

## Original Article

## RELIABILITY OF DIAGNOSTIC PERFORMANCE OF ALVARADO SCORE AND ULTRASOUND IN PATIENTS SUSPECTED OF HAVING ACUTE APPENDICITIS

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**Objective:** To evaluate diagnostic reliability of Alvarado score and ultrasound in patients who have suspicion of having acute appendicitis to get to a safe diagnosis without radiation exposure.

**Methods:** This is a retrospective study conducted on 100 patients who presented in emergency with presumed acute appendicitis at Fatima Memorial Hospital from 2016 to 2018. Study design is retrospective cross sectional.

**Results:** Using a cutoff value of  $\geq 5.5$  Alvarado score resulted in sensitivity of 76%, specificity of 93%, accuracy of 84%, PPV 94%, and NPV 73%. US showed a sensitivity of 66%, specificity of 97.6%, accuracy of 79%, PPV 97% and NPV 67%. There was no difference of accuracy between the two modalities. Using both of these modalities can eliminate the use of CT scan.

**Conclusions:** Using Alvarado score as tool of exclusion and US as 1st investigation of choice, a case of acute appendicitis is not only diagnosed correctly but also radiation hazards of CT scan can be eliminated.

**Keywords:** acute appendicitis, ultrasound, alvarado score

### Introduction

Acute appendicitis is acute inflammation of appendix.<sup>1</sup> It is a common acute surgical condition for which mainstay standard treatment is appendectomy.<sup>2</sup> While delay in diagnosis and intervention may lead to serious complications like perforation and abscess or mass formation, rushing to surgery without considering other pathologic conditions can lead to unindicated appendectomy up to 15-30%.<sup>3</sup> Computed abdominal tomography (CAT) is now gold standard tool for diagnosis. It is highly sensitive and specific. While helping surgeons reach a definitive diagnosis of acute appendicitis, radiation exposure remains an Achilles heel for this effective diagnostic modality which can lead to increased incidence of cancer.<sup>4,5</sup> Hence, other diagnostic modalities have also been suggested.

Ultrasound scan is not only cost effective but also has lesser radiation exposure. Its efficacy is marred by operator dependability leading to its low sensitivity. Alvarado score is a clinical scoring system of for diagnosis of acute appendicitis developed by Alvarado<sup>6</sup>. To our knowledge no evaluation has been done or published study yet to compare diagnostic performance of Alvarado score and ultrasound in our set up.

### Methods

It was a retrospective cross sectional study conducted in Surgical Unit-1 Fatima Memorial Hospital Lahore. This study was conducted for 2

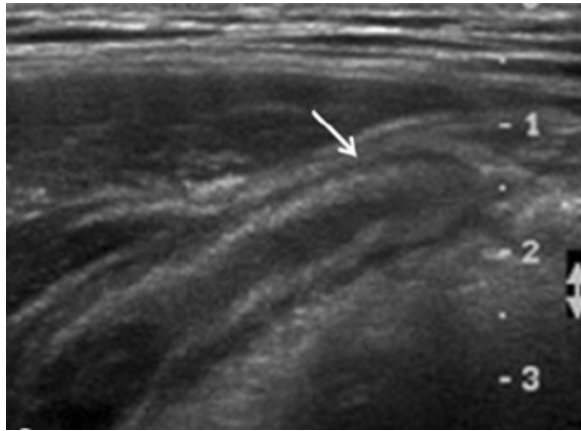
years from January 2016 to December 2018. Sample size calculated was 100 with 95% confidence interval. All patients, both males and females aged above 18 years coming to hospital with acute abdomen suspected of having acute appendicitis were included in the study. Patients aged less than 18 years of age or who had previous appendectomy were the exclusion criteria of the study.

Demographic data was collected from medical records. Alvarado score was calculated for each patient in accordance with original Alvarado score. Alvarado score comprised of the following components:

M= migration of pain to RIF	1
A=anorexia	1
N=nausea and vomiting	1
T=tenderness RIF	2
R=rebound tenderness	1
E=elevated temperature	1
L=leucocytosis	2
S= shift to the left	1
<b>Total</b>	<b>10</b>

All patients in the study had ultrasound scan of the abdomen for diagnosis of appendicitis. All ultrasounds were performed by a single radiologist on Toshiba Xario 100 ultrasound machine using a 3.5-5MHz Curvilinear and 7.5-15 MHz Linear probe. Both transverse and longitudinal images were taken. Following parameters were used for confirmation of diagnosis: Tenderness right iliac fossa (RIF) elicited by transducer, noncompressible appendix, increased

cross sectional diameter of the appendix > 6mm, appendicolith, infiltration of peri-appendiceal fat and free fluid in RIF (**Fig.1**).



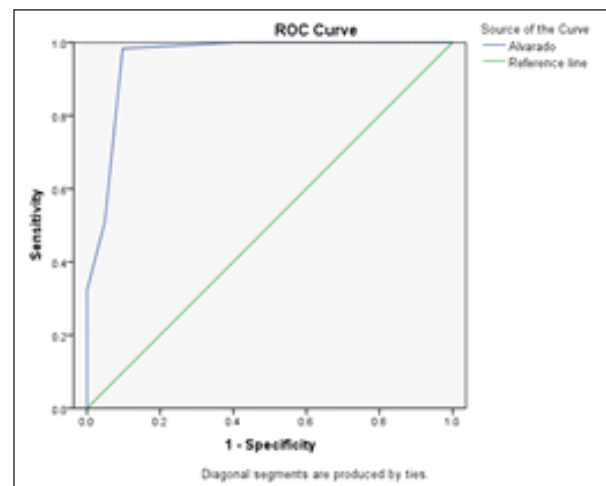
**Fig-1:** showing an inflamed appendix measuring about 8 mm in cross sectional diameter with increased peri appendiceal echogenicity.

All surgeries were done by level 5 expert surgeon. Following operations, all samples were sent to histopathology for confirmed diagnosis. We used SPSS version 21 for data analysis in our study. Regarding continuous variables, descriptive statistics were computed and described as mean ± SD. Categorical variables were stated using frequency distributions. Paired samples were subjected to t-test to report differences in the means of numerical variables and Chi-square test was applied for qualitative variables. P value of <0.05 was taken as significant.

**Results**

Our study included 100 patients out of which 68 were males and 22 were females. Age of the patients range from 20-54 years with a mean age of 33.6±11.2 years. Surgery was performed in 59 patients and samples sent confirmed acute appendicitis on histopathology. A total of 41 patients did not had appendicitis but some other diseases confirmed on ultrasound scan. These patients were treated accordingly without doing an appendectomy. The abdominal ultrasound examination was the first imaging in all patients. True positive patients reported were 39 cases (39%), true negative in 40 cases (40%), False positive 1 case (1%) and false negative 20 cases (20%). Statistically checked, these findings found to be significant (p=0.001) showing great difference of ultrasound findings between appendicitis positive and appendicitis negative groups (**Table-**

**1**). The various ultrasound parameters included in our study were also analysed and all of them were found to be statistically significant as shown in(**Table-2**). Alvarado score in both groups; i.e. appendicitis positive and appendicitis negative group also showed significant difference. True positive patients were found in 45 cases (45%), true negative in 38 cases (38%), false positive in 3 cases (3%) and false negative in 14 cases (14%). When analysed statistically, these findings found to be significant (p=0.001) showing great difference of Alvarado score between appendicitis positive and appendicitis negative groups (**Table- 3**). In our study, the best cut-off point found was ≥5.5 that was predictive of appendicitis. It resulted in sensitivity of 76%, specificity of 93%, accuracy of 83%, positive predictive value of 94% and negative predictive value of 73% (**Fig-4**). When analysed further, Alvarado score was also found to be tool of exclusion; a score ≤ 4.5 has highest sensitivity of 98% while a higher score ≥6.5 resulted in highest specificity of 97.8% (**Table-5**). On comparing the two diagnostic modalities, there is almost no difference in accuracy and specificity of the two modalities (p> 0.001) indicating efficacy of both modalities in diagnosis of acute appendicitis (**Table-4**).



**Fig-2:** Receiver operating characteristic curve for the performance of Alvarado score.

**Table-1:** Comparison between ultrasound report and biopsy proven cases of acute appendicitis

Alvarado Score	Actual Condition		Total
	Appendicitis	No Appendicitis	
Yes (Appendicitis)	39	1	40
No (Appendicitis)	20	40	60
Total	59	41	100

In the end, we suggest initial diagnostic tool should be Alvarado score followed by ultrasound examination. This scheme can eliminate use CT scan in patients with Alvarado score  $\geq 5.5$  and positive ultrasound findings.

**Table-2:** Analysis of ultrasound parameters for statistical significance

Ultrasound Parameters	Appendicitis	No Appendicitis	P-Value
Cross sectional diameter of appendix	6.53 $\pm$ 1.150	3.46 $\pm$ 1.22	0.0001
Transducer induced tenderness RIF	Yes	15	0
	No	44	41
Appendix non compressible	Yes	19	0
	No	40	41
Appendicolith	Yes	12	0
	No	47	41
Peri-appendicular Fat	Yes	21	0
	No	38	41
Fluid RIF	Yes	28	0
	No	31	41

**Table-3:** Comparison between Alvarado score and biopsy proven cases of acute appendicitis.

Alvarado Score	Actual Condition		Total
	Appendicitis	No Appendicitis	
Yes (Appendicitis)	45	3	48
No (Appendicitis)	14	38	52
Total	59	41	100

**Table-4:** Comparison of diagnostic performance of ultrasound and Alvarado score.

	Ultrasound (n=100)	Alvarado score=5.5 (n=100)
Sensitivity	66%	76%
Specificity	97%	93%
Accuracy	79%	83%
Positive predictive value	98%	94%
Negative predictive value	67%	73%

### Discussion

Although CT scan is the investigation of choice for diagnosis of acute appendicitis but radiation exposure and long term risk of cancer remains the pitfall of this scan<sup>4</sup>. These hazards can be dealt with utilization of a clinical score and an US scan if diagnosis is in doubt. In the current study graded compression US was done in all cases and we found a sensitivity of 66%, specificity of 97.6%, accuracy of 79%, PPV 97% and NPV 67%. These findings suggest that acute appendicitis can be diagnosed on basis of a positive ultrasound. Moreover, if an ultrasound is negative, it does not mean that

appendicitis is ruled out and patient can be discharged. Blitman et al also concurred with our these findings<sup>7</sup>. However Pinto et al reported variations in diagnostic accuracy ranging from 44% to 100%<sup>8</sup>. He attributed these variations to lack of operator skills, obesity and increased bowel gas content. We included an expert sonologist in our study to overcome these issues. We found out that there is an increasing trend of doing US scan as 1<sup>st</sup> imaging scan and decrease in CT scan concomitantly<sup>9</sup>. This is due to fact that we trust expertise of our sonologists and US results, although these results are operator dependent. Other reason is that US is cheap and cost effective. We also observed that convincing patient for getting an US scan is easy because of affordability issue. This fact is opposite to some authors as Kotagal et al noted 8 times higher use of CT scan in non-paediatric hospitals.<sup>10</sup> Various scoring systems have been formulated to be used as diagnostic tool in cases of suspected acute appendicitis<sup>11</sup>. Alvarado in his original article reported a cut-off value of 7 for diagnosis<sup>6</sup>. Sun et al reported that use of 6 as cut-off value has higher sensitivity and is more compatible with diagnosis of acute appendicitis<sup>12</sup>. In this study, a cut-off point of  $\geq 5.5$  was found to be best for compatibility with acute appendicitis. This resulted in sensitivity of 76%, specificity of 93%, accuracy of 84%, PPV 94%, and NPV 73%. These findings show that a cut-off value of  $\geq 5.5$  can be confidently labelled as an appendicitis case. By using these two modalities, we found out that we can safely predict possibility of suspected acute appendicitis. Stephen et al stated that neither of the two modalities are significantly advantageous to predict acute appendicitis possibility<sup>13</sup>. This is in contrast to our findings as we not only got satisfactory results for predicting but also nullified the rate of negative appendectomy. Addis et al with Flum & Koepsell cited annual negative appendectomy rate of 15%<sup>14,15</sup>. Our study showed declining trends to nil in negative appendectomy rate using these two diagnostic modalities comprising of ultrasound and Alvarado scoring system.

### Conclusion

Using Alvarado score as tool of exclusion and US as 1<sup>st</sup> investigation of choice, a case of acute appendicitis is not only diagnosed correctly but also radiation hazards of CT scan can be eliminated.

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