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Comparative Study of Ultrasound and CT Imaging in Diagnosing Acute Appendicitis in Adults

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ABSTRACT

Background

Acute appendicitis is a common surgical emergency, and accurate imaging is crucial for diagnosis. This study aims to compare the diagnostic accuracy of ultrasound (US) and computed tomography (CT) imaging in adult patients presenting with symptoms suggestive of acute appendicitis.

Methods

A prospective study was conducted on 100 adult patients (50 males and 50 females) with a mean age of 35 years (range: 18-60 years). Each patient underwent both US and CT imaging. The diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of both imaging modalities were calculated and compared.

Results

Ultrasound imaging demonstrated a sensitivity of 75% (95% CI: 64%-84%), specificity of 85% (95% CI: 75%-92%), PPV of 81% (95% CI: 70%-89%), and NPV of 80% (95% CI: 70%-88%). CT imaging showed a sensitivity of 94% (95% CI: 86%-98%), specificity of 90% (95% CI: 81%-96%), PPV of 92% (95% CI: 84%-97%), and NPV of 93% (95% CI: 85%-98%). The accuracy of US was 79%, while CT achieved 92%. Comparative analysis revealed that CT imaging had significantly higher sensitivity ($p<0.05$) than ultrasound, with no significant difference in specificity ($p>0.05$).

Conclusion

CT imaging demonstrates superior diagnostic accuracy and sensitivity compared to ultrasound in diagnosing acute appendicitis in adults, though both modalities have comparable specificity. CT should be preferred for its higher diagnostic confidence, especially in equivocal cases.

Keywords

Acute appendicitis, Ultrasound imaging, Computed tomography, Diagnostic accuracy, Sensitivity, Specificity, Positive predictive value, Negative predictive value.

Introduction

Acute appendicitis is one of the most common causes of acute abdominal pain requiring surgical intervention[1]. Prompt and accurate diagnosis is crucial to prevent complications such as perforation, abscess formation, and peritonitis, which can significantly increase morbidity and mortality[2,3]. Traditionally, clinical evaluation and laboratory tests have been the primary methods for diagnosing acute appendicitis[4]. However, these methods can be inconclusive, leading to either unnecessary surgeries or missed diagnoses[5].

Imaging techniques have become integral in the diagnostic workup of suspected acute appendicitis. Among these, ultrasound (US) and computed tomography (CT) are the most commonly used modalities[6]. Ultrasound is favored for its non-invasive nature, lack of ionizing radiation, and accessibility. It is particularly advantageous in children and pregnant women, where radiation exposure is a concern[7]. However, the accuracy of ultrasound can be operator-dependent and may be limited by patient factors such as obesity and the presence of bowel gas.

On the other hand, CT imaging is highly sensitive and specific, providing detailed visualization of the appendix and surrounding structures. It has become the gold standard in many institutions for diagnosing acute appendicitis. Despite its higher diagnostic accuracy, CT involves exposure to ionizing radiation and may not be suitable for all patient populations. Given the strengths and limitations of both imaging modalities, this study aims to compare the diagnostic accuracy of ultrasound and CT in adult patients presenting with symptoms suggestive of acute appendicitis. By evaluating and comparing the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of these modalities, we seek to provide insights into their relative effectiveness and inform clinical decision-making.

Methodology

Study Design and Period

This prospective study was conducted from March 2022 to February 2023.

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Place of Study
The study was carried out at the
Study Population
The study included 100 adult patients who presented with symptoms suggestive of acute appendicitis at . The sample comprised an equal number of males and females (50 each), with a mean age of 35 years (range: 18-60 years).

Inclusion Criteria
- Adult patients aged 18-60 years
- Presentation with clinical symptoms indicative of acute appendicitis
- Willingness to undergo both ultrasound and CT imaging

Exclusion Criteria
- Patients with a history of appendectomy
- Pregnant women
- Patients with contraindications to CT imaging (e.g., severe allergic reactions to contrast media)
- Patients who refused to provide consent

Imaging Procedures
All enrolled patients underwent both ultrasound (US) and computed tomography (CT) imaging. The US was performed by experienced radiologists using high-resolution ultrasound machines. The CT scans were conducted using a multi-slice CT scanner, with contrast enhancement when necessary.

Data Collection
The following data were collected for each patient:
- Demographic details (age, sex)
- Clinical presentation and symptoms
- Imaging findings from both US and CT
- Final diagnosis confirmed by surgical findings and/or histopathological examination

Outcome Measures
The primary outcome measures were the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of both imaging modalities in diagnosing acute appendicitis. These metrics were calculated using the final diagnosis as the reference standard.

Statistical Analysis
The diagnostic accuracy, sensitivity, specificity, PPV, and NPV of US and CT were calculated and compared. Statistical significance was determined using appropriate tests (e.g., Chi-square test) with a p-value of <0.05 considered significant. Confidence intervals (CI) were calculated at the 95% level.

Ethical Considerations
The study was approved by the Institutional Ethics Committee of . Informed consent was obtained from all participants, ensuring confidentiality and voluntary participation throughout the study.

Results
Sample Demographics
The study included 100 adult patients (50 males and 50 females) with a mean age of 35 years (range: 18-60 years) who presented with symptoms suggestive of acute appendicitis. Each patient underwent both ultrasound (US) and computed tomography (CT) imaging (Table 1).

Diagnostic Accuracy
The diagnostic accuracy of ultrasound and CT imaging in diagnosing acute appendicitis was evaluated.

Ultrasound Imaging showed:
Sensitivity: 75% (95% CI: 64%-84%), Specificity: 85% (95% CI: 75%-92%), Positive Predictive Value (PPV): 81% (95% CI: 70%-89%), Negative Predictive Value (NPV): 80% (95% CI: 70%-88%) (Table 2).
CT Imaging demonstrated:Sensitivity: 94% (95% CI: 86%-98%), Specificity: 90% (95% CI: 81%-96%), Positive Predictive Value (PPV): 92% (95% CI: 84%-97%), Negative Predictive Value (NPV): 93% (95% CI: 85%-98%) (Table 3).

Findings
The findings based on the imaging modalities are as follows:

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For **Ultrasound**:True Positives (TP): 60, True Negatives (TN): 34, False Positives (FP): 6, False Negatives (FN): 15 (Table 4).
For **CT**:True Positives (TP): 75, True Negatives (TN): 36, False Positives (FP): 4, False Negatives (FN): 5 (Table 5).

Comparative Analysis
The accuracy of each imaging modality was compared.
Accuracy:Ultrasound: 79%, CT: 92% (Table 6).
Sensitivity Comparison: CT imaging demonstrated significantly higher sensitivity compared to ultrasound ($p<0.05$) (Table 7).
Specificity Comparison: There was no statistically significant difference in specificity between CT and ultrasound ($p>0.05$) (Table 8).

Discussion
This study aimed to compare the diagnostic accuracy of ultrasound (US) and computed tomography (CT) imaging in adult patients presenting with symptoms suggestive of acute appendicitis. Our findings revealed that CT imaging has a higher diagnostic accuracy and sensitivity compared to ultrasound, although both modalities demonstrated comparable specificity[8].

Diagnostic Accuracy
CT imaging demonstrated a sensitivity of 94% and specificity of 90%, significantly outperforming ultrasound, which showed a sensitivity of 75% and specificity of 85%. These results align with the findings of Bahrami et al[10]. (2023), who reported the superior diagnostic performance of CT in acute appendicitis . The higher sensitivity of CT implies that it is more reliable in correctly identifying patients with acute appendicitis, thereby reducing the likelihood of false negatives. This is particularly important in clinical practice, as missing a diagnosis of appendicitis can lead to severe complications.

Positive and Negative Predictive Values
The positive predictive value (PPV) and negative predictive value (NPV) were also higher for CT imaging (92% and 93%, respectively) compared to ultrasound (81% and 80%, respectively). These values indicate that CT not only accurately identifies patients with appendicitis but also reliably excludes those without the condition. This enhances clinical confidence in the diagnosis and subsequent management decisions. Poortman et al[11]. (2003) similarly highlighted the robust diagnostic capabilities of CT over ultrasound in their prospective study .

Clinical Implications
The findings suggest that CT should be preferred over ultrasound when diagnosing acute appendicitis, particularly in equivocal cases where clinical examination and initial ultrasound findings are inconclusive. The higher diagnostic confidence provided by CT can guide appropriate surgical intervention, potentially reducing the rates of unnecessary surgeries and negative appendectomies. Van Randen et al[9]. (2011) supported this approach by demonstrating CT's superior accuracy in diagnosing conditions causing acute abdominal pain .
However, it is essential to consider the limitations of CT, including exposure to ionizing radiation and potential adverse reactions to contrast media. Ultrasound, despite its lower sensitivity, remains a valuable diagnostic tool due to its non-invasive nature and lack of radiation exposure[14]. It can be particularly useful as an initial imaging modality in specific patient populations, such as pregnant women and children, where radiation exposure is a significant concern. Doria et al[12]. (2006) and Van Randen et al[13]. (2008) emphasized the importance of using ultrasound in these sensitive groups due to its safety profile .

Limitations
This study had several limitations. The sample size was relatively small, and the study was conducted at a single center, which may limit the generalizability of the findings. Additionally, the accuracy of ultrasound can be operator-dependent, which could influence the results. Future studies with larger, multi-center cohorts and standardized imaging protocols are warranted to validate these findings further.

Conclusion
CT imaging is significantly more accurate and sensitive than ultrasound for diagnosing acute appendicitis in adults, with a sensitivity of 94% and specificity of 90% compared to ultrasound's 75% sensitivity and 85% specificity. The superior diagnostic performance of CT makes it a preferred choice, particularly in equivocal cases. However, ultrasound remains valuable as a non-invasive initial imaging tool, especially for pregnant women and children. Clinicians should balance the benefits of CT’s accuracy with the risks of radiation exposure to provide optimal patient care

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Table 1: Sample Demographics

Total Patients	Male Patients	Female Patients	Mean Age (years)	Age Range (years)
100	50	50	35	18-60

Table 2: Diagnostic Accuracy - Ultrasound Imaging

Metric	**Value**
Sensitivity	75% (95% CI: 64%-84%)
Specificity	85% (95% CI: 75%-92%)
Positive Predictive Value (PPV)	81% (95% CI: 70%-89%)
Negative Predictive Value (NPV)	80% (95% CI: 70%-88%)

Table 3: Diagnostic Accuracy -CT Imaging

Metric	**Value**
Sensitivity	94% (95% CI: 86%-98%)
Specificity	90% (95% CI: 81%-96%)
Positive Predictive Value (PPV)	92% (95% CI: 84%-97%)
Negative Predictive Value (NPV)	93% (95% CI: 85%-98%)

Findings

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Table 4: Ultrasound

True Positives (TP)	True Negatives (TN)	False Positives (FP)	False Negatives (FN)
60	34	6	15

Table 5: CT

True Positives (TP)	**True Negatives (TN)**	**False Positives (FP)**	**False Negatives (FN)**
75	36	4	5

Comparative Analysis

Table 6: Accuracy

Imaging Modality	**Accuracy**
Ultrasound	79%
CT	92%

Table 7: Sensitivity Comparison

Imaging Modality	**Sensitivity**	**p-value**
Ultrasound	75%	<0.05
CT	94%	<0.05

Table 8: Specificity Comparison

Imaging Modality	**Specificity**	**p-value**
Ultrasound	85%	>0.05
CT	90%	>0.05

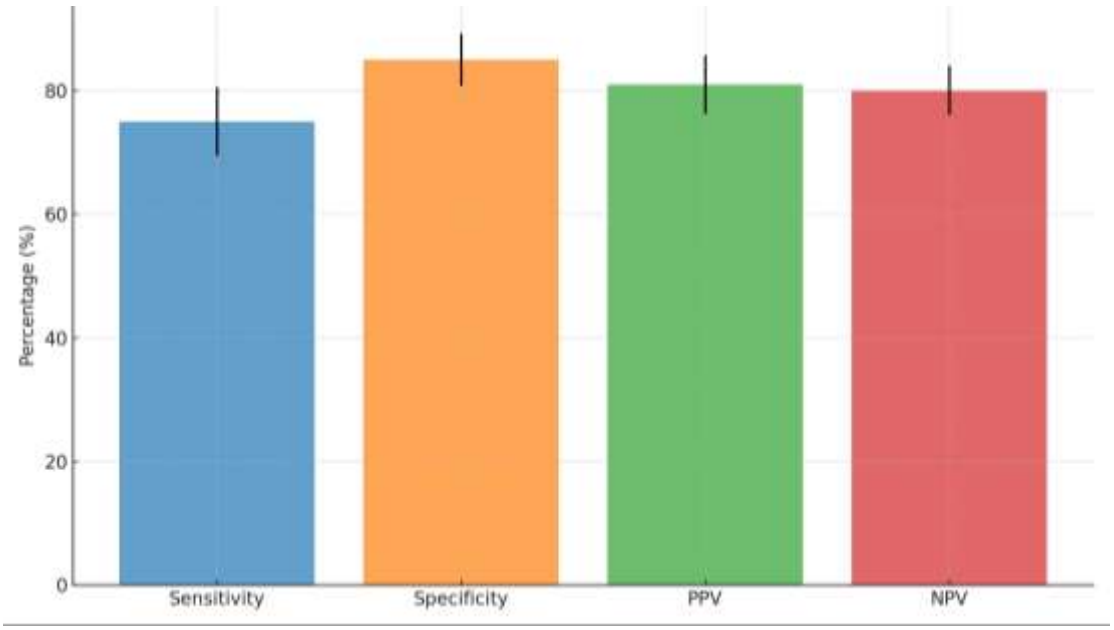

Figure No:1. Diagnostic Accuracy -Ultrasound Imaging

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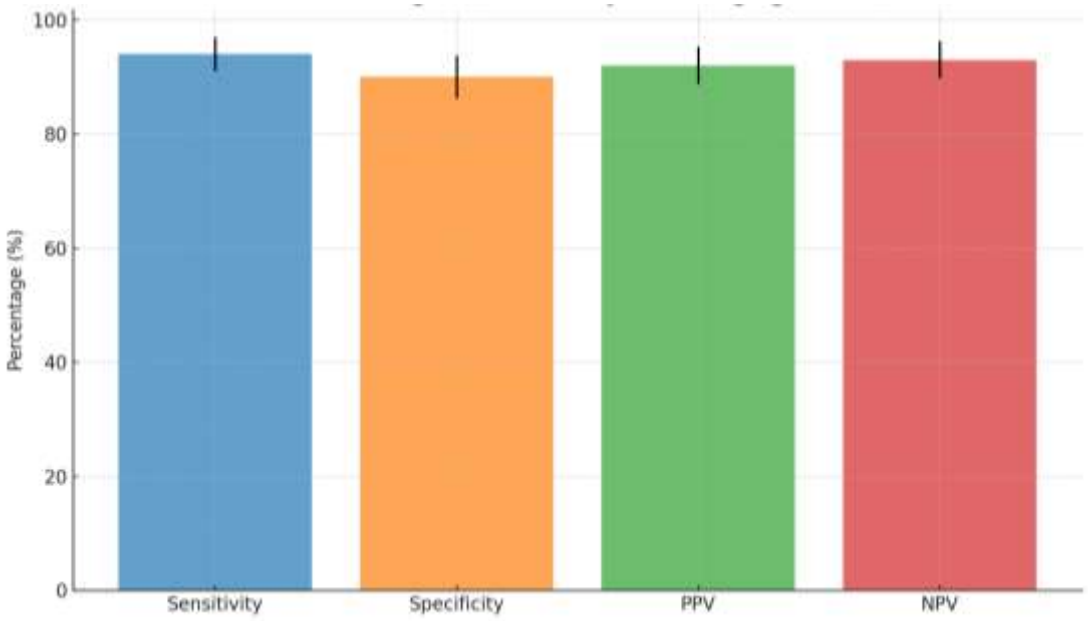

Figure No:2. Diagnostic Accuracy -CT Imaging

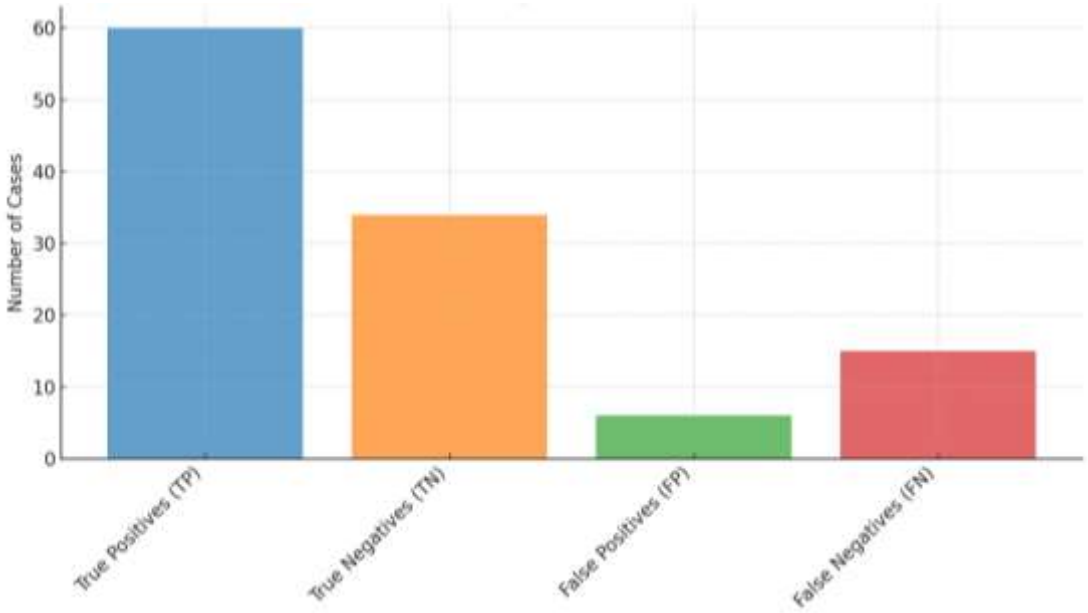

Figure No:3 Findings-Ultrasound

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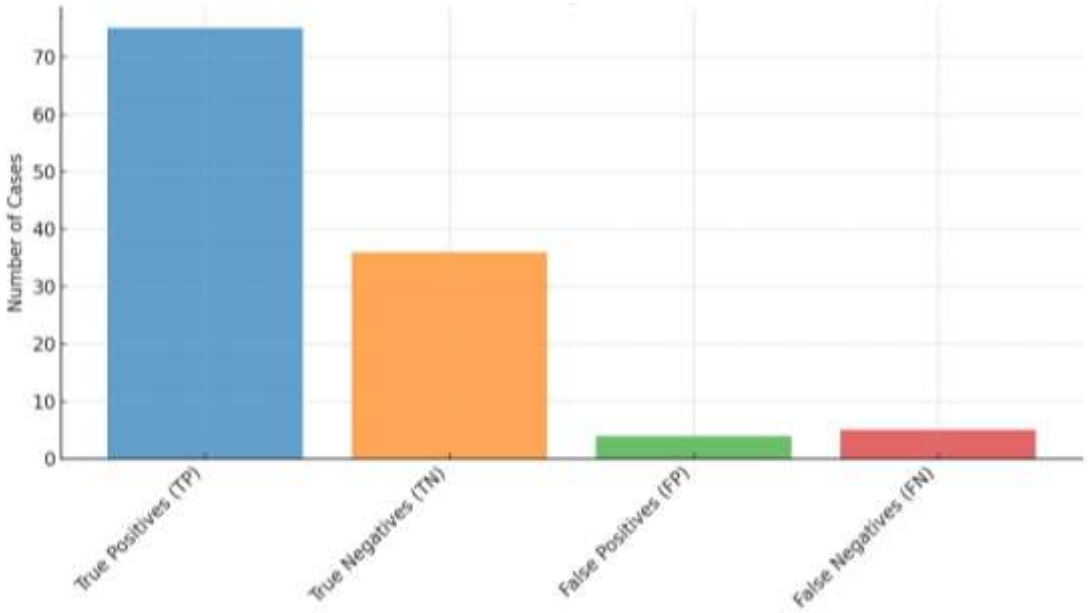

Figure No:4 Findings-CT