Original Research Article

# Ultrasound evaluation of acute appendicitis

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## Abstract

**Background:** Acute appendicitis (AA) is the commonest cause of abdominal pain requiring surgical intervention. Although the correct diagnosis can be made in most patients on the basis of history, physical examination, and laboratory tests. Diagnosis is uncertain in 20–33% of the patients who present with atypical symptoms. Laboratory results are often non-specific. Imaging has an important role not only in diagnosing appendicitis and its complication, but also suggesting alternate diagnosis in appropriate cases. **Aim:** To compare imaging findings with operative findings and evaluation of sensitivity, specificity, positive and negative predictive value of ultrasound in diagnosing acute appendicitis. **Methods:** This prospective study was done after consent and clinical examination of 87 patients with suspected acute appendicitis. All the patients had undergone abdominal ultrasonography. Following clinical, laboratory, and imaging findings; appropriate surgery was done in all patients. Later operative findings were compared with imaging and histopathological findings, and finally evaluated effectiveness of ultrasonography in diagnosing acute appendicitis. **Results:** Out of 87 patients (53 male and 34 female; age range 18–80 years) 76patients (87%) had appendicitis on sonography and 12 patients (13%) had negative sonographic findings. The surgical findings were positive for appendicitis in 79 (90%) of the 87 patients who had surgery. Four patients with negative ultrasound findings underwent surgery and had appendicitis. Another patient with appendicular abscess on ultrasonography findings underwent surgery and had ileum perforation. Therefore, 07 of 11 patients with negative sonographic findings did not have appendicitis. On the basis of these numbers, sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of abdominal ultrasonography in diagnosing appendicular pathology were 94%, 87%, 98%, 64% and 94% respectively. **Conclusion:** Acute appendicitis is the most common cause of acute abdomen. A prompt and accurate diagnosis can be done with the help of ultrasonography to minimize patient's morbidity and mortality because clinical evaluation results can be inaccurate. Ultrasound can therefore be used as a cheap and inexpensive way of confirming acute appendicitis by increasing diagnostic accuracy and reducing negative appendectomy rate. Thus ultrasonography plays an important role in the management of patients with acute appendicitis.

**Key Words:** Appendicitis, Ultrasonograpy, Laparotomy.

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## INTRODUCTION

Acute appendicitis (AA) is the commonest cause of abdominal pain requiring surgical intervention. Appendicitis is often seen in the second to fourth decade of life, and about 7% of the population suffering during their lifetime.[3] One of the criteria for the diagnosis based on clinical signs and examinations is the Alvarado standard, which includes symptoms (abdominal pain, migration, nausea and vomiting) symptoms (anorexia, tenderness and rebound tenderness, fever), and laboratory criteria (leukocytosis and left shift).[4] Although the correct diagnosis can be made in most patients on the basis of history, physical examination, and laboratory tests, diagnosis is uncertain in 20–33% of the patients who present with atypical symptoms.[1,2] Laboratory results are often non-specific. Severe complications result from perforation of acute appendicitis generally resulting from delayed diagnosis. Hence surgical intervention will be the

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first priority for the surgeons. In addition, incorrect diagnosis of appendicitis imposes unnecessary surgery to the patient and leads to lack of recovery of the main problem following the operation and patient dissatisfaction with the medical system.[5] A negative appendectomy might not only expose the patient to the risk of surgical procedure, but also a higher risk of acute myocardial infarction related to surgical removal of the tonsils and appendix before the age of 20 has been reported.[6] The rate of unnecessary laparotomies is still high. To balance an acceptable positive laparotomy rate with minimal delayed or missed diagnoses, the clinician must take into account all the available historical and physical findings, laboratory data, and appropriate imaging method. In fact, following significant advances in accuracy, imaging is an important part of the modern work-up of appendicitis that remains a high-risk disease for delayed or missed diagnosis in the emergency department.[7,8]

Imaging has an important role not only in diagnosing appendicitis and its complications, but also suggesting alternate diagnosis in appropriate cases. Multi-detector computed tomography (MDCT) is considered the gold standard technique to evaluate patients with suspected AA because of its high sensitivity and specificity.[9,10] Magnetic Resonance Imaging (MRI) has also shown high accuracy in the detection of AA especially when radiation protection in children and in pregnant patients is of major importance.[2,3] On the other hand research focusing on various aspects of US Imaging in the diagnosis of AA has gained major importance over recent years as radiation protection[11] broad availability and cost effectiveness became increasingly important aspects of the modern imaging techniques in the diagnosis of AA. Adult patients who lack perfect clinical symptoms and suspected to have acute appendicitis should use ultrasound as the primary imaging so that the differential diagnosis is put aside.[12] Among the imaging methods currently used in the clinical practice, Ultrasound (US) is a valuable tool. It was first introduced by Puylaert in 1986, who described the "graded compression" technique apt to better visualize the inflamed appendix.[13] By using the graded compression technique, a linear high-frequency transducer is placed on the right lower quadrant and pressure is applied gradually while imaging, displacing overlying gas-filled loops of the bowel. Moreover, this noninvasive option is repeatable, avoids the exposure to non-ionizing radiation and can be less expensive as compared to Computed Tomography (CT) costs. At US, findings suggestive of appendicitis include a thickened wall, a non-compressible lumen, outer appendiceal diameter greater than 6 mm, absence of gas in the lumen, appendicoliths, echogenic inflammatory peri-appendiceal fat change, and increased blood flow in the appendiceal wall. When compared to other diagnostic tests, US is inferior to CT as to sensitivity due to its low negative predictive value for appendicitis. It may not be as useful for excluding appendicitis. More recently, color and power Doppler examination of the appendix have proven to be a useful adjunct to improve the sensitivity by demonstrating increased flow in an inflamed appendix.[14,15] Despite the fact that the role of ultrasound in the diagnosis of acute appendicitis has been proven, it is highly dependent on the experience, skill, and knowledge of the operator.[16,17] 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.[18,19,20] Accordingly the purpose of this study was to evaluate the diagnostic accuracy of the US method in the diagnosis of acute appendicitis.

## MATERIALS AND METHODS

This prospective study involves 87 patients referred to the Department of Radiodiagnosis, with clinical history of acute appendicitis during the study period of Jan 2020 to June 2020. All patients aged above 18 years with a clinical presentation of acute appendicitis were included and conservatively managed cases were excluded from the study. Informed consent of the patients were obtained prior to examination. A detailed history of all patients included in the study was taken along with thorough clinical examination and laboratory investigation findings were recorded as per proforma. Clinically diagnosed acute appendicitis cases were subjected to Ultrasound examination using Phillips IU 22 machine. Scanning at the point of maximum tenderness was found to be more useful in localizing the appendix and that had decreased the duration of time required for examination by Graded Compression technique. After the Ultrasound diagnosis had been established, patients in the study group were subjected to surgery [fig 1]. The operative findings were noted and the operative findings were compared with the clinical diagnosis and the Ultrasonography findings. The accuracy of ultrasound was assessed by comparing with each operative finding and the specimen resected was sent for histopathological examination for the confirmation of the diagnosis.

**Statistical Methods:** Sensitivity, specificity, positive predictive value, negative predictive value was used. The statistical software namely SPSS was used for analysis of the data and Microsoft Word and Excel were used to generate graphs, tables, etc.

## RESULTS

During the 6-month period from Jan 2020 to June 2020, a prospective study was made on a consecutive series of 87 patients referred to the BIMS Hospital, Belagavi with

clinical features suggestive of Acute Appendicitis. The results were as follows; out of 87 patients, 53 were male (61%) and 34 were female (39%). [Table 1] The numbers of patients were highest in the age group of 21 to 30 years (43%) followed by 31 to 40 years (24 %). [Table 2] All 87 patients presented with abdominal pain, amongst those 52 (60%) patients had a history of RIF pain, 40 (46%) patients had anorexia, and 60 (69%) patients had nausea and vomiting. On examination, all 400 patients had tenderness in RIF, 34 (39) patients had elevated temperature [Table 3]. Out of 87 patients, 76 patients (87%) had appendicitis on sonography and 11 (12%) had negative sonographic findings. Out of 76 patients, 7 cases were appendicular perforation [Table 4]. The surgical findings were positive for appendicitis in 79 (90%) of the 87 patients, who had surgery. Four patients with negative ultrasound findings underwent surgery and had appendicitis. Another patient with appendicular abscess on Ultrasonography findings underwent surgery and had ileum perforation [Table 5]. All appendectomy specimens subjected to Histopathology examination, 83 were positive for appendicitis. On the basis of these numbers, Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of abdominal ultrasonography in diagnosing appendicular pathology were 94%, 87%, 98%, 64%, and 94% respectively [Table 6].

## DISCUSSION

A total of 50 patients were included in our study, out of which 32 were male and 18 were female patients. The highest incidence was seen in patients with acute abdomen is between 20-30 years of age followed by 30-40 years. Lewis *et al.* study found out the second and third decades were the most common age groups for acute appendicitis [21] Addis *et al.* and Blab E *et al.* studies were reported male:female ratio of 1.6:1.[22,23] In our study,the highest incidence of abdominal pain was seen in between 20-30 years of age, which was similar to Lewis *et al.* study. In our study, male to female ratio was approximately male predominance noticed and this study was similar to Addis *et al.* and Blab E *et al.* studies. Schwartz SL *Et al.* reported pain in the right iliac fossa was present in all cases of appendicitis.[24] George Mathews *et al.* study revealed 99% of the cases of acute appendicitis had RIF tenderness.[25] All the patients in the present study had pain and tenderness in the right iliac fossa, which were similar to Schwartz Sl and George Mathews *et al.* studies.

In the present study, Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of abdominal ultrasonography in diagnosing appendicular pathology were 94%, 87%, 98%, 64% and 94% respectively.

Daga *et al.*[26] observed Sensitivity, Specificity, positive predictive value, and negative predictive value of Ultrasonography (US) in the diagnosis of acute appendicitis were 96.5%, 85.7%, 98.8%, and 66.7% respectively with an overall accuracy of 95.7%. C, Subash K, *et al.* study[27] showed the Sensitivity, Specificity, positive predictive value, negative predictive value and overall accuracy of ultrasound in the diagnosis of acute appendicitis were found to be 95.12%, 88.88%, 97.5%, 80% and 82% respectively. Tauro LF *et al.*[29] showed sensitivity of 91.37%, specificity of 88.09%, positive predictive value of 91.37%, negative predictive value of 88.09% and diagnostic accuracy of 90%. Joshi *et al.*[28] study revealed the Sensitivity, Specificity, positive predictive value, and negative predictive value of ultrasound in diagnosis of acute appendicitis were found to be 96%, 93%, 98%, and 88% respectively.

In our study, ultrasound findings were correlating well with Daga *et al.* C, Subash K, *et al.*, Tauro LF *et al.* and Joshi *et al.* studies. In the present study, imaging findings of acute abdomen were correlating well with per operative findings.

Using US it is possible to confirm appendicitis by visualizing the inflamed appendix (successful in 90%) or to exclude appendicitis either by visualization of the normal appendix (successful in 50%) or by demonstrating an alternative condition (possible in 20%). This means that there will always be a rather large group of patients in whom the US result is equivocal making further studies necessary.

### Limitations of study:

The sample size included evaluation of the patients with abdominal pain, who also underwent surgical evaluation. Patients who were not operated, but had significant imaging findings were excluded from the sample size.

## CONCLUSION

Ultrasound is easily available, noninvasive, non-ionizing, and inexpensive modality, which should be the initial investigation in diagnosing acute appendicitis, high sensitivity and specificity ultrasound, which helps in reducing negative appendectomy rate and provides alternative causes of RIF pain thus excluding appendicular pathology. Despite the fact that the role of ultrasound in the diagnosis of acute appendicitis has been proven, it is highly dependent on the experience, skill, and knowledge of the operator. Pediatric patients, thin young adults, and pregnant patients; ultrasound is primary imaging method (avoids excessive radiation). Computed tomography for patients with inconclusive ultrasound, if perforation suspected, or if obese.[7] It should be emphasized that USG does not replace clinical diagnosis, but is a useful adjunct in the diagnosis of acute appendicitis.

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