

THE DIAGNOSTIC ACCURACY OF ULTRASOUND IN ACUTE APPENDICITIS

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ABSTRACT

Background: Acute appendicitis is one of the most common causes of acute abdominal pain requiring urgent surgical intervention. Early and accurate diagnosis is essential to prevent complications such as perforation and peritonitis. Ultrasonography is frequently used as a first-line imaging modality due to its safety, availability, and absence of ionizing radiation. **Objective:** To evaluate the diagnostic accuracy of ultrasonography in detecting acute appendicitis by comparing ultrasound findings with the final diagnosis based on surgical and histopathological results. **Methods:** This prospective diagnostic accuracy study included 250 patients with clinical suspicion of acute appendicitis who underwent trans-abdominal ultrasound examination at Al-Salam Teaching Hospital in Mosul, Iraq, between August 2021 and September 2024. Ultrasound findings were compared with the reference standard consisting of intraoperative findings and histopathological examination. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated. **Results:** Among the 250 patients included in the study, 190 (76%) were confirmed to have acute appendicitis. Ultrasound findings were positive in 170 (68%) patients. The diagnostic performance of ultrasound demonstrated a sensitivity of 86.8%, specificity of 91.7%, positive predictive value of 97.1%, negative predictive value of 68.8%, and an overall diagnostic accuracy of 88%. **Conclusion:** Ultrasonography demonstrates high sensitivity and specificity in diagnosing acute appendicitis and can be considered a reliable first-line imaging modality in patients with suspected appendicitis. Its availability, safety, and cost-effectiveness make it particularly valuable in resource-limited healthcare settings.

KEYWORD: Acute appendicitis, Diagnostic accuracy, Sensitivity, Specificity, Ultrasonography.**INTRODUCTION**

Acute appendicitis is one of the most prevalent causes of acute abdominal pain, necessitating immediate surgical surgery. It accounts for a sizable fraction of emergency department visits and surgical hospitalizations worldwide.^[1] Early and precise diagnosis is critical to avoiding complications like perforation, abscess formation, and peritonitis, which are associated with higher morbidity and longer hospital stays.^[2] Despite advances in diagnostic imaging and laboratory studies, diagnosing acute appendicitis remains difficult due to the variety of clinical presentations and symptoms that overlap with other abdominal conditions.^[3]

Traditionally, the diagnosis of acute appendicitis has been based on clinical examination and laboratory abnormalities such as leukocytosis and elevated inflammatory markers.^[4] However, relying exclusively on clinical judgment might result in a high risk of negative appendectomy, especially in women, children, and the elderly.^[5] As a result, imaging modalities have become an essential component of the diagnostic pathway for suspected appendicitis, helping to increase diagnostic accuracy while reducing unnecessary surgical interventions.^[6]

In the examination of suspected acute appendicitis, several imaging modalities are used, including

ultrasonography, computed tomography (CT), and magnetic resonance imaging.^[7] Computed tomography (CT) is considered very accurate and is frequently used as a reference imaging modality due to its excellent sensitivity and specificity. However, CT is associated with ionizing radiation exposure, is rather expensive, and is only available in a few healthcare settings. These restrictions are especially important in low-resource settings, where access to modern imaging may be limited.^[8]

Ultrasound is commonly utilized as the first imaging modality in the examination of suspected appendicitis since it is noninvasive, widely available, affordable and does not use ionizing radiation. In addition, ultrasonography can be conducted at the bedside and repeated as needed.^[9] The typical sonographic features of acute appendicitis include a noncompressible blind-ended tubular structure in the right lower quadrant with an outer diameter greater than 6 mm, wall thickening, periappendiceal fluid collection, increased echogenicity of surrounding fat, and the presence of an appendicolith.^[10]

Despite its benefits, ultrasound's diagnostic performance in acute appendicitis can be impacted by a variety of circumstances, including operator expertise, patient body habitus, intestinal gas, and appendix anatomical position.

These limitations may result in differences in sensitivity and specificity across therapeutic contexts. Nonetheless, ultrasonography remains an important first-line diagnostic tool, particularly in children, pregnant women, and resource-limited healthcare systems where CT is not commonly available.^[11]

The aim of this study is to assess the diagnostic accuracy of ultrasonography in detecting acute appendicitis by comparing ultrasound results to the reference standard, which could include intraoperative findings and/or histological analysis of the excised appendix.

2. PATIENTS AND METHODS

This is a prospective diagnostic accuracy study for 250 patients who presented with clinical suspicion of acute appendicitis for which trans-abdominal ultrasound was done and subsequently they underwent surgical intervention with histopathological examination of the appendix for having the definitive clinical diagnosis. The study was conducted at the radiological department of Al Salam Teaching hospital in Mosul city/Iraq, from the period of (August 2021 to the end of September 2024). The study excluded patients with a previous history of appendectomy, patients with incomplete medical or

imaging records, patients who decline participation in the study and those with alternative diagnoses confirmed without adequate follow-up.

All ultrasound examinations will be performed using a high-frequency linear transducer (5–12 MHz) and when necessary, a curvilinear transducer (3–5 MHz) for deeper structures. The examination will focus on the right lower quadrant using the graded compression technique, which helps displace bowel gas and improve visualization of the appendix. The sonographic diagnosis of acute appendicitis will be based on the presence of one or more of the following criteria; noncompressible tubular structure in the right lower quadrant, outer appendiceal diameter greater than 6 mm, thickened appendiceal wall, presence of appendicolith, periappendiceal fluid collection and increased echogenicity of periappendiceal fat.

The ultrasound findings were recorded as positive, negative, or inconclusive for appendicitis. The final diagnosis of acute appendicitis will be confirmed using the reference standard, which includes; intraoperative findings during appendectomy and histopathological examination of the removed appendix. For patients managed conservatively, the final diagnosis may be established based on clinical follow-up and additional imaging if necessary.

Data will be collected using a standardized data collection sheet including six parts, part one for patients' demographic characteristics (age, gender). Part two for patients' clinical presentation and duration of symptoms. Part three for laboratory findings (for example, white blood cell count). Part four for ultrasound findings. Part five for surgical findings and lastly, part six for histopathological results.

Data analysis will be performed using statistical software (SPSS version 31). Descriptive statistics were used to summarize patient characteristics. The diagnostic performance of ultrasound was evaluated by calculating; sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and overall diagnostic accuracy.

3. RESULTS

A total 250 patients with clinical suspicion of acute appendicitis were included in this study. The mean age was 29.42 ± 12.63 years with range of 14-65 years. The majority of patients (48%) were in the second and third decades of life. Moreover, 142 (56.8%) patients were males and 108 (43.2%) patients were females with male: female ratio of 1.31:1.

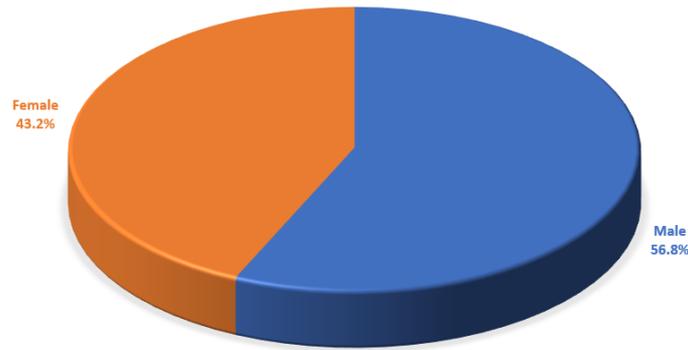


Figure 1: Distribution of the study participants according to their gender.

Ultrasound examination of abdomen revealed findings suggestive of acute appendicitis in 170 (68%) patients, while 80 (32%) had negative or inconclusive ultrasound findings, as shown in figure 2.

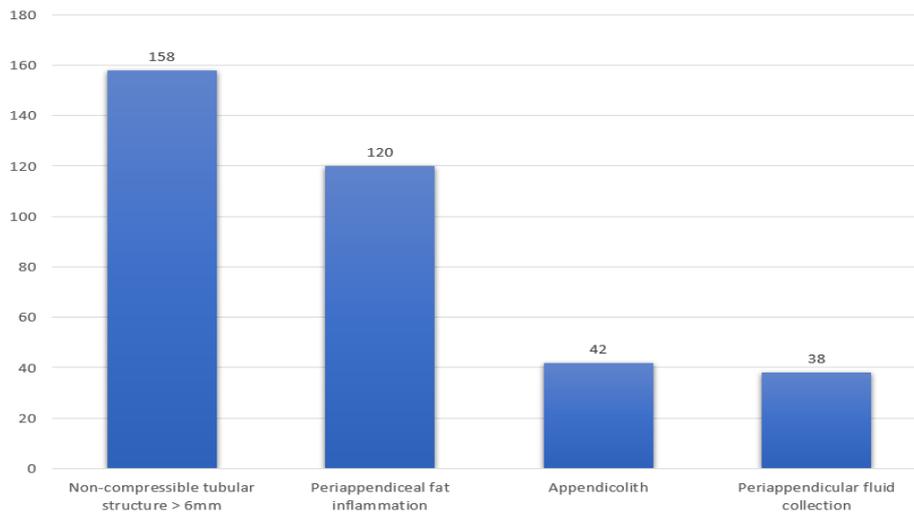


Figure 2: Distribution of the study participants according to their ultrasound findings.

Out of the 250 patients included in the study, 190 (76%) were confirmed to have acute appendicitis. The remaining patients were distributed as shown in figure 3.

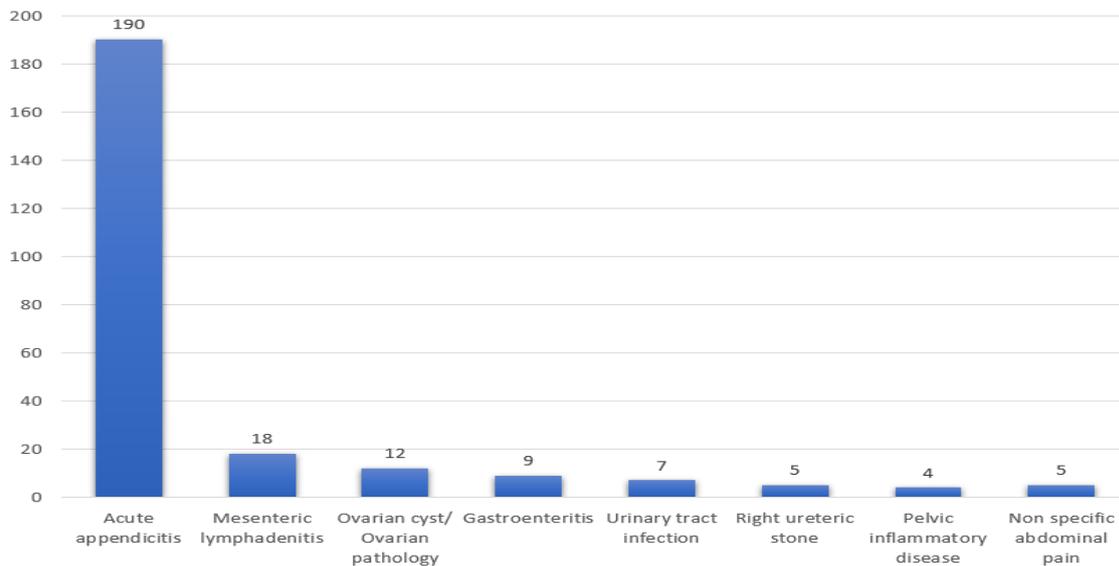


Figure 3: Distribution of the study participants according to their final diagnosis.

Table 1 shows comparison between ultrasound and final diagnosis. It's evident that 165 out of 170 patients diagnosed as acute appendicitis by ultrasound were truly positive. Whereas 25 patients out of 80 patients were falsely negative.

Table 1: Comparison between ultrasound and final diagnosis.

Ultrasound Results	Appendicitis present	Appendicitis absent	Total
Positive	165 (true positive)	5 (false positive)	170
Negative	25 (false negative)	55 (true negative)	80
Total	190	60	250

Table 2 shows accuracy measurements of the ultrasound in comparison to the final diagnosis. Ultrasound demonstrated high sensitivity and specificity with overall accuracy of 88%, indicating its reliability as initial diagnostic modality for suspected acute appendicitis.

Table 2: Accuracy measurements of the ultrasound.

Sensitivity	Specificity	Positive predictive value	Negative predictive value	Overall accuracy
86.8%	91.7%	97.1%	68.8%	88%

4. DISCUSSION

Acute appendicitis is one of the most common surgical emergencies globally, accounting for a significant portion of acute abdominal pain presented to emergency departments.^[12] Early and accurate diagnosis is crucial to avoid consequences like perforation, peritonitis, and abscess formation. Because the clinical presentation of appendicitis can be similar to multiple other abdominal disorders, imaging has become an important part of the diagnostic process.^[13] Ultrasonography is commonly employed as a first-line imaging modality because to its safety, absence of ionizing radiation, accessibility, and affordability.^[14]

In the current study, ultrasound had a sensitivity of 86.8%, specificity of 91.7%, and overall diagnostic accuracy of 88% for detecting acute appendicitis. These findings are consistent with prior studies that assessed the diagnostic performance of ultrasound in patients with suspected appendicitis. For example, Pinto et al. found that ultrasound had a sensitivity of 85% and specificity of 92% in identifying acute appendicitis.^[15] Similarly, a prospective study conducted by Ross et al. found sensitivity and specificity values of 84% and 93%, respectively.^[16] These comparable results confirm ultrasound's reliability as an initial diagnostic technique. Doria et al. found that adult and pediatric populations had pooled sensitivity and specificity values of 88% and 94%, respectively.^[17] These findings are consistent with the findings of the present study, indicating that ultrasonography has a high diagnostic accuracy across a wide range of patient demographics and clinical situations.

The most prevalent sonographic finding in this study was a non-compressible tubular structure with a diameter greater than 6 mm. This characteristic was discovered in the vast majority of verified appendicitis cases. Previous studies have consistently shown that an appendiceal width higher than 6 mm is the most reliable ultrasonography criterion for identifying acute appendicitis. Additional secondary signs detected in this study were periappendiceal fat inflammation,

appendicolith development, and periappendiceal fluid collection, which have previously been described in earlier imaging studies as key supportive diagnostic findings.^[18,19]

The presence of false negative cases in the current study demonstrates one of ultrasound's known limitations. In this study, 25 patients with proven appendicitis showed negative ultrasonography results. Similar limitations have been noted in other study where appendix vision may be hampered by obesity, intestinal gas, retrocecal appendiceal location, or inexperienced operators.^[20]

The negative appendectomy rate seen in the current study was quite low (2.6%), which is consistent with rates reported in the literature when imaging is frequently employed. Drake et al. found that using imaging procedures considerably reduced negative appendectomy rates compared to clinical diagnosis alone.^[21]

Another significant finding in this study was the existence of multiple alternative diagnoses among patients who did not have appendicitis. The most common alternate causes of right lower quadrant pain were mesenteric lymphadenitis, ovarian pathology, urinary tract infections, and ureteral stones. Reddan et al. obtained similar results, emphasizing the usefulness of ultrasound in diagnosing alternative abdominal diseases that mimic appendicitis.^[22]

Despite the hopeful results, this study has a number of limitations. The accuracy of an ultrasound examination can vary depending on the operator's experience. Furthermore, this study was carried out in a single facility, which may restrict the generalizability of the results. Future multicenter studies with bigger sample sizes could assist to validate these findings and explain the role of ultrasound in appendicitis diagnosis.

Overall, this study supports the use of ultrasonography as an effective and reliable first-line imaging modality in evaluating patients with suspected acute appendicitis.

The excellent sensitivity and specificity obtained in this investigation are consistent with previously published studies, highlighting the clinical use of ultrasound in emergency diagnostic pathways.

5- CONCLUSION

Ultrasonography showed high diagnostic performance in detecting acute appendicitis, with good sensitivity, specificity, and overall accuracy. The findings of this study support the use of ultrasound as a reliable first-line imaging modality in the evaluation of patients with suspected acute appendicitis. Its noninvasive nature, wide availability, and absence of radiation exposure make it particularly suitable for routine clinical use, especially in resource-limited settings.

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