

## ACCURACY OF GREY SCALE ULTRASOUND IN CORRECTLY IDENTIFYING ACUTE APPENDICITIS

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### ABSTRACT

**Objective:** To validate diagnosis of acute appendicitis using grey scale ultrasound.

**Study Design:** Cross sectional validation.

**Place and Duration of Study:** The study was conducted at Radiology Department, Armed Forces Institute of Radiology and Imaging (AFIRI) Rawalpindi, from Mar 2013 to Aug 2013.

**Material and Methods:** All the patients were referred to the sonography section of Emergency Radiology Department for suspected diagnosis of acute appendicitis. All patients of suspected appendicitis had ultrasound of abdomen. Indication of any above stated criteria resulted in appendectomy of the patient. Patients were operated by conventional method of appendectomy. Results regarding appendix by ultrasonography and surgical outcome were recorded on the proforma. Data entry and analysis were done by using SPSS 21.

**Results:** Mean age of patients was  $21.39 \pm 4.332$  years. There were 77 (48.1%) male and 83 (51.9%) female patients. Clinically, there were 126 (79%) patients positive for appendicitis and on ultrasound findings 121 (76%) patients had appendicitis. Surgical outcome showed 125 (78%) patients as positive. Sensitivity and specificity of ultrasound for the diagnosis of appendix was 87.20% and 65.71%. While positive predictive value (PPV) and negative predictive value (NPV) of ultrasonography was 90.80% and 58.97% respectively. Overall diagnostic accuracy of ultrasound was 82.5%.

**Conclusion:** In patients who present with clinically suspected acute appendicitis, imaging with ultrasound was effective technique to confirm the clinical diagnosis.

**Keywords:** Acute Appendicitis, Surgical Outcome, Ultrasound.

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### INTRODUCTION

Acute appendicitis is a very common cause of acute abdomen, which is equally prevalent through out the developing and developed world. Its prevalence is around 7% in a lifetime. The presentation and symptoms of acute appendicitis are often peculiar among all age groups from pediatric to adult population, making its diagnosis intricate<sup>1</sup>. Although appendicitis is commonly encountered clinical complain but its preoperative diagnosis usually depends upon clinical assessment. It is quite difficult due to the resemblance of symptoms with inflammatory, vascular and obstetric conditions. The proper and authenticated diagnosis requires to minimize the negative

appendectomies rate by improving diagnostic procedures<sup>2</sup>. The main cause of appendicitis is invasion of bacteria in appendicular wall and mucosal ulceration, which is instigated by many other causes. Acute appendicitis is a result of injury of mucosa and spread from that injury through its wall secondary to obstruction<sup>3-5</sup>. There are no specific symptoms particularly for this disease; the symptoms of patients at presentation are overlapping with many other diseases having variation from patient to patient. Even though many diagnostic improvements have been made for this disease with various clinical and laboratory techniques as well as with various scoring systems to help in decision making form clinical management, the decision to operate is still puzzling<sup>6</sup>. The miss diagnosis of appendicitis can lead to severe outcomes like risk of perforation of appendicitis, peritonitis, abscesses which increases the mortality rate up to

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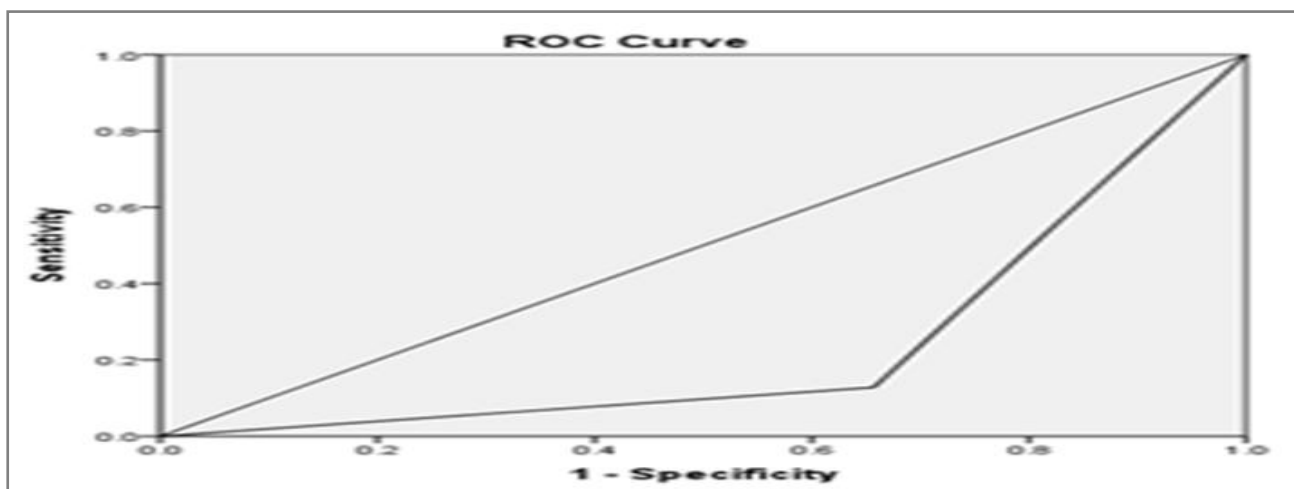
ten times. The rate of missed appendicitis is about 12%<sup>7</sup>.

The diagnosis of appendicitis has been improved with the help of new computerized technologies, different imaging techniques like ultrasound computed tomography (CT), laparoscopy and radioisotope imaging<sup>8</sup>. These imaging techniques are used to enhance the reliability of clinical diagnosis. The commonly used imaging techniques are ultrasound and CT<sup>9</sup>. These imaging techniques have shown very high accuracy for diagnosis of appendicitis. The use of ultrasound has been proved to have around 90% sensitivity, specificity and accuracy for diagnosis of appendicitis. The correct diagnosis of other diseases having symptoms like appendicitis through ultrasound has shown around 90-95%

## MATERIAL AND METHODS

This cross-sectional validation study was conducted after approval from the hospital ethical committee and all the data was collected after informed written consent of all patients. A total of 160 patients were included in the study.

World Health Organization (WHO) sample size calculator was used to calculate sample size using taking sensitivity, specificity and expected prevalence of 68% and 88%<sup>11</sup>, and 82%<sup>10</sup> respectively. Desired precision 10%, and confidence level of 95%. Patients of both genders and age more than 15 years with suspected appendix on the clinical basis were included in the study, by non probability convenience sampling. Patients with palpable lump and chronic or repeated episodes of pain were



**Figure: Diagonal segments are produced by ties.**

correct diagnosis<sup>10</sup>. In another clinical study, ultrasound was used to assess the appendix and it was found that in (82%) cases, ultrasound correctly identified the appendix with a sensitivity of 68.0% and specificity of 88.0% taking post-operative finding as gold standard<sup>11</sup>. The aim of this study would be to determine the sensitivity, specificity and diagnostic accuracy of ultrasonography for diagnosis of acute appendicitis in a community hospital with commonly available low frequency curvilinear transducer, considering its cost effectiveness and with less radiation side effects. So that unnecessary appendectomies could be avoided.

excluded from the study. All the patients were referrals to the sonography section of emergency radiology department for suspected diagnosis of acute appendicitis. These patients were subsequently undergoing an appendectomy. All the patients had abdominal ultrasound. Patients were operated by conventional method of appendectomy. Information regarding demographic characteristics including age, gender, weight, height and BMI was taken on a pre designed proforma. Results regarding appendicitis by ultrasonography and surgical outcome were also recorded on the proforma. Data was entered and analyzed using SPSS

(Version 21). Frequencies and percentages were calculated for qualitative variables and mean  $\pm$  SD was calculated for quantitative variables. A 2x2 cross table was utilized to calculate sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for

Gender distribution of patients shows that there were 77 (48.1%) male and 83 (51.9%) female patients. Clinically when patients were assessed for appendicitis there were 126 (79%) patients who were clinically positive for appendicitis while the remaining 34 (21%) of the patients

**Table-I: Distribution of Demographic Characteristics of the Participants**

Characteristics	Frequency	Percentage (%)
<b>Age of the participants</b>		
Mean $\pm$ SD	21.39 $\pm$ 4.332	
<b>Gender of the participants</b>		
Male	77	48.10
Female	83	51.90
<b>Acute Appendicitis by clinical findings</b>		
Positive	126	78.80
Negative	34	21.30
<b>Acute Appendicitis by Ultrasound</b>		
Positive	121	75.60
Negative	39	24.40
<b>Acute Appendicitis by Histopathology</b>		
Positive	125	78.10
Negative	35	21.90

**Table-II: Cross tabulation of ultrasound vs. surgical outcome.**

		Surgical outcome Histopathology		Total
		Positive	Negative	
Ultrasound Positive	Positive	109	12	121
	Negative	16	23	39
Total		125	35	160

**Table-III: Diagnostic accuracy of ultrasound vs. surgical outcome.**

Diagnostic Parameter	Value (%)
Sensitivity	87.20
Specificity	65.71
Positive Predictive Value	90.80
Negative Predictive Value	58.97
Diagnostic Accuracy	82.5

ultrasound taking surgical outcome as gold standard (figure).

## RESULTS

A total of 160 suspected patients of appendicitis fulfilling the inclusion and criteria were selected in the study. Mean age of all patients was 21.39  $\pm$  4.332 years having minimum age of 15 years and maximum age of 36 years.

were negative for acute appendicitis (table-I). Ultrasound findings showed that there were 121 (76%) patients who had acute appendicitis while the remaining 39 (24%) patients were not diagnosed with it. Surgical outcome of patients showed positive findings for acute appendicitis among 125 (78%) patients while the remaining 35 (22%) of patients had negative findings for acute appendicitis (table-I).

The 2x2 table shows that there were 109 (68.13%) true positive case and 23 (14.38%) were true negative cases on the basis of ultrasound findings and compared with surgical outcome. The false positive cases were 12 (7.5%) and 16 (10%) cases were false negative as elaborated in (table-II). According to the results, sensitivity and specificity of ultrasound for the diagnosis of appendix was 87.20% and 65.71%. While PPV and NPV of ultrasonography was 90.80% and 58.97% respectively. Overall diagnostic accuracy of ultrasound was 82.5% (table-III).

## DISCUSSION

The patients who present with acute appendicitis require a prompt surgical intervention in the accident and emergency department because delay in diagnosis or treatment may result in any severe outcome. Instantaneous surgery is performed in the patients having typical symptoms and signs of acute appendicitis at the time of presentation, but the patients who have ambiguous and a typical symptoms are referred for imaging. With lots of improvement in imaging and radiological imaging techniques, its use has enhanced. The studies have proved that ultrasound can be very effective and accurate in deciding straight away surgery or requirement of further investigation through CT<sup>12,13</sup>. The appropriate diagnosis of acute appendicitis is difficult and requires more attention because there are many other diseases which have identical symptoms and signs as acute appendicitis including urinary tract stones, acute pyelonephritis, infections/inflammatory conditions of cecum/ascending colon, gallbladder disease, ectopic pregnancy and some other abnormal diseases like complicated ovarian cysts, torsion and hemorrhage. Previous studies have shown that many advanced imaging modalities like CT and color doppler have very high accuracy for diagnosis of different abdominal diseases but the main issue is the availability of these imaging modalities. In developing countries like ours these advanced facilities are very limited in most of the hospital even at tertiary care hospitals. Conversely the

facility of gray scale ultrasound is usually available at most of the settings<sup>14,15</sup>. In this present study, diagnostic accuracy of ultrasound was compared with the surgical outcome of patients of appendix. Diagnostic accuracy results show that sensitivity and specificity of ultrasound for the diagnosis of appendix was 87.20% and 65.71%. While PPV and NPV of ultrasonography was 90.80% and 58.97% respectively. Overall diagnostic accuracy of ultrasound was 78.12%. The use of ultrasound is common for the diagnosis of acute appendicitis but its accuracy has shown great variation in different studies in our population. An evidence based review study showed that ultrasound has an overall sensitivity of 86% and 81% specificity. The PPV and NPV were also quite better having a value of 84% and 85% respectively. The results of this present study were similar for sensitivity but were weaker with respect to specificity, PPV and NPV<sup>16</sup>. In another meta-analysis of 22 articles, conducted in Korea, the efficacy of US was assessed in diagnosis of appendicitis and it was found that over all sensitivity was 86.7% and over all specificity was 90%. The author of this meta-analysis concluded that ultrasound can be more efficient for diagnosis of appendix in younger age and male patients. The published literature shows that ultrasound has an accuracy of (82% to 96%) in pediatric population with a great variation in sensitivity ranging from (44% to 100%) and the specificity of (47% to 99%). Similarly, the overall sensitivity of ultrasound in adult and adolescent patient was 86% with specificity of 81% as found in another published series<sup>17</sup>. Results of this study are in line to the reported range for sensitivity, specificity, PPV and NPV respectively. There might be several reasons of this variation, the main reason might be the expertise level of radiologist because ultrasound is an operative dependent technique and its accuracy has great variation with respect to capability and skills of the operator<sup>18</sup>. Female fertile age may prove a hurdle for correct diagnosis of appendix due to overlapping signs and symptoms of acute abdominal conditions<sup>19-23</sup>.

The patient who have previously undergone through laparotomy surgery and obese patients also have difficulty in diagnosis of appendix through ultrasound due to difficulty in adequate compression of the right lower quadrant<sup>18</sup>. Similarly, the variation in location of appendix is also a type of misdiagnosis on the basis of clinical signs and symptoms<sup>19,20</sup>. In clinically suspected patients of acute appendicitis use of imaging technique is essential for correct and prompt diagnosis because it has been observed that appendicitis has best outcome with early diagnosis. Ultrasound with graded compression is a preferred and preeminent imaging technique in patients referred to emergency department with clinically suspected patients of acute appendix. Ultrasound is an easy to perform technique at any time in any setting without any specific preparation. Ultrasound diagnostic accuracy increases with operator's skill and expertise.

## CONCLUSION

In patients who present with clinically suspected acute appendicitis, imaging with ultrasound was effective technique to confirm the clinical diagnosis.

## CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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