

A Prospective Study to Determine Sensitivity and Specificity of Ultrasonogram in Diagnosis of Acute Appendicitis: Comparison with Histopathology Report

Rajasekhar Konduru¹, Prashanth Thimme Gowda²

¹Assistant Professor, Department of General Surgery, ²Associate Professor, Department of Radiodiagnosis, Narayana Medical College Chinthareddyapalem, Nellore, Andhra Pradesh, India

Corresponding author: Dr. Prashanth Thimme Gowda, Associate Professor, Department of Radiodiagnosis, Narayana Medical College Chinthareddyapalem, Nellore, Andhra Pradesh, India

DOI: <http://dx.doi.org/10.21276/ijcmsr.2018.3.4.4>

How to cite this article: Rajasekhar Konduru, Prashanth Thimme Gowda. A prospective study to determine sensitivity and specificity of ultrasonogram in diagnosis of acute appendicitis: comparison with histopathology report. *International Journal of Contemporary Medicine Surgery and Radiology*. 2018;3(4):C14-C17.

A B S T R A C T

Introduction: Acute appendicitis is one of the most common surgical abdominal emergencies where timely intervention and correct diagnosis plays a crucial role in reduction of morbidity and mortality. Ultrasound remains one of the best imaging modality in diagnosis of cases for acute appendicitis in typical cases. Present study was aimed mainly to determine the sensitivity and specificity of ultra sonogram in diagnostic accuracy of cases of acute appendicitis.

Material and methods: A prospective study for one year was conducted after ethics approval among all the cases suspected with acute appendicitis. Diagnostic ultrasound was performed on the cases and operated. The findings of the ultrasonogram were compared with Histopathological report. The sensitivity, specificity, positive and negative predictive value of ultrasonogram was evaluated. Chi-Square test was done to determine the significance between the groups and p value <0.05 was considered significant.

Results: 125 cases were enrolled with males 56% and females 44%. Mean age of the study group was 31.21± 2.8 years. 84% were confirmed as histopathological positive, 94 cases were positive by diagnostic ultrasound. Negative appendectomy rate was 4.8%. The total rate of false diagnosis by ultrasound was 13.6%. The positive predictive value was 94% and negative predictive value was 56% in the present study.

Discussion: High resolution sonography with graded compression is a very promising examination in diagnosis of acute appendicitis in problem cases and in women of reproductive age group. Present study suggests always a closer interaction between sonologists and surgeons in arriving at a correct diagnosis.

Key words: *Acute appendicitis, Ultrasonogram, sensitivity, specificity, Predictive value.*

INTRODUCTION

Acute appendicitis is one of the most common surgical abdominal emergencies where timely intervention and correct diagnosis plays a crucial role in reduction of morbidity and mortality. This condition is mostly observed in the second to fourth decade of life and less common in infants and younger children. Males are less commonly affected than females with males 13% and females 25%.¹ A thorough clinical examination with a combined perfect investigation of choice reduces unwanted appendectomy and its associated morbidity. Several scoring systems have been developed which helps in arriving at a diagnosis but the accuracy of these scoring systems still are not conclusive in accurate diagnosis. The most commonly used are the Alvarado score and AIR—Appendicitis Inflammatory Response (Andersson) score.^{2,3} Hence improving the diagnostic accuracy is a corner stone for decreasing the negative appendectomy rate and the negative risk of wrong

diagnosis. A new grading system has been proposed by the world society of emergency surgery (WSSES) which is based on clinical finding, imaging studies and surgical findings which is aimed to provide a standard classification system and ultimately providing post appendectomy management.⁴ However classic signs and symptoms of acute appendicitis are present in 70% of population but 30% of the cases present with atypical manifestations and a serious concern for false appendectomy. Ultrasound remains one of the best imaging modality in diagnosis of cases for acute appendicitis in typical cases however with the introduction of CT; ultra sonogram still remains as basic imaging modality in uncomplicated cases of appendicitis. Most of the studies conducted earlier have reported the sensitivity and specificity of USG in appendicitis as up to 70% in diagnosis.⁵ Histopathological confirmation is still gold standard in diagnosis of cases of acute appendicitis. Hence conducting a combined study with USG and histo pathological examination provides greater accuracy in reducing the cases of false positives and prevents

unnecessary appendectomies. At Ultra sonogram, findings suggestive of acute appendicitis include a thickened wall, a non compressible lumen, outer Appendiceal diameter greater than 6mm, appendicoliths, and absence of gas in the lumen. Most of the studies report US inferior to CT due to its low positive predictive value. The sensitivity of US is highly dependable on the skill and experience of the operator.⁶ Present study was aimed mainly to determine the sensitivity and specificity of ultra sonogram in diagnostic accuracy of cases of acute appendicitis. Further the study also compared the report of ultra sonogram with histopathological report of the cases in the study.

MATERIAL AND METHODS

A prospective study was conducted by the department of general surgery in association with department of Radio diagnosis at a tertiary care hospital of south India for a period of one year from January 2016 to December 2016. The study proposal was presented before the institutional ethical committee and approved. The study was conducted as per the guidelines of the ethical committee. The details of the study were clearly explained to the cases and well informed written consent was obtained from all the cases participating in the study. All the patients attending the surgical emergency and OPD with a suspicion of acute appendicitis were thoroughly examined clinically by a senior resident of surgery department and then referred to the department of radio diagnosis for further confirmation of acute appendicitis. The socio demographic data, clinical history, duration of signs and symptoms were collected and noted in a separate questionnaire form of the study. Ultra sonogram of the total abdomen was performed by a senior radiologist of the department and findings were noted. Scanning of the abdomen was performed with the patient lying in supine position with 2-5 MHz curvilinear probe and then examination of the lower quadrant by Graded compression technique with 6-12 MHz linear probe.⁷

Scanning Procedure: Scanning was done in supine position while applying gradual compression which displaces the shadowing gas contents in caecum and ascending colon permitting clear visualization of retro caecal area. This also brings the intra abdominal structures closer to the transducer and its focal zone. Sonographic findings were classified as: 1) Positive when appendices were identified and their maximal outer diameter was >6mm. 2) Negative when appendices were identified and \leq 6mm in maximum outer diameter and 3) Non visualized appendix. In cases where appendix was not visualized, scanning the area where patient shows maximum tenderness by fingertip was usually the site of appendix. Identifying the secondary signs like, fluid in right paracolic gutter or hyperechogenic mesenteric fat for helping in diagnosis were not used because they were not available in all ultra sonogram reports.

Surgery was performed on all the patients' clinically and sonographically confirmed as appendicitis and the excised appendix was sent to the pathology laboratory for histo-pathological examination. Operative findings and histopathological findings were followed up to determine the accuracy of ultra sonography.

Inclusion criteria: All the cases above 18 years of age and underwent Ultrasonography with clinical suspicion of acute appendicitis and underwent surgery and histopathological examination of excised appendix.

Exclusion criteria: Patients not consented for surgery, with past H/o appendicectomy, with Appendiceal lump, associated with perforation or peritonitis and not willing for surgery. False positive cases were defined as cases positive by US and histopathologically confirmed as negative for appendicitis. A case was considered true positive if both USG and histopathological report was confirmatory for acute appendicitis. For cases that had negative US report but underwent surgery and histopathologically confirmed as appendicitis were referred as true positive. True negative cases revealed negative US and negative histopathological report but operated based on clinical suspicion or complication.

STATISTICAL ANALYSIS

The entire clinical data, Ultrasonographic findings and histopathological report were recorded and entered in SPSS version 16.0 software and analyzed. Chi-Square test was done to determine the significance between the groups and p value <0.05 was considered significant.

RESULTS

A total of 175 cases attending the surgical OPD and emergency with suspicion of appendicitis were enrolled in the study. 125 cases were operated and excised appendix was sent for histopathological examination. All the 125 operated cases underwent ultrasound examination and the report was correlated with histopathological report. Of the 125 cases enrolled in the study, with males 56% and females 44%. 56% of the cases in the study were between 18-35 years and only 8% of cases were above 60 years. The mean age of the study group was 31.21 ± 2.8 years (range 18-63 years). Right lower quadrant pain was the most common feature observed in 96% of cases with associated nausea (38%), vomiting (28%) and fever (14%). Leukocytosis was observed in 74% of cases in the study.

105 of the cases (84%) were confirmed as histopathological positive for appendicitis. Of the 105 cases, 94 cases were also positive by diagnostic ultrasound (True positive), 11 cases were reported negative by diagnostic ultrasound but positive by histopathology (False negative). Of the remaining 20 cases in the study which are negative by histopathology, 14 cases were reported negative by diagnostic ultrasound (True negative) and 6 were reported positive by ultrasound (False

Total no of cases	Confirmed Histo Pathologically	Sonography			
		True Positive	True Negative	False Positive	False Negative
125	105	94	14	6	11

Table-1: Results of sonographic studies in diagnosis of acute appendicitis

USG finding	No	%
Appendix visualization	105	100
transverse sign	105	100
Probe tenderness	103	98.10
Appendicolith	12	11.43
Free fluid in iliac fossa	14	13.33
Loss of sub mucosal integrity	35	33.33
Mesenteric echogenicity	75	71.43
Table-2: USG findings in positive cases by HPE		

Total number of cases	125
USG Positive	100
USG Negative	25
HPE positive	105
HPE Negative	20
USG Negative cases operated	25
HPE Positive	5
HPE Negative	20
Results	
True Positive	94
True Negative	14
False positive	6
False negative	11
Table-3: correlation of USG with HPE report among the cases in the study	

positive). [Table-1] Overall there were 6/125 false positives with a negative appendectomy rate of 4.8%. There were 11 false negatives of 125 patients (8.8%).

Appendix was visualized in 115 cases of our study with other associated features of inflammation and findings on ultrasound. Table-2 summarizes the various findings in histopathologically positive cases of appendicitis. Transverse sign and Probe tenderness were the most common findings observed in our study with 98-100%. The total rate of false diagnosis by ultrasound (false positives + false negatives) was therefore 17/125 (13.6%).

Table-3 summarizes the correlation between diagnostic ultrasound and HPE report among the cases in the study. Diagnostic role of ultrasound was evaluated by determining sensitivity, specificity, positive predictive value and negative predictive value. The ultrasound examination asserted the diagnosis of acute appendicitis in 100 of 125 cases with a sensitivity of 87.04% and specificity of 70% in the present study. The positive predictive value was 94% and negative predictive value was 56% in the present study.

DISCUSSION

Ultrasound examination is a common imaging technique extensively used for surgical abdominal emergencies. It's a dynamic real imaging technique which is economical and non hazardous which can be safely used even in pregnancy due to lack of radiation hazard. Its importance in acute right lower quadrant pain is highlighted by its ability to differentiate various causes of pain with high degree of specificity and sensitivity as mentioned in various studies. With the introduction of computed tomographic technique the question of diagnostic ultrasound in diagnosis of acute

appendicitis has raised many doubts and CT is used in cases where appendix could not be visualized in various conditions like obese patients, inflamed appendix with surrounding mesenteric fat etc. Acute appendicitis presents atypically in about 30% of cases and increases the chances of unnecessary appendectomy and laparotomy. This rate is even higher in women of child bearing age group because of pelvic inflammatory disease and complicated pregnancies.⁸ The present study is mainly aimed to determine the sensitivity and specificity of ultrasound in diagnosis of acute appendicitis so that negative rate of appendectomy can be reduced by coupling ultrasound with clinical examination and evaluation.

In the present study males were predominant than females and the common age group was 18-35 years which is on par with the reports of many studies globally. In our study, the clinical picture presented typically with classical right lower quadrant pain in 96% of cases which is similar to the findings in the study of Paulson EK.⁹ Most common position of appendix in our study was retrocaecal in 78% of cases followed by pelvic in 12% of cases. According to the study of Wakely et the position of the appendix was retrocaecal and retrocolic in 68% of cases which is closer to our findings in the study.¹⁰ The negative appendectomy rate in our study was 4.8% in our study which is very less when compared to the reports of Balthazar E.J who reported as high as 12.8% in his study.¹¹ The sensitivity of abdominal diagnostic ultrasound in our study was 87.04% which is 100 cases of 125 cases. This index is higher than the reports of previous series of radiological studies with a range of 70-80% and lesser than the reports of Franke et al who reported as high as 92% in a multicentric study.¹² The specificity in our study was 70% which is almost on par with the findings of Vidmar et al who reported the specificity of 71% in his study whereas contrary to the findings of Douglas et al who reported as less as 57% in his study.^{13,14}

The positive predictive value was 94% as similar to the finding of Birnbaum and Wilson who reported as 95.9% in their study but higher than Flum D.R with 81% in their study.^{15,16} It is in this variable that lays the main contribution of ultrasound examination for the diagnosis of acute appendicitis in this work. The negative predictive value was 56% which is far below than the reports described in the literature. The low negative predictive value requires prudence in ruling out the diagnosis of acute appendicitis and the patient should be observed clinically and carefully before discharge from the hospital.

In the present study, 11 cases were false negative by ultrasound, with 4 cases that were obese with abdominal wall and in rest of 7 cases the position of appendix on retrocaecal. Few of the authors in their reports claim that sensitivity and accuracy of ultrasonogram is low among patients with a BMI > 30kg/m². Hence tomography would be a better choice of investigation among these patients.

In the present study, 6 were reported as false positive and all the cases were of terminal ileitis. Few of the studies reported inflamed Meckel's diverticulum as the most common cause of false positive in cases of acute appendicitis. Timely intervention in diagnosis of acute appendicitis is important

to reduce negative appendectomy and to reduce the risk of complications like perforation which increases morbidity by 15 fold and mortality by 50 fold.

CONCLUSION

To conclude, high resolution sonography with graded compression is a very promising examination in diagnosis of acute appendicitis in problem cases and in women of reproductive age group. Because of its easy availability and to perform, it should be a primary imaging study in cases of suspected appendicitis with atypical and typical presentations. It also aids in identification of complications due to delay and other conditions that mimics appendicitis. Hence the present study suggests always a closer interaction between sonologists and surgeons in arriving at a correct diagnosis which improves care and safety of the patient thus avoiding unnecessary therapeutic interventions.

REFERENCES

1. Birnbaum BA, Wilson SR. Appendicitis at the millennium. *Radiology* 2000; 215(2):337-48.
2. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med.* 1986;15(5):557-64.
3. Andersson M, Andersson RE. The appendicitis inflammatory response score: a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. *World J Surg.* 2008;32(1):1843-9.
4. Gomes CA, Sartelli M, Di Saverio S, Ansaloni L, Catena F, Coccolini F, et al. Acute appendicitis: proposal of a new comprehensive grading system based on clinical, imaging and laparoscopic findings. *World J Emerg Surg.* 2015;10(4):60.
5. Abu-Yousef MM, Bleicher JJ, Maher JW, Urdaneta LF, Franken EA Jr, Metcalf AM. High-resolution sonography of acute appendicitis. *AJR* 1987; 149(1):53-8.
6. Abu-Yousef MM. Ultrasonography Of Right Lower Quadrant. *Ultrasound Quarterly* 2001;17(4):221-5.
7. Puylaert J. Acute appendicitis: US evaluation using graded compression. *Radiology* 1986; 158(3):355-60.
8. Andersen B., and Nielsen T.F.: Appendicitis in pregnancy: diagnosis, management and complications. *Acta Obstet Gynecol Scand* 1999; 78(1):758-762.
9. Paulson EK, Kalady MF, Pappas TN. Clinical practice. Suspect appendicitis. *N Engl J Med* 2003; 348(3):236-42.
10. Wakeley CPG: The position of vermiform appendix. *J Anat* 1993; 67(1): 277-283.
11. Balthazar E.J., Rofsky N.M., and Zucker R.: Appendicitis: the impact of computed tomography imaging on negative appendectomy and perforation rates. *Am J Gastroenterol* 1998; 93(3): 768-771.
12. Franke C, Böhner H, Yang Q, Ohmann C, Röher HD. Ultrasonography for diagnosis of acute appendicitis: results of a prospective multicenter trial. Acute Abdominal Pain Study Group. *World J Surg* 1999; 23(2):141-6.
13. Vidmar D, Omejc M, Cerar A, Mekicar J, Repse S. Influence of ultrasonography on clinical decision making in suspect acute appendicitis in adults. *Eur Surg* 2006; 38(6):445-50.
14. Douglas CD, Macpherson NE, Davidson PM, Gani JS. Randomised controlled trial of ultrasonography in diagnosis of acute appendicitis, incorporating the Alvarado score. *BMJ* 2000; 321(7266):919-22.
15. Flum D.R., and Koepsell T.D.: Evaluating diagnostic accuracy in appendicitis using administrative data. *J Surg Res* 2005; 123(5):257-261.
16. Birnbaum BA, Wilson SR. Appendicitis at the millennium. *Radiology* 2000; 215(2):337-48.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 02-10-2018; **Accepted:** 26-10-2018; **Published online:** 04-11-2018