

Diagnostic Value of Ultrasonography in Patients Suspected Acute Appendicitis

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Abstract

Introduction: Appendectomy is one of the most frequently performed abdominal operations in surgical practice. Preoperative imaging has been demonstrated to improve diagnostic accuracy in appendicitis. Abdominal ultrasonography (US) is the most commonly and first-line imaging modality used for diagnosing acute appendicitis (AA). The aim of this study was to demonstrate the diagnostic value of abdominal ultrasonography for diagnosing acute appendicitis. **Methods:** In a retrospective study, we analyzed 200 consecutive patients with abdominal pain that undergoing appendectomy, from June 2009 to April 2012. Patient characteristics, preoperative ultrasonography (US) and laboratory assessment including WBC were collected. Final diagnosis of appendicitis was confirmed by histopathological examination. Results were compared with US. **Results:** Two hundred patients were admitted to this study that undergoing appendectomy. Mean age was 24 years (range: 1 to 91 years), and 57% were females. Patient White blood cell counts were found to be high in 78% while it was 86% for AA group and 64% for NA group ($p < 0.05$). One hundred sixty-six of these patients (83%) were diagnosed as acute appendicitis on pathology, and 34 (17%) were diagnosed differently. 157 of patients underwent US, eighty two of this patients diagnosed as acute appendicitis on US examinations and in 78 of them were also reported as acute appendicitis on histopathological examination. The sensitivity and specificity of abdominal US for diagnosing appendicitis were 70% and 90.2% respectively. Positive predictive value (PPV) was 93% and negative predictive value (NPV) was reported 62%. **Conclusion:** Ultrasonography has a high PPV and specificity, so as a diagnostic tool, positive US strongly suggests the diagnosis of AA. A low negative predictive value recommends that negative US is not sufficient to exclude the diagnosis of AA and patients could not be managed on an outpatient basis following a negative scan.

Key words: Acute Appendicitis, Ultrasonography

Introduction

Acute appendicitis (AA) is one of the most common causes of acute surgical abdomen.¹ Also Appendectomy is one

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of the most frequently performed abdominal operations in surgical practice.²

The diagnosis of AA is still base on medical history and physical examination³ and surgery remains the treatment of choice for AA.⁴

If accurate diagnosis is made in time, AA can be treated easily, otherwise delay in diagnosis and treatment can lead to gangrene perforation and diffuse peritonitis.⁵ Although the rate of unnecessary appendectomies is comparatively high (20-30%) it is considered acceptable because the rate of perforated appendices is 7-30 %.⁶

While AA traditionally is diagnosed clinically, but not all patients present with the classic symptoms.⁷⁻⁹ The presence of an atypical clinical picture makes the diagnosis difficult in some patients such as: pediatric; elderly patients; obese; female patients in reproductive age or pregnant and patients with pelvic or retrocecal appendices.³ So other supplementary modalities may be necessary to help diagnosing AA. These include the use of clinical scoring system or diagnostic algorithms such as the Alvarado system, serum inflammatory markers, and radiologic imaging.^{4,7}

Preoperative imaging has been demonstrated to improve diagnostic accuracy in appendicitis.¹⁰ More ultrasound (US) and computed tomography (CT) are used to help diagnosing AA.⁷

Abdominal ultrasonography (US) is the most commonly and first-line imaging modality used for diagnosing AA¹, as it is widely available and lack of radiation exposure inherent in computed tomography (CT).^{1,6} Also, US is an operator- dependent modality,

and the diagnostic values are different in various studies.¹² The aim of this study was to demonstrate the diagnostic value of abdominal US for diagnose of acute appendicitis.

Methods

Patients

In a cross-sectional retrospective study, we collected the data of 200 consecutive patients with abdominal pain that undergoing appendectomy, from June 2009 to April 2012 in Emam Ali Hospital of Zahedan University of Medical Science.

Patients have not Pathology reports of appendices were excluded from the study.

The study was approved by ethical committee and all participants provided written consent.

Data collection and measurements

For each patient we collected the data including: demographic information (age, sex), history of pain, physical examination, laboratory assessment including WBC, preoperative US, operative findings and pathology report.

Ultrasound was carried out by radiology residents, by the use of high-resolution B-mode ultrasonography (model LOGIC 7; GE) with linear and curved transducers with ultrasound frequencies ranged between 2.5 and 7.5 MHz. The diagnostic criteria for acute appendicitis in US including maximum diameter greater than 6 mm, lack of compressibility, hyperemia on Doppler, the presence of free fluid in the right lower quadrant and infiltration of the periappendiceal fat.¹³⁻¹⁵ Sonographic results

were classified as either “positive” or “negative.”

The histopathological diagnosis of acute appendicitis was confirmed by the presence of polymorphonuclear cells in the muscular layer (transmural infiltration) of the appendicular wall. White blood cell count (WBC) higher than 10500/mm³ was accepted as leukocytosis.

Statistical analysis

Final diagnosis of appendicitis was confirmed by histopathological examination. Results were compared with US. The sensitivity and specificity of all US images were calculated based on the pathology results of the appendectomy. All statistical analysis were performed using SPSS for Windows (version 15.0). P-values less than 0.05 were accepted as significant.

Table 1: Diagnostic Values of the abdominal ultrasound in acute appendicitis (n =200).

Value	%
Sensitivity	70 %
Specificity	90.2 %
Positive predictive value	93 %
Negative predictive value	62 %

Results

200 patients were admitted to this study with abdominal pain that undergoing appendectomy. Patients have not Pathology

reports of appendices were excluded from the study.

The mean age of the patient undergoing an appendectomy was 24 years and ages ranged from 1 to 91 years. 29% of patients were under the 18 years old. We presented 84 male (42.2%) and 116 female (57.8%).

Patients White blood cell counts were found to be high (>10500/mm³) in 78% while it was 86% for AA group and %64 for NA group (p < 0.05).

One hundred sixty-six of these patients (83%) were diagnosed as acute appendicitis on pathology, and 34 (17%) were diagnosed differently. The most differential diagnose was ovarian complications. 5% of appendix specimens removed were perforated.

153 of patients underwent ultrasonography; eighty two of these patients diagnosed as acute appendicitis on US examinations and in 78 of them were also reported as acute appendicitis on histopathological examination.

A positive US was considered a true positive if the diagnosis of appendicitis was confirmed by histology and a false positive if the specimen showed no features of inflammation. By the same token, a negative US was considered a true negative if the specimen showed no features of inflammation and a false negative if histology confirmed appendicitis.

The sensitivity and specificity of abdominal ultrasonography for diagnosing appendicitis were 70% and 90.2% respectively. Positive predictive value (PPV) was 93% and negative predictive value (NPV) was reported 62 %.(Table 1, 2)

Table 2:

	True-positive	True-negative	False-positive	False-negative	Total
Number of Patient's	82	37	4	34	200

A comparison of the US results between genders was made. Among the men, ultrasound diagnosed AA in 68%. In the 74 women it showed a correct diagnosis in 63%. Although US was more accurate in men but there was no significant difference with Chi-square test ($p = 0.12$).

17 patients of our study were pregnant and in 50% of them US could not detect AA. It may be due to low accuracy of US in pregnancy for diagnose of AA. 59 of patients were under the 18 years old and US right diagnose of AA in 60%.

Discussion

Acute appendicitis (AA) is one of the most commonly diagnosed causes of acute abdomen.⁴

The most important diagnostic tool is still physical examination but recently imaging tools is widely used in the diagnose and differential diagnose of patients with acute abdominal pain.¹⁶ With developments in diagnostic ultrasonography (US) and CT scan, the diagnostic accuracy of AA has improved from 75% to 97%.¹⁷⁻¹⁹

US is part of the diagnostic tools for cause of acute abdomen diagnosis and is relatively

inexpensive, safe, and available. US can be performed at the bedside, involves a short acquisition time, does not use ionizing radiation, and may show evidence of other causes of abdominal pain. It is particularly useful in evaluating young women, pregnant patients and children.¹⁹

In this study all 200 patients were demonstrating positive symptoms and physical signs for appendicitis.

White blood cell counts were high for the 78% of the patients. Also other studies such as Elangovan et al found high levels of white blood cell count in 80 percent of AA patients.^{20, 21} But unfortunately, the white blood cell is elevated in up to 70 percent of patients with other causes of right lower quadrant pain²⁰, so it has a low accuracy for differentiation of abdominal pain causes.

We used US for 200 suspicious acute appendicitis patient and found US had a sensitivity of 70% and a specificity of 90.2%. The positive predictive value of US was 93% and the negative predictive value of test was 62%.

In another study US had 71.2% sensitivity, 83.3% specificity and 72.4% accuracy. The PPV of US was 97.4%, the NPV was 25%.²²

Scammell et al have shown US as a diagnostic tool for acute appendicitis in children had a sensitivity of 83.3%, a specificity of 97.4 %, a PPV of 92.1% and a NPV of 94.0%.²³ This ratios is more than of our results.

Rajeev gave these results at his study on 118 preoperatively US performed appendectomy patients as 63.3%, 82.14%, 91.93% and 41.07%.²⁴

This variation in result of different studies may be due to some reasons. Previous studies have shown two main factors in practice that significantly influence on US diagnosis of AA ,including the experience of the radiologist, patient factors or technique used.^{19,25}

Visualization of a normal appendix is more difficult in patients with a large body habitus. With increase in patient's weight, the detection rate of the appendix is significantly decreases. Accuracy of US also decreases with retrocecal location of the appendix.²⁶

17 patients of our study were pregnant and in 50% of them US could not detect appendicitis. It may be due to low accuracy of US in pregnancy for AA diagnosis.

Whatever, comparing this study with other studies reveals that US provides reliable findings for the diagnosis of acute appendicitis.

In our study the PPV of US was 93%, so as a diagnostic tool, positive US strongly suggests the diagnosis of AA, however in this study, US is done by radiology residents without much experience. We found the

NPV of US was 62%. A low negative predictive value recommends that patients could not be managed on an outpatient basis following a negative scan.

Conclusion

Ultrasonography has a high PPV and specificity, so as a diagnostic tool, positive US strongly suggests the diagnosis of AA. A low negative predictive value recommends that negative US is not sufficient to exclude the diagnosis of AA and patients could not be managed on an outpatient basis following a negative scan.

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