

## ORIGINAL ARTICLE

## ROLE OF ULTRASOUND IN DIAGNOSIS OF ACUTE APPENDICITIS

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**Background:** Acute appendicitis is the inflammation of appendix. Alvarado scoring is a parameter of diagnosing acute appendicitis on clinical basis. Ultrasonography and CT scan are imaging studies which are very helpful in diagnosis of acute appendicitis. In this study the role of ultrasonography and Alvarado score was compared in terms of their sensitivity, accuracy, positive predictive value and false positive rate in the diagnosis of acute appendicitis. **Methods:** From Oct 2016 to Jan 2017, one hundred (100) patients were selected and placed in two groups with fifty patients in each group. Group one was the one in which ultrasonography was used as diagnostic tool for acute appendicitis and then the patients underwent appendectomy. Group two was the one in which no ultrasonography was done and their appendectomy were done on the basis of Alvarado score. The appendectomy samples of both groups were sent to pathology labs for histopathology. **Results:** Ultrasonography was found to have greater sensitivity (0.85), accuracy (0.80) more positive predictive value (0.85) and less false positive rate (0.32) than that of Alvarado score (0.66, 0.66, 0.66, and 0.34 respectively) for diagnosing acute appendicitis. **Conclusion:** For diagnosis of appendicitis, ultrasonography is better than Alvarado score in terms of sensitivity, accuracy, positive predictive value and false positive rate.

**Keywords:** Acute appendicitis, Ultrasonography, Alvarado score

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## INTRODUCTION

Acute Appendicitis is an acute inflammation of the appendix. Acute appendicitis is one of the most common emergencies occurring in every hospital worldwide. Acute appendicitis commonly presents with pain in right iliac fossa along with tenderness, queasiness, retching, loss of hunger, and raised temperature. But roughly 40% of individuals don't have these classical symptoms and signs.<sup>1</sup> In curing acute appendicitis antibiotics have no role. The first line management of acute appendicitis is appendectomy. If acute appendicitis is not treated properly, it can lead to complications like perforation, sepsis, and death.<sup>2</sup>

The diagnosis of acute appendicitis mostly depends upon the signs and symptoms of patients. In 1986, Alvarado constructed a 10 point clinical scoring system for the diagnosis of acute appendicitis.<sup>3</sup> This system consist of 6 signs and symptoms items and 2 laboratory investigation items making total scoring of 10 as shown in Table-1.

Table-1: Alvarado score

Variables	Clinical features	score
Symptoms	Migratory RIF pain	1
	Anorexia	1
	Nausea and vomiting	1
Sign	Tenderness (RIF)	2
	Rebound tenderness	1
	Elevated temperature	1
Laboratory	Leucocytosis	2
	Shift to left	1
Total score		10

Score <5= Appendicitis unlikely, Score 5-6= Appendicitis possible, Score 7-8= Appendicitis probable, Score 9-10= Appendicitis highly probable

A prospective study performed in terms of diagnostic accuracy of Alvarado scoring, at the cut point of 5 score was good at 'ruling out' admission for appendicitis which showed the sensitivity of 99%, at the cut point of 7, recommended for 'ruling in' appendicitis and progression to surgery the overall specificity of 81%.<sup>4,5</sup>

In cases when signs and symptoms alone are not significant in diagnosis then repeated monitoring, imaging modalities and blood tests become more important.<sup>6</sup> Ultrasound (US) and CT scan are the most widely used imaging modalities. Out of these, CT scan is more accurate in diagnosing acute appendicitis.<sup>7</sup> But, due to risk of radiations from CT scan ultrasound is favoured as first line imaging modality in children and pregnant women.

To evaluate the appendix with trans-abdominal US, in 1986, Puylaert described a graded-compression technique.<sup>8</sup> In this technique a transducer is used and gentle pressure is applied on the right lumbar quadrant. This pressure will displace the intervening bowel gas and it will decrease the distance between the appendix and transducer so a clear image can be seen. Major right lumbar quadrant US findings in acute appendicitis are:

- A thick-walled, non-compressible, sausage shaped structure arising from the base of the cecum
- Appendix with more than 6 mm outer diameter
- Peri-appendiceal fluid collection
- Appendicolith may be present
- Echogenic, prominent peri-cecal fat

Fitz in 1880s published the 1<sup>st</sup> paper on acute appendicitis.<sup>8,9</sup> Puylaert in 1986 for the 1<sup>st</sup> time

highlighted the role of US in diagnosing acute appendicitis that showed ultrasound sensitivity and specificity of 89% and 100% respectively for diagnosing acute appendicitis.<sup>8</sup> The benefit of US is that the patient can identify the site of tenderness by himself.<sup>10</sup> Lim HK and Quillin SP rectified the positive role of colour Doppler in identifying diseased appendix which in colour Doppler when inflamed and thick shows circumferential colour as compared to normal thin gut wall and signals disappear when gangrene or perforation is present.<sup>11,12</sup>

In resources constrained area like Azad Jammu & Kashmir where CT scan and colour Doppler scans are not easily available, this study was conducted to compare ultrasonography with Alvarado score in diagnosing acute appendicitis in terms of their sensitivity, accuracy, positive predictive value and false positive rate.

## METHODOLOGY

This was a cross-sectional, quantitative study carried out at Surgical Department, Abbas Institute of Medical Sciences (AIMS) Muzaffarabad. The ethical approval for this study was obtained from Ethical Review Board of AIMS. The study was carried out over a duration of four months, from October 2016 to January 2017. Data was collected from patients admitted in the Department of Surgery through OPD and Emergency.

Total 100 patients were studied. Patients were placed into two groups. In Group 1, there were 50 patients who underwent abdominal ultrasonography by graded compression technique for diagnosing appendicitis. The ultrasonography findings for acute appendicitis were marked as negative and positive. The appendix seen in right iliac fossa as non-compressible blind ended aperistaltic tubular structure with diameter more than 6 mm was marked as positive and when appendix was not visualized or visualized as normal appendix with or without alternative diagnosis was marked negative.<sup>8</sup> In Group 2, patients were diagnosed and operated on the basis of Alvarado scoring. Patients with Alvarado scoring  $\geq 6$  were included in this group; they were operated due to suspected acute appendicitis.<sup>3</sup> The patients with Alvarado score  $\geq 6$  with positive ultrasonography went through appendectomy immediately. Patients who had a negative ultrasound but they had Alvarado 8 or more also went through operation.

Operative findings in both groups were classified as negative and positive. Positive appendectomies were those in which appendectomy samples showed acute or sub-acute inflammatory changes on histopathology. Negative appendectomies were those in which appendix was normal looking on operation and appendectomy samples did not show any kind of acute inflammation on histopathology.

## RESULTS

Total 100 (42 males and 58 female) patients were studied during this study. Group 1 consisted of those 50 (22 males and 28 females) patients in whom USG was done for the diagnosis and then appendectomy was done. Group 2 had those 50 patients in whom no USG was done and appendectomy was done on the basis of clinical diagnosis.

In Group 1 USG was positive in 34 patients and negative in 16 patients. Out of 34 patients with positive USG reports, histopathology reports of 29 patients were positive, and in 5 patients it was negative. Out of 16 patients with negative USG reports but Alvarado score  $\geq 8$  also went for appendectomy; histopathology reports of 5 were positive and 11 were negative.

Group 2 consisted of 20 male and 30 female patients; these patients were diagnosed as acute appendicitis on the clinical basis and USG was not done. Histopathology reports of 33 patients showed positive and reports of 17 patients were negative.

Positive appendectomy rate and negative appendectomy rate calculated for acute appendicitis. In group one 29 patients were true positive, 5 were false positive, 5 were false negative and 11 were true negative as shown in the Table-1 given below. This group has the false positive rate of 0.32 and the positive predictive value of 0.85.

**Table-1: Ultrasonography result of Group 1**

	Histopathology Positive	Histopathology Negative
USG Positive	29 *TP	5 **FP
USG Negative	5 ***FN	11 ****TN

\*TP (True positive)=USG and Histopathology both are positive

\*\*FP (False Positive)=USG is positive and Histopathology is negative

\*\*\*FN (False negative)=USG is negative and Histopathology is positive

\*\*\*\*TN (True negative)=USG and Histopathology both are negative

Sensitivity and specificity of this group were also calculated. This study showed the sensitivity of 0.85 and specificity of 0.68. The sensitivity and specificity were calculated using the formula given below:

$$\text{Sensitivity} = \frac{\text{True positive}}{\text{All positive}} = \frac{29}{34} = 0.85,$$

$$\text{Specificity} = \frac{\text{True negative}}{\text{All negative}} = \frac{11}{16} = 0.68$$

$$\text{Accuracy} = \frac{(\text{TP} + \text{TN})}{(\text{TP} + \text{FP} + \text{FN} + \text{TN})} = \frac{(29 + 11)}{(29 + 5 + 5 + 11)} = \frac{40}{50} = 0.8$$

Group 2 of 50 patients showed 33 true positive appendectomies and 17 negative appendectomies. The overall sensitivity of Group 2 was 0.66 and the accuracy was 0.66; false positive rate was 0.34 and the positive predictive value was 0.66. A brief comparison of both groups is shown in Table-2.

**Table-2: Comparison of Statistical values of Groups**

Statistical Values	Group 1	Group 2
Sensitivity	0.85	0.66
Accuracy	0.80	0.66
Positive Predictive Value	0.85	0.66
False Positive Rate	0.32	0.34

## DISCUSSION

Acute appendicitis is a common surgical emergency all over the world. Its diagnosis is a real test for the doctor. Different diagnostic techniques are used for its diagnosis. Some prefer the clinical diagnosis while others prefer laboratory and imaging studies. Out of these, TLC, USG abdomen and CT scan abdomen are the best techniques but none of these is ideal because of their merits and demerits. However, use of these multiple diagnostic techniques simultaneously shows better results.

In our study most patients diagnosed of acute appendicitis had age 18–40 years. The second common age group was 10–18 years. These findings were similar to a study by Lewis who found that under 10% of patients were affected in both age gathering of 1–10 years and 50 years or more with male:female proportion of 2.<sup>13</sup>

We performed USG on the patients using low frequency croveline. Acute appendicitis diagnosis was standardized based upon the work of Pulyert, USG imaging protocols.<sup>8</sup> Considering anatomical landmarks, i.e., iliac vessels, psoas muscle and cecum using graded compression technique, appendix was identified in the right iliac fossa. On the basis of USG, 34 patients were identified as a case of acute appendicitis; 5 of these 34 patients showed normal appendices on surgery and histopathology leading 5 results as false positive. Rate of negative appendectomy done on the basis of USG was 15%, much lower than 24% of Group 2 where the diagnosis was totally clinical. The retrocecal appendix contributed to false negative ultrasonography in this study. Retrocecal position and perforation of the appendix are one of the common causes of misdiagnosis in acute appendicitis.<sup>14</sup>

There are various criteria for diagnosing acute appendicitis on the basis of ultrasound but the most important one is the outer diameter. Other criteria of diagnosis include lack of compressibility, inflammatory fat changes, hyperemia in the appendiceal wall and fluid surrounding the inflamed appendix.<sup>8</sup> We did not include these criteria for diagnosis and only focusing on the diameter of 7 mm or more we got the sensitivity value 0.85, the specificity value 0.68, the accuracy value 0.8, positive predictive value (PPV) 85% and the negative predictive value (NPV) 68% which are nearly equal to the values calculated by Parisjani. Values calculated by Parisjani were sensitivity of 0.75, specificity of 0.69, accuracy of 0.74, PPV of 88% and NPV of 46.1%.<sup>15</sup>

In this study NPV was 68% in appendicitis suspicious patients. This may be due to the fact that USG is an operator dependent technique. In situations where USG fails to visualize appendix, laboratory investigations should be done to support the NPV. On the other hand in situations where clinical diagnosis is

not clear and WBC is within normal limits, USG can be used to confirm the diagnosis of acute appendicitis.<sup>16,17</sup>

In special cases like obese patient, where ultrasound has low predictive value, colour Doppler and CT scan are better imaging modalities.<sup>7,18</sup> USG is easily available, cost effective and does not require any special preparation. As it does not require any contrast material and has no risk of radiation hazards, it should be used in cases of appendicitis while in doubtful or unresolved situations CT scan can be used. USG has some limitations like operator dependency, large amount of bowel gas, severe abdominal pain, obese patients and retrocecal or perforated appendix.<sup>14</sup>

Our study clearly showed that for the diagnosis of acute appendicitis USG scan is accurate and specific imaging modality which is inline with other studies.<sup>19–22</sup>

## CONCLUSION

Ultrasonography is an accessible, cost effective and non-interventional tool highly effective to detect and diagnose appendicitis and its complications. Graded compression ultrasound is a preferred technique where outer diameter >6 mm and non-compressibility are the most sensitive findings to make the diagnosis of acute appendicitis. Ultrasonography when combined with clinical diagnosis gives better results and decreased negative appendectomy rate.

## RECOMMENDATIONS

USG scan should be done in all cases and should be done as early as possible where clinical findings of acute appendicitis are equivocal, to avoid complications and negative appendectomies, and skills of radiologists should be improved by refresher training as compression USG scan is very much operator dependent.

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