

Diagnostic Accuracy of Ultrasound in Patients with Suspected Acute Appendicitis in Rapti Academy of Health Sciences

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Abstract

Introduction: Acute appendicitis is a leading cause of acute abdominal pain globally. It is typically diagnosed clinically using various scoring systems, with ultrasound and computed tomography used in certain cases. Ultrasound is often the preferred test for several reasons. This study aims to assess the diagnostic accuracy of ultrasound in suspected acute appendicitis.

Methods: This descriptive, cross-sectional study was conducted in the Radiology Department of Rapti Academy of Health Sciences from September to December, 2024. It included 89 patients with suspected appendicitis who underwent abdominal ultrasound from July to November, 2024 and met the inclusion criteria. Ultrasound findings were compared with histopathological results, and sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated.

Results: Most of the patients were male which was 48 (53.9%) with the most common age group being from 21 to 35 years. The mean age was 37 years. The most common ultrasonographic feature of acute appendicitis was increased diameter of the appendix of more than 6 mm seen in 78 (87.6%) cases. The sensitivity and specificity of ultrasonography were 97.6% and 42.9%, respectively. The positive predictive value and negative predictive value were 95.2% and 60%, respectively. The diagnostic accuracy was 93.1%.

Conclusion: Ultrasound demonstrated high sensitivity and positive predictive value, making it an effective test for confirming the presence of the disease. Ultrasound is accessible, affordable, and radiation-free, but its low specificity limits its reliability. CT can be used for confirmation, though it's costly and involves radiation.

Keywords: appendicitis; ALVARADO score; ultrasonography of abdomen

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Introduction

Acute abdominal pain accounts for 7-10% of all emergency department visits.¹ Acute appendicitis is the most common acute abdominal condition worldwide.² In developed countries, acute appendicitis occurs at a rate of 5.7-50 patients per 100,000 inhabitants per year, with a peak between the ages of 10 and 30.^{3,4} The rate of perforation varies from 16% to 40% with a higher frequency occurring in younger age groups (40-57%) and in patients older than 50 years (55-70%).⁵

The diagnosis of acute appendicitis traditionally relies on history, clinical examination, and laboratory tests, but clinical diagnosis is challenging. Scoring systems include clinical findings and inflammatory markers. However, negative appendicitis rates in surgery can reach 50%.⁶⁻⁸

Ultrasonography (USG) and Computed tomography (CT) are commonly used for diagnosing acute appendicitis. USG has sensitivities of 75-90% and specificities of 86-100%.⁹

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Recently, USG's radiation safety, wide availability, and cost-effectiveness have made it a preferred initial imaging option for suspected cases of acute appendicitis.¹⁰ Key USG features include a blind-ending, non-compressible tubular structure in the right iliac fossa, measuring more than 6 mm, with a target sign. Several studies have evaluated USG's diagnostic value compared to CT, with inconclusive results.¹¹⁻¹⁴ Histopathology of appendectomy specimens often shows acute appendicitis, gangrenous, perforated, or other variations.¹⁵

This study aims to assess ultrasound's diagnostic accuracy in suspected acute appendicitis at Rapti Academy of Health Sciences. The findings of this study will provide information for ultrasonography of abdomen, which will improve diagnostic accuracy of acute appendicitis.

Methods

This was a descriptive, cross-sectional study conducted in the Department of Radiology of Rapti Academy of Health Sciences from September to December, 2024. All patients with suspected appendicitis presenting to the hospital and undergoing ultrasound of the abdomen and histopathology from July to November, 2024, were included in the study. The inclusion criteria were all patients with suspected appendicitis with ultrasonography of the abdomen and histopathology report. The exclusion criteria were those not giving consent, patients without histopathology reports and those not giving consent.

Ethical approval was taken from the Institutional Review Committee of Rapti Academy of Health Sciences (Ref: 397). An informed written consent was taken from the patients. Collected data was evaluated using Microsoft Excel and SPSS. All patients with suspected acute appendicitis underwent ultrasonography of the abdomen. Ultrasound of the liver, biliary tree, pancreas, both kidneys, and spleen was performed with a 3.5-6 MHz curvilinear probe prior to graded ultrasound of the right iliac fossa and pelvis. Then, a linear probe of 7-12 MHz was used to visualize the appendix arising from the caecum and was separated from the terminal ileum. It was then followed along its whole length. The normal appendix was a tubular structure with a size of less than 6 mm and wall thickness of less than 3 mm. Presence of any of these findings in USG was considered to be diagnostic of acute appendicitis.

The finding of the radiological investigation was confirmed by doing histopathology of the specimen. The biopsy specimen was received in 10% formalin in the histopathology department with proper labeling. Then tissue grossing was done, and gross findings were recorded. Staining of these slides was done by routine hematoxylin and eosin (H&E) staining and then viewed under a microscope by the pathologist.

The collected data was entered into Microsoft Excel software and final data analysis was performed in the Statistical Package for Social Sciences (SPSS) version 16. The statistical analysis comprised descriptive statistics with categorical data described with frequency and percentage. The sensitivities, specificities, and diagnostic

accuracy of USG were calculated and compared. The diagnostic accuracy can be defined as the potential of ultrasonography to diagnose acute appendicitis in patients whose histopathology report shows features of appendicitis.

Results

Among 89 patients fulfilling the inclusion criteria, 48 (53.9%) were male and 41(46.1%) were female as shown by figure 1. The range of age of patients was 9 to 84 years with the mean age being 37 years. The most common age group was from 21 to 35 years. On clinical scoring of the AIVARADO score, 46 (51.6%) patients had a score of 7-10. While 24 (26.9%) of 89 patients showed a score of 5-6 and 14 (15.7%) showed 1-4, as shown in Figure 2.

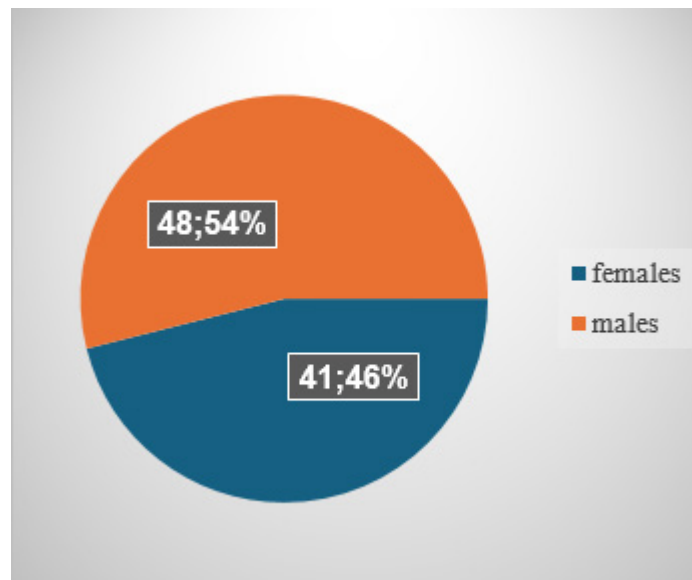


Figure 1: Distribution of the study participants based on gender

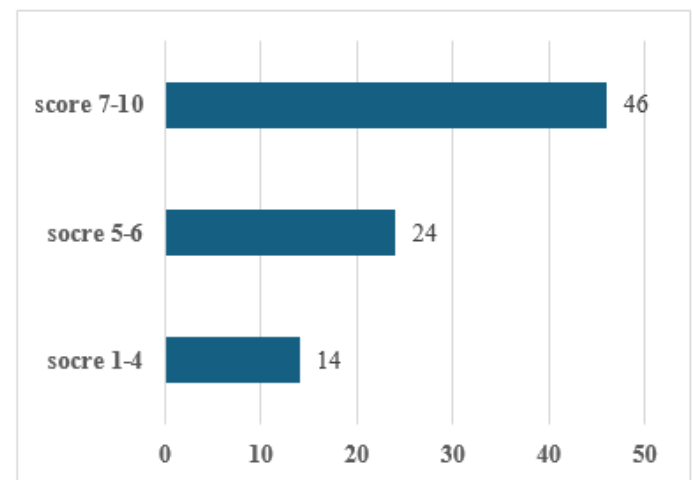


Figure 2: AIVARADO scores of the study participants

The ultrasonography showed features of acute appendicitis among 84 (94.3%) out of 89 patients, as shown in Table 1. There was a normal appendix in ultrasonography in 5 (5.6%) patients. Among various features of appendicitis in

ultrasonography, the most common feature was increased diameter of the appendix of more than 6 mm as shown in Figure 4, which was present in 78 (87.6%) cases followed by presence of the target sign in 70 (78.6%) cases. The other feature in ultrasonography was thickening of the omentum in 68 (76.4%) cases.

Table 1: Ultrasonographic features of acute appendicitis

| Ultrasound features | | Frequency (%) |
|-----------------------|----------------|---------------|
| Diameter of appendix | Less than 6 mm | 11 (12.4%) |
| | More than 6 mm | 78 (87.6%) |
| Target sign | Present | 70 (78.6%) |
| | Absent | 19 (21.4%) |
| Appendicolith | Present | 30 (33.7%) |
| | Absent | 59 (66.3%) |
| Free fluid | Present | 29 (32.5%) |
| | Absent | 60 (67.5%) |
| Local abscess | Present | 20 (22.4%) |
| | Absent | 69 (77.6%) |
| Thickening of omentum | Present | 68 (76.4%) |
| | Absent | 21 (23.6%) |

The histopathology showed appendicitis in 82 (92.1%) cases, as shown in Figure 5. 4 (4.4%) cases showed normal appendix in histopathology, while 3 (3.3%) showed low-grade mucinous appendiceal neoplasm, as shown in Figure 3.

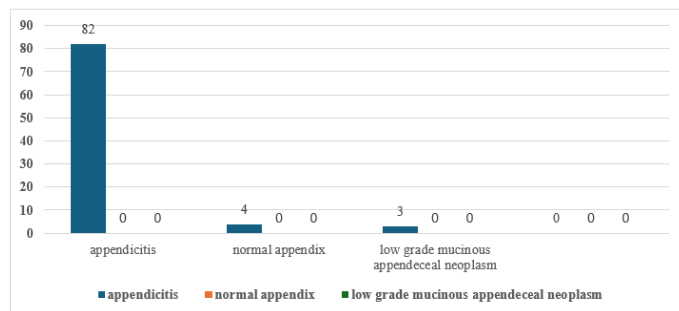


Figure 3: Histopathology of appendix

The various types of appendicitis in histopathology were acute appendicitis in 51 (62.1%), acute suppurative appendicitis in 12 (14.6%), acute suppurative appendicitis with periappendicitis in 10 (12.1%), and acute gangrenous appendicitis in 9 (10.9%).

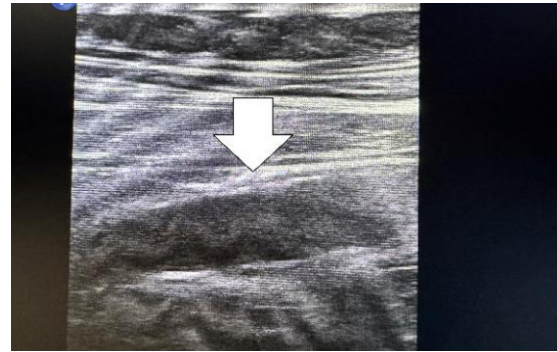


Figure 4: White arrow showing inflamed appendix in the ultrasonography

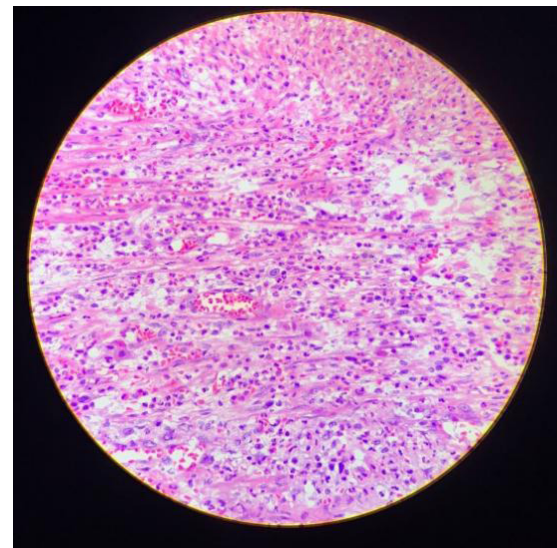


Figure 5: H & E staining of acute appendicitis (40X)

Table 2: Ultrasonography and histopathology findings

| | | Histopathology (Appendicitis) | | Total |
|--------------------------------|----------|-------------------------------|----------|-------|
| | | Positive | Negative | |
| Ultrasonography (Appendicitis) | Positive | 80 | 4 | 84 |
| | Negative | 2 | 3 | 5 |
| Total | | 82 | 7 | 89 |

True positives (TP) = 80, False positives (FP) = 4, False negatives (FN) = 2, True negatives (TN) = 3

Sensitivity = $80 / (80 + 2) = 0.97$ (97%)

Specificity = $3 / (3 + 4) = 0.429$ (42.9%)

Positive predictive value (PPV) = $80 / (80 + 4) = 0.952$ (95.2%)

Negative predictive value (NPV) = $3 / (3 + 2) = 0.63$ (63%)

Our study showed the sensitivity and specificity of ultrasonography in acute appendicitis as 97.6% and 42.9%, respectively. The positive predictive value and negative predictive value were 95.2% and 60%, respectively with a diagnostic accuracy of 93.1%.

Discussion

Our study showed a male predominance of 53.9%, which was similar to the study done by Parsijani et al., which showed male-to-female ratio to be 2:1.¹⁶ Another study by Gurung et al. showed male predominance, which is 78 males and 35 females.¹⁷ However, study by Jefferay et al. showed acute appendicitis to be more frequent in females.¹⁸

The majority of our patients belonged to the age group 21 to 35 years, which was similar to study by Alelyami et al., which showed an age range of 21 to 40 years.¹⁹ Another study by Parsijani et al. showed an age range of 4 to 76 years, which is similar to our study, which showed an age group range of 9 to 84 years.¹⁶ The most common ultrasonographic feature in acute appendicitis was increased diameter of more than 6 mm in our study, which was similar to that of Khanal et al. which showed this feature in 86.7% cases.¹⁸

Our study showed ultrasonography to have high sensitivity and high PPV, similar to the study by Gurung et al., which showed a sensitivity of 96% and PPV of 98%.¹⁷ The diagnostic accuracy shown by our study is comparable to the value in the study by Khanal et al., which was 85.9%.¹⁸ Another study by Lehmann et al. showed a high sensitivity of 89.6% and a high PPV similar to our study.²⁰ However, this study showed high specificity of 93.8% and high NPV of 94.6%, which was in contrast to our study.²⁰ The low specificity in our study might be due to the unusual anatomical location of the appendix like retrocecal, which might not be visualized by the probe. Certain patient factors like obesity, severe pain leading to noncompliance to ultrasound, and the presence of a gaseous abdomen leading to difficulties in compressing and reaching the site of the appendix. Hence, this might lead to high false positive results, resulting in low specificity. The other underlying intra-abdominal conditions, like Meckel's diverticulum, cecal diverticulitis, and pelvic inflammatory disease, might cause false positive results leading to low specificity. In these doubtful situations, we can evaluate the patient by computed tomography of the abdomen. A study by Lietzen et al. showed computed tomography to have a sensitivity of 96.7% and specificity of 95.9%.²¹

The diagnostic accuracy shown by our study is high and similar to the study by Khanal et al., which was 85.9%.¹⁸ The high diagnostic accuracy makes ultrasonography a useful tool to identify the presence or absence of disease.

Conclusion

Ultrasonography has a high sensitivity, due to which it is a good investigation to rule in disease. It also has advantages of cost-effectiveness and no radiation exposure. It has a low specificity, due to which it may lead to high false positives. Hence, in cases of dilemma, one cannot fully rely on this investigation. In selective dilemma cases, CT scans can be used to rule out appendicitis as it has high specificity.

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