is still the most common indication for emergency abdominal surgery. The clinical diagnosis of appendicitis is difficult in a few cases. Approximately 20-33% of patients will present atypically [1],[2]. Delay in the diagnosis and surgery in these atypical cases of appendicitis result in perforation. This occurs in 17-39% of patients with appendicitis. The elderly and very young patients are at a higher risk [1],[3]. To prevent high morbidity and mortality, most of the surgical authorities have advocated timely surgical intervention (early appendectomy), accepting that a

significant number of normal appendices will be removed [1], [4]. The diagnosis of appendicular inflammation cannot be accurately made, based on a single symptom, sign or diagnostic test in all cases. The diagnosis of acute appendicitis can be established accurately in over 80% of the cases by some experienced senior surgeons [5], [6].

Abdominal ultrasonography (USG) has a definitive role in the diagnosis of acute appendicitis, establishes an alternative diagnosis in patients with acute right lower abdominal pain and reduces the number of negative laparotomies [7],[8],[9].

### Materials and Methods

This prospective study was carried out in the department of Surgery, in collaboration with the department of Radio-diagnosis, at our Medical College Hospital, over a period of 2 years from March 2000 to February 2002. A total of 100 patients (52 men and 48 women; age range 8 years to 57 years) who presented with pain in the right lower abdomen, in whom acute appendicitis was suspected based on clinical features, were subjected to abdominal USG examination .

### Inclusion Criteria

1. All patients who presented with pain in the right lower abdomen, in whom acute appendicitis was suspected, were included in this study.
2. Patients with appendicular masses who were managed conservatively and later underwent interval appendicectomy, were included.
3. Patients with a history suggestive of recurrent appendicitis were also included in the study.

### Exclusion Criteria

1. Patients with chronic infectious diseases like ileo-caecal tuberculosis were not included in this study.
2. Patients with carcinoid tumours and other neoplastic lesions of the appendix were not included in the study.

Clinical diagnosis of acute appendicitis was done by consultants, based on the symptom of pain which was localized to the right lower quadrant, a history of migration of pain, vomiting, fever and peritoneal signs. Based on the sonological report, a definitive surgical management was instituted.

Graded compression USG was done using 3.5 - 7.5 MHz linear – array transducers according to the situation. The following accepted criteria were considered for the diagnosis of an inflamed appendix.

- a. [Table/Fig 1] Visualization of non-compressible appendix as a blind ending tubular aperistaltic structure [10].
- b. [Table/Fig 2] Target appearance of  $\geq 6$ mm. (6 millimeters) in the total diameter on cross section  
(81%) maximal mural wall thickness  $\geq 2$ mm [11].
- c. [Table/Fig 3] Diffuse hypoechogenesity (associated with a higher incidence of perforation).
- d. Lumen may be distended with anechoic / hyper echoic material.
- e. Loss of wall layers.
- f. [Table/Fig 4] Visualization of appendicolith (6%). (Table/Fig 4a & Table/Fig 4b)
- g. [Table/Fig 5] Localized peri-appendiceal fluid collection.
- h. Prominent hyper echoic mesoappendix / pericaecal fat.
- i. Free pelvic fluid.

Grebeldinger [12] has stated that the most relevant criteria for USG evaluation was non-compressibility (97.67%). The second criterion was thickened wall (86.04%).

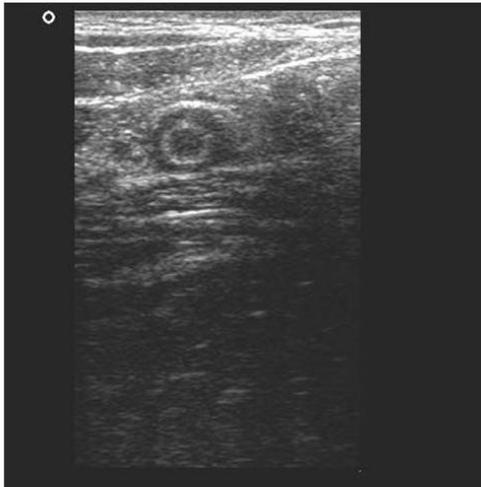
It was kept in mind that a normal appendix is not visualized on USG examination and such a finding was taken as a negative test by USG in the diagnosis of appendicitis.

The accuracy of USG in diagnosing appendicitis was compared with clinical

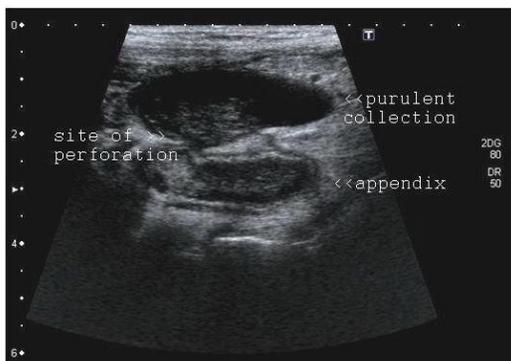
diagnosis, laparotomy findings and resulting histopathological examination (HPE).



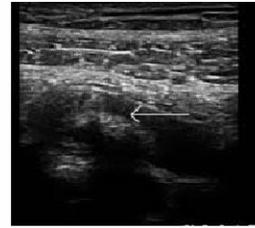
[Table/Fig 1] Tubular enlarged hypoechoic edematous appendix.



[Table/Fig 2] Inflamed appendix with target sign on USG.



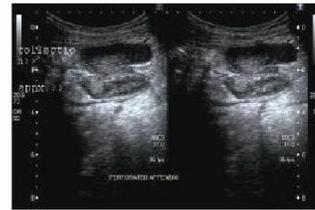
[Table/Fig 3] Sonographic picture perforated appendix.



[Table/Fig 4 a] Tubular fluid filled, dilated, inflamed appendix with arrow pointing Appendicolith.



[Table/Fig 4 b] Tubular fluid filled, dilated, inflamed appendix with arrow pointing Appendicolith.



[Table/Fig 5] Inflamed appendix with localized peri-appendiceal fluid collection.

## Results

Before the analysis of the data, certain assumptions were done.

1. HPE diagnosis was accepted as the final confirmation of the diagnosis.
2. All cases which were treated conservatively were discharged and those cases of appendicectomies in which HPE was negative, were all considered as true negatives.
3. Though USG was done by 4 radiologists in our hospital, no significance was attached to the inter observer variation, as all the radiologists had equally good experience with USG.
4. Though many consultants were involved in clinical diagnosis, again no significance was attached to the inter observer variation.

The above observation shows that, out of 100 cases for whom USG abdomen was

done, 58 cases (58%) were sonologically positive for appendicitis and 3 cases were appendicular masses\_ [Table/Fig 6]. Among USG negative cases (42%), an alternative diagnosis could be attained in more than half the number of cases, such as right ureteric colic, pelvic inflammatory disease, ovarian cyst and intestinal ascariasis. 18% of cases were inconclusive [Table/Fig 7] .



[Table/Fig 6] Complex echogenicity lesion in RIF with surrounding inflammatory Changes. (Appendicular mass)

[Table/Fig 7] USG diagnosis of RIF pain

Pathology	No. of cases	Percentage (%)
Acute Appendicitis	58	58%
Right Ureteric Colic	10	10%
Pelvic inflammatory disease	6	6%
Ovarian Cyst	3	3%
Appendicular Mass	3	3%
Intestinal Ascariasis	2	2%
Inconclusive	18	18%

The above observation shows that all the cases presented with pain in the right iliac fossa (RIF) and clinical suspicion of acute appendicitis which were the selection criteria for the present study. Tenderness in RIF was the most common sign elicited in all the cases (100%). Irrespective of the pathology, vomiting was found to be present in 91% of the cases. Murphy’s triad of symptoms i.e. pain in abdomen, vomiting and fever held good in the diagnosis of acute appendicitis in our study [Table/Fig 8]. Smith [13] studied 100 cases of acute appendicitis in which only 60 patients had a temperature of 37.2°C, which tallied with our study.

[Table/fig 8] Clinical signs and symptoms

Symptoms	No. of cases	Percentage (%)
Pain Abdomen	100	100%
Migration of pain	22	22%
Vomiting	91	91%
Fever	37	37%
Dysuria	9	9%
Diarhoea	3	3%
<b>Signs</b>		
RIF tenderness	100	100%
Rebound tenderness	65	65%
Guarding	23	23%
Tachycardia	79	79%
Rovsing’s sign	43	43%
Leucocytosis	75	75%
Neutrophilia	86	86%
Urine Microscopy - Pus cells and RBCs	11	11%

Rebound tenderness was present in 65% of the cases and Rovsing’s sign was positive in 43% of cases. A total of 58 cases were diagnosed to have appendicular pathology by USG and all these patients were operated upon. Out of the 58 operated cases, 53 were HPE positive and 5 were found to be negative on HPE [Table/Fig 9] . The sonologically negative cases were managed conservatively. In the conservative group of 42 cases, appendicectomy was done for 10 cases due to the persistence of symptoms and due to the surgeon’s suspicion. Out of these 10 operated cases, 5 were reported to be acute appendicitis on HPE [Table/Fig 10] . 3 cases of appendicular masses were treated conservatively and were subjected to interval appendectomy after 3 months of interval.

[Table/Fig 9] Histopathological Diagnosis

Histopathology diagnosis	No. of cases
Acute appendicitis	53
Chronic Appendicitis	4
Lymphoid hyperplasia	6
Total	68

**[Table/Fig 10]**

**(Table/Fig 10) Correlations of USG diagnosis with HPE**

Total No. of cases	100
<b>USG positive</b>	<b>58</b>
USG negative	42
HPE positive	53
HPE negative	5
<b>USG negative cases operated</b>	<b>10</b>
HPE positive	5
HPE negative	5
<b>Results</b>	
Total cases of USG	100
USG positive	58
HPE positive	53
True positive	53
True negative	37
False positive	5
False negative	5

**(Table/Fig 11) Evaluation of USG**

Evaluation of USG	Values (%)
Sensitivity	91.37%
Specificity	88.09%
Positive predictive value	91.37%
Negative predictive value	88.09%
Diagnostic accuracy	90%
False positive error rate	11.90%
False negative error rate	8.62%
Likelihood ratio positive	7.67%
Likelihood ratio negative	0.097%

The overall specificity (88.09%) and sensitivity (91.37%) of USG in diagnosing appendicular pathology were high, indicating accurate diagnosis by USG in almost all patients with pain in RIF (For Table/Fig 11 refer to ) [Table/Fig 10].

**Discussion**

USG is a valued tool for clinically suspected appendicitis and it enhances the diagnostic accuracy in cases with pain in the RIF and reduces the number of negative appendicectomies.

Of the 58 cases of appendicitis, pain in abdomen and vomiting were the predominant clinical symptoms, but they are not specific for acute appendicitis. Tenderness in RIF was present in almost all cases. Rebound tenderness, guarding and Rovsing’s sign if present, are more specific

for acute appendicitis. These findings tallied with the findings of the study by Rosemary Kozar et al [14]. Leucocytosis was present in 75% of the cases and Neutrophilia in 86% of the cases. A study of 225 patients by Doraiswamy (1982) [15] showed leucocytosis in 42% and neutrophilia in 96% of the cases.

Abdominal USG could diagnose 58 cases as appendicitis out of a total of 100 cases who presented with clinical features similar to appendicitis, from which true positive cases of appendicitis were found after surgery and HPE. John et al [16] reviewed a total 140 cases of appendicitis in which they could diagnose 70 cases as appendicitis by USG.

The overall specificity and sensitivity were found to be 88.09% and 91.37% respectively, which showed that USG has a high specificity and sensitivity in diagnosing appendicitis. The overall specificity and sensitivity rates were at par with the values drawn by Skanne et al [17], Hahn et al [18], Tarzan Z et al [19] and Puylaert et al [20], whose specificity values varied from 90-100% and sensitivity ranges varied from 70-95%.

**Limitations And Drawbacks Of The Study**

This study does not include diagnostic laparoscopy, which is the recent modality of diagnosis and treatment of acute appendicitis. We have not included contrast CT abdomen for the accurate diagnosis of doubtful cases due to the cost factor. This study would have been more accurate if we would have included all cases with right iliac fossa pain. USG is operator dependant; though USG was done by 4 radiologists in our hospital, no significance was attached to the inter observer variation as all the radiologists had equally good experience with USG.

## Conclusion

Acute appendicitis is the most common acute abdominal condition, necessitating emergency surgery. When the clinical signs and the symptoms are combined with USG findings, the diagnostic accuracy is significantly high. USG helps in diagnosing other causes of RIF pain which helps in excluding appendicular pathology. The overall specificity of abdominal USG in the diagnosis of acute appendicitis was 88.09% and sensitivity was 91.37%. It should be emphasized that USG does not replace clinical diagnosis, but is a useful adjunct in the diagnosis of acute appendicitis. We recommend USG as a valuable tool in diagnosing acute appendicitis in spite of sophisticated investigations like CT abdomen and laparoscopy; thus, reducing the cost of treatment and preventing negative laparotomies.

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