

Accuracy of ultrasonography in the diagnosis of acute appendicitis

Khanal BR, Ansari MA, Pradhan S

Department of Radiology and Imaging, Tribhuvan University Teaching Hospital, Maharajgunj, Kathmandu, Nepal.

Abstract

Aims and Objectives: To assess the accuracy of ultrasonography in the diagnosis of acute appendicitis.

Methodology: A prospective randomized study was carried in the Dept. of Radiology and Imaging, Tribhuvan University, Teaching Hospital, Maharajgunj, Kathmandu, Nepal. A total of 120 patients, who were clinically diagnosed as acute appendicitis were subjected to ultrasonography of the abdomen. A detailed ultrasonography was performed and the findings were recorded. Twenty one cases had alternate diagnosis. Ninety nine cases ultimately underwent laparotomy and the retrieved appendices were sent for histopathological examination. Intra-operative, histopathological and ultrasonographic diagnoses were then statistically analyzed.

Results: Ultrasonographic, intra-operative and histopathological findings were statistically insignificant ($P \geq 0.05$). The sensitivity, specificity, positive predictive value, negative predictive value and accuracy percentage of ultrasonography in the diagnosis of acute appendicitis was 85.7%, 100%, 100%, 6.7% and 85.9% respectively.

Conclusion: Ultrasonography has a high degree of accuracy in the diagnosis of acute appendicitis. However, the diagnosis should be considered with the diameter of appendix over 6 mm. Therefore acute appendicitis with diameter of appendix having less than 6 mm should be evaluated with other diagnostic parameters.

Key words: Acute Appendicitis, Ultrasonography.

Acute appendicitis remains the most common indication for emergency operation. It is a common cause of abdominal pain for which prompt diagnosis is rewarded by a marked decrease in morbidity and mortality. The decision for surgical intervention is still primarily based on precise clinical criteria.

In young men, limited number of alternative diagnosis usually permits a high degree of diagnostic accuracy. It is generally accepted that in men the negative appendectomy rate should be below 20% and rates of 10%-15% are commonly reported^{1,2}. In contrast, young women commonly present with acute gynaecological illnesses that closely mimic acute appendicitis. Reported negative appendectomy rates in ovulating women thus remain disturbingly high and range from 34%-46%^{3,4}. Major factors contributing to this continued high negative appendectomy rate are non-specificity of clinical findings, lack of readily available techniques allowing direct visualization of appendix and identification of specific diagnostic features of acute appendicitis⁵.

The overall mortality rate for acute appendicitis is less than 1% but in elderly patient it is higher, ranging from 5 -15%^{3,6-8}. Lack of early diagnosis results in perforation and complications such as abdominal abscess, wound infection, infertility and death⁹. There is approximately 15-35% negative laparotomy rate with significant chances of

morbidity especially in the younger women (up to 45%). This is due to high prevalence of common obstetrical and gynaecological disorders notably, the pelvic inflammatory diseases (PIDs)^{10,11,12}.

Patients with acute appendicitis typically present with central abdominal pain shifting to the right lower quadrant (RLQ) or may present with generalized abdominal pain. Vomiting is common in children. Clinical examination reveals signs of acute intra-abdominal process e.g., local and rebound tenderness, muscle guarding, rigidity, cutaneous hyperaesthesia, and tenderness on rectal examination. Since almost one third of patients with acute appendicitis present with atypical symptoms^{10,13}, differential diagnosis is diverse, such as gastroenteritis, lymphadenitis, ovarian and tubal disorders (in young women), renal colic, peptic ulcer and acute cholecystitis. Diagnosing acute appendicitis by other means is difficult. The ileal air fluid level has specificity of 95% and sensitivity of 51%, where as a sentinel loop has a sensitivity of 78% but specificity of only 62%⁶. The accuracy of barium enema examination is between 50-84%^{14,15}.

Correspondence

Dr. Mukhtar Alam Ansari
Dept. of Radiology and Imaging
Tribhuvan University Teaching Hospital
Maharajgunj, Kathmandu
E-mail: malam32789@yahoo.com

Helical CT has reported sensitivities of 90% - 100%, specificities of 91%-99%, accuracies of 94%-98%, positive predictive values of 92%-98%, and negative predictive values of 95%-100%. Laparoscopy has also been shown by some authors to be particularly useful in young women of reproductive age because gynaecological conditions may mimic acute appendicitis¹⁶. The rate of diagnostic error is twice as high in women of reproductive age than in men^{10,12,15,16}.

Even with various diagnostic modalities, negative appendectomy rate of 15-25% has been widely accepted. However, the complication rate of unnecessary operation is up to 13%,^{13,17} close to that of genuinely inflamed appendix^{12,17,18}. Removing a normal appendix carries a mortality of 0.65 for every 1000 operations^{10,14}. Prolonged clinical observation in an attempt to minimize unnecessary operation may mean delayed operation in 28% of cases and a greater risk of perforation^{12,15,18}.

There have been numerous publications on the use of ultrasound as a diagnostic tool. These studies demonstrate sensitivity of 75%-94% and specificity of 87%-96%^{14-17, 19-20}. Several prospective studies have been conducted where the results of ultrasonography were used as an aid for surgeons in making an operative decision.

This study was conducted to evaluate diagnostic accuracy of ultrasonography in acute appendicitis. An attempt at assessing the accuracy of clinical diagnosis has also been made. This study was based on the presumption that an accurate diagnosis helps to reduce high negative appendectomy rates and thereby benefit the affected patients²¹.

Aims and Objectives

Aims:

To evaluate the accuracy of ultrasonography in diagnosis of acute appendicitis

Specific Objectives:

- i) To find out sensitivity, specificity, positive and negative predictive value of ultrasound in patients with acute appendicitis
- ii) To compare the findings of ultrasound with that of surgery

Materials and methods

A prospective study was carried out in the Dept. of Radiology and Imaging, Tribhuvan University, Teaching Hospital, Maharajgunj, Kathmandu, Nepal. A total of 120 patients suspected of acute appendicitis were included in the study.

Inclusion criteria

Patients more than 14 years of age who presented with right lower quadrant pain lasting less than 72 hours and diagnosed clinically as acute appendicitis.

Exclusion criteria

- i) Patients less than 15 years.
- ii) Patients in whom ultrasonography could not be performed.
- iii) Patients with clinical signs of appendicular lump/ abscess requiring conservative management or drainage.
- iv) Patients who did not undergo operation for acute appendicitis.

After initial evaluation at the emergency department of TUTH, patients with clinical diagnosis of acute appendicitis were subjected to ultrasonography of the abdomen. Informed consent was taken prior to the study. SONOACE 8800 GAIA-MT machine was used and ultrasound was performed with high frequency linear array transducer. Low frequency curvilinear transducer was used only in needy cases. Examination was commenced from right upper quadrant in the region of the hepatic flexure followed by the ascending colon and ended in the right lower quadrant in the region of Caecum. Graded compression was applied until the iliac vessels and Psoas muscles were clearly visible.

Scanning at the point of maximum tenderness was found to be more useful in localizing appendix and that has been reported to decrease the average time of examination by one third and yield correct diagnosis in 94% of the cases, whether the diagnosis is that of appendicitis or not. In patients with significant abdominal guarding or extreme discomfort, gradual application and release of transducer pressure was useful in ensuring the adequacy of an examination. Asking the patient to flex their lower extremities at hips and knees facilitated the examination by decreasing the abdominal tension. Analgesics were found to be useful in accomplishing a successful and a painless examination.

Since appendix has a variable position, it may not always be visible from an anterior approach; so lateral or postero-lateral scanning was performed and was found to be useful especially in retrocecal appendix location. Scanning both with full and empty urinary bladder, allowed easier visualization of an otherwise hidden appendix.

In addition to scanning of the appendix, scanning of other abdominal organs, especially those on

the right side was performed. Ultrasound was useful in establishing an alternative diagnosis in significant percent of patients who presented with suspected appendicitis.

Ultrasonographic diagnosis of acute appendicitis was based on the criteria of Jeffery et al²¹ which includes the following:

i) Non-compressible, immobile, blind ended tubular structure with target like appearance in transverse view, with greatest maximal diameter of visualized structure more than or equal to 6 mm (Fig. 1).

ii) If the appendix is not visualized or if a non-appendicular pathology is discovered, the scan was considered as normal. Findings like localized fluid collection (Fig.2), dilated bowel loops were also considered suggestive of acute appendicitis, as they are often associated with perforation.

History, clinical examination, laboratory investigations and ultrasound findings were recorded in the pro-forma made. Intra-operative findings were recorded and appendices were sent for histopathological examination. Transmural polymorphonuclear leukocyte infiltration in histopathology was considered as the final diagnostic marker of acute appendicitis.

Results

- Among the 99 patients who underwent laparotomy, 76 were males and 23 were females.
- Age ranges from 15-74 years, mean age was 27.3 ± 9.2 years.
- Appendix was visualized in 84 cases (85.7%) by ultrasound.
- Target sign was positive in 58 cases (58.7%) and had a sensitivity, specificity, positive predictive value and negative predictive value of 59.2%, 100%, 100%, 2.4% respectively
- Appendix with transverse diameter ≥ 6 mm was seen in 84 cases (85.7%).
- Right iliac fossa collection was seen in 35 patients (35.4%).
- Diagnosis of acute appendicitis was made in 84 cases (85.7%) by ultrasound. Histopathological examination of the specimen of the appendix showed findings suggestive of acute appendicitis in 98 cases (99 %).
- Correlation of findings of ultrasonography, intra-operative and histopathological examination was statistically insignificant ($P \geq 0.05$).
- Overall accuracy of ultrasound in diagnosing acute appendicitis had a sensitivity, specificity, positive predictive value, negative predictive value and accuracy percentage of 85.7%, 100%, 100%, 6.7% and 85.9% respectively.

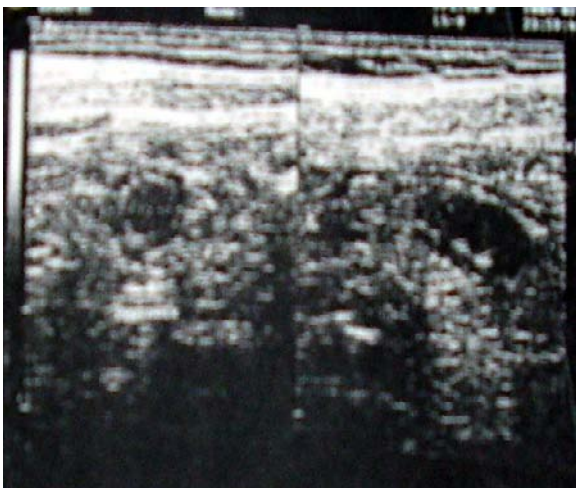


Fig 1: Transverse and longitudinal sonogram of acute appendicitis shows a target sign.

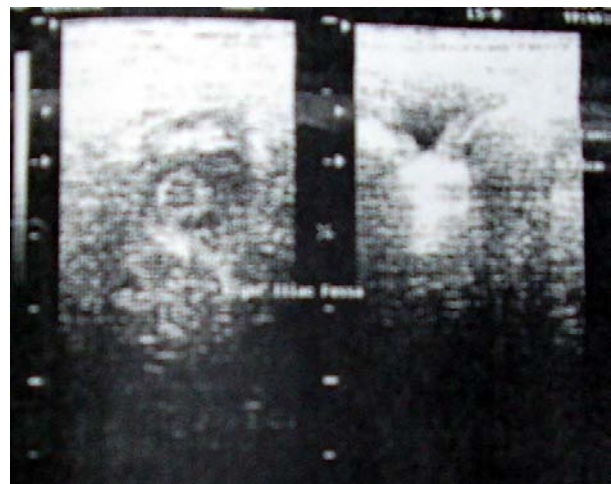


Fig 2: Transverse sonogram of acute appendicitis shows target sign and periappendiceal collection.

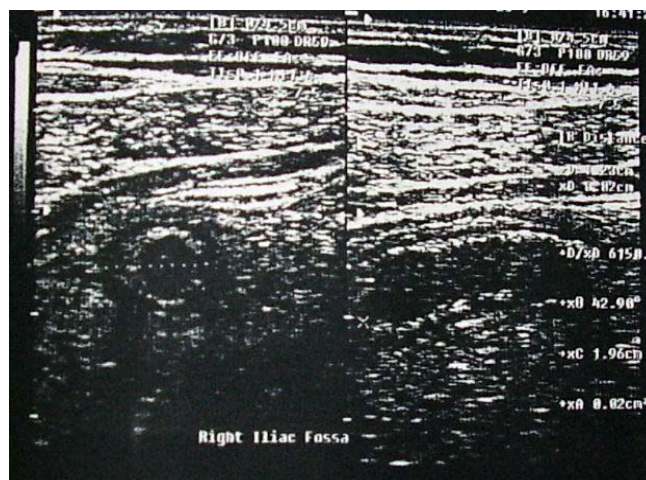


Fig 3: Transverse and longitudinal sonogram of a acute appendicitis shows transverse diameter >6 mm.

Discussion

Acute appendicitis is a common surgical problem. An accurate and prompt diagnosis is essential to minimize morbidity. While the clinical diagnosis may be straight forward in patients who present with classic signs and symptoms, atypical presentations may result in diagnostic dilemma and delay in treatment. Ultrasound examination with graded compression has currently been established as a highly accurate modality in the diagnosis of patients suspected of having acute appendicitis. Normal appendix is not usually visualized by ultrasound, however; if it becomes inflamed, it is seen as a blind- ended tubular structure with a laminated wall arising from the base of the caecum (Fig. 3).

It should be aperistaltic and non compressible. A threshold diameter of 6 mm is invaluable in diagnosing acute appendicitis. Right iliac fossa collection is considered as indirect evidence of appendicitis. In our study 35 cases (35.4%) had right iliac fossa collection. Out of 15 ultrasonographically false negative patients, two had right iliac fossa collection.

In a study done by Jefferey RB et al²² and Julien B.C. M. Puylaert,¹⁹ acute appendicitis was more frequent in females, while in our study we had slight male preponderance. Study done by Lakhey²³ Paleswan, at TUTH, 2000 also showed male dominance. In the United States, male had higher rates of appendicitis than females for all age groups (over all rate ratio,1.4:1)¹¹. Male preponderance (76.8%) in our study might have been due to familial biasness in health seeking, during illness for males, as opposed to females in our society. In the United States, highest incidence of acute appendicitis is seen in the population aged 10-30 years almost similar to our study (15-34 years).

The criterion of threshold transverse diameter of 6 mm of appendix was more sensitive in diagnosing acute appendicitis. In a study done by Jefferey RB²⁴ 78 out of 80 (97.5%) patients had visible appendices with transverse diameter of ≥ 6 mm.

The overall accuracy of ultrasound in diagnosing acute appendicitis with sensitivity, specificity, positive predictive value, negative predictive value and accuracy percentage of 85.7%, 100%, 100%, 6.7% and 85.9% respectively, as seen in our study, is almost similar to the results from the study done by Puylaert et al¹⁹, Yousef et al¹⁴ and Jefferey et al.²².

Conclusion

This study showed that there is a high degree of accuracy in diagnosing acute appendicitis with ultrasound. It is thus, recommended that ultrasound should be considered as an important modality in patient evaluation in all clinically diagnosed cases of acute appendicitis and in doubtful cases, for a better management decision and patient care. However, the diagnosis should be considered with the diameter of appendix over 6 mm. Therefore acute appendicitis with diameter of appendix having less than 6 mm should be evaluated with other diagnostic parameters.

References

1. Berry J Jr, Malt RAI. Appendicitis near its centenary. *Ann Surg* 1984;200:567-575.
2. Lewis FR, Holcroft JW, Boey J, Dunphy JE. Appendicitis: A critical review of diagnosis and treatment in 1000 cases. *Arch Surg* 1975;110: 677-81.
3. Fitz RH. Perforating inflammation of the vermiform appendix: with special

- reference to its early diagnosis and treatment. *Am J Med Sci.* 1886;92:321-46.
4. Buchman TG, Zuidema GD. Reasons for delay of the diagnosis of acute appendicitis. *Surg Gynecol Obstet* 1984;158:260-266.
 5. Acute appendicitis high - Resolution real-time US findings from the Dept. of Radiology and Surgery, University of California, San Francisco, 1986, RSNA Annual meeting.
 6. Anonymous. A sound approach to the diagnosis of acute appendicitis. *Lancet.* 1987;1:198-200.
 7. Fenyo G. Acute abdominal disease in the elderly: experience from two series in Stockholm. *Am J Surgery* 1982;143:751-754.
 8. Balsano N, Cayten CG. Surgical emergencies of the abdomen. *Emerg Med Clin North Am.* 1990;8:399-410.
 9. Walker AR, Segal I. What Causes Appendicitis? *J Clin Gastroenterol* 1990;12:127-129.
 10. Lewis FR, Holcroft JW, Boey J, Dunphy JE. Appendicitis: A critical review of diagnosis and treatment in 1000 cases. *Arch Surg* 1975;110:677-684.
 11. Addis DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States, *Am j Epidemiol* 1990;132:910-25.
 12. Berry J, Malt R. Appendicitis near its centenary. *Ann Surg.* 1984;200:567-75.
 13. Gilmore OJ, Browett JP, griffin PH, et al. Appendicitis and mimicking conditions: a prospective study. *Lancet*, 1975;6:421-4.
 14. Abu-Yousef MM, Bleicher JJ, Maher JW et al. High resolution sonography of acute appendicitis. *AJR* 1987;149:53-8.
 15. Puylaert JB, Rutgers PH, Lisang RI, et al. A prospective study of ultrasonography in the diagnosing of appendicits. *N Engl J Med.* 1987;317:666-9.
 16. Jones PF. Practicalities in the management of the acute abdomen. *Br J Surg,* 1990;77:365-7.
 17. Pearsons RH. Ultrasonography for diagnosing appendicitis. *BMJ.* 1988;297:309-10.
 18. Scher KS, coil JA. The continuing challenge of perforating appendicitis. *Sug gynaecol Obs.* 1980;150:535-8.
 19. Julien BCM, Puylaert. Acute appendicitis: US evaluation using graded
 20. compression. *Radiology* 1986;158:355-60.
 21. Larson JM, Pierce JC, Ellinger DM, et al. The validity and utility of sonography in the diagnosis of acute appendicitis in the community setting. *AJR* 153;4:687-91.
 22. Schwerk WB, Wichtrup B, Rothmund M, Ruschoff J. Ultrasonography in the diagnosis of acute appendicitis: a prospective study. *Gastronenterology* 1989;97:630-63.
 23. Jeffrey Jr. RB. Sonography of Acute Appendicitis. (e-edcredits.com/articles/CME-Jeffrey-apply.doc).
 24. Paleswan JL, Comparative study of ultrasound and Alvarado Score in the diagnosis of Acute Appendicitis, December 2000.
 25. Jeffrey RB, Laing FC, Townsend RR. Acute appendicitis: Sonographic criteria based on 250 cases. *Radiology* 1988;167:327-9.