Research Article

Reliability of diagnostic performance of Alvarado score and ultrasound in patients suspected of having Acute appendicitis

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ABSTRACT

Background: Acute appendicitis is a surgical emergency and delay in diagnosis can lead to morbidity of the patient. CT despite of being gold standard investigation carry radiation hazards and risk of cancer. **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. **Material & 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:** Retrospective cross sectional. **Results:** Using a cutoff value of ≥5.5 Alvarado score resulted in sensitivityof 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. **Conclusion:** 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.

Key words: Acute appendicitis, Ultrasound, Alvarado score

INTRODUCTION:

Acute appendicitis is acute inflammation of appendix[1]. It is a common acute surgical condition for which mainstay standard treatment is appendectomy[2]. 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 upto 15-30%[3]. 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[4,5]. 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[6]. 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.

Objective: To evaluate diagnostic reliability of Alvarado score and ultrasound abdomen in patients with suspected acute appendicitis to get to a safe diagnosis without radiation exposure.

MATERIAL & Methods

Study design: Retrospective cross sectional study.

Duration: Study was conducted for 2 years from January 2016 to December 2018.

Sample size: 100 patients.

Place: Surgical unit 1 Fatima Memorial Hospital Lahore.

Inclusion criteria:

All patients, both males and females aged above 18 years coming to hospital with acute abdomen suspected of having acute appendicitis.

Exclusion criteria:

Patients aged less than 18 years of age or who had previous appendectomy.

Data collection procedure

All patients fulfilling inclusion criteria were included in 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 components shown in figure 1.

Fig1. Components of Alvarado score.

Characteristics	Score
M = migration of pain to the RLQ	1
A = anorexia	1
N = nausea and vomiting	1
T = tenderness in RLQ	2
R = rebound pain	1
E = elevated temperature	1
L = leukocytosis	2
S = shift of WBC to the left	1
Total	10

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.2).
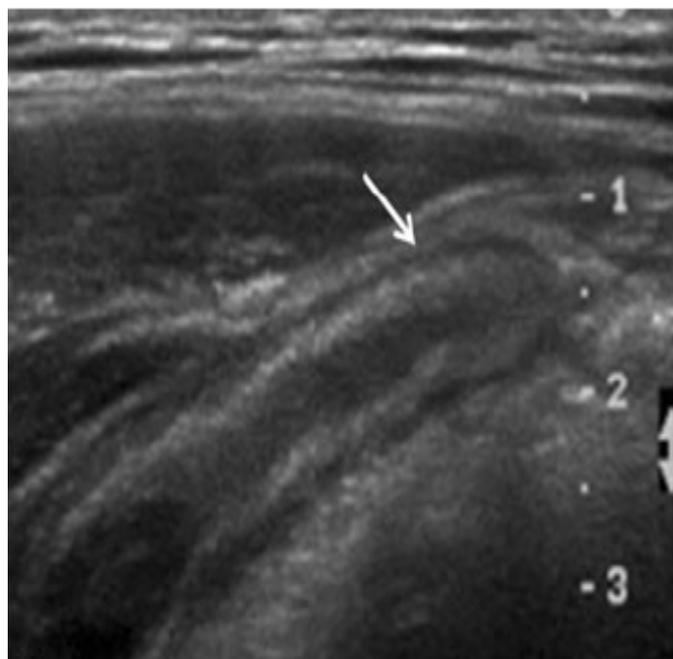

Figure 2: showing an inflamed appendix measuring about 8 mm in cross sectional diameter with increased peri appendiceal echogenicity

All surgeries were done by level 5 expert surgeon. Following operations, all samples were sent to histopathology for confirmed diagnosis.

Statistical analysis

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

A total of 100 patients were included in the study. 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. (Table 1)

**Table 1.** The final diagnosis in the negative appendicitis group (n=41)

Diagnosis	Number of cases
Ovarian cyst	15
Ileocecal tuberculosis	19
Ureteric stone	2
Mesenteric lymphadenitis	5
Total	41

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. No significant difference was found in both groups between the positive and negative appendicitis regarding patient`s gender.The demographic data is summarised in table 2.

Table 2. Demographic characteristics of patients in our study (n=100)

Demographic data		Appendicitis 59(59%)	No appendicitis 41(41%)	P-Value
Age		38.46±11.72	40.68±11.74	0.35
Gender	Male	40	28	
	Female	19	13	1.00

Regarding presenting symptoms, chief symptoms found were pain right iliac fossa (94%), vomiting (34%) and fever (28%) Fig 3.

Fig 3. Prevalent symptoms in the study
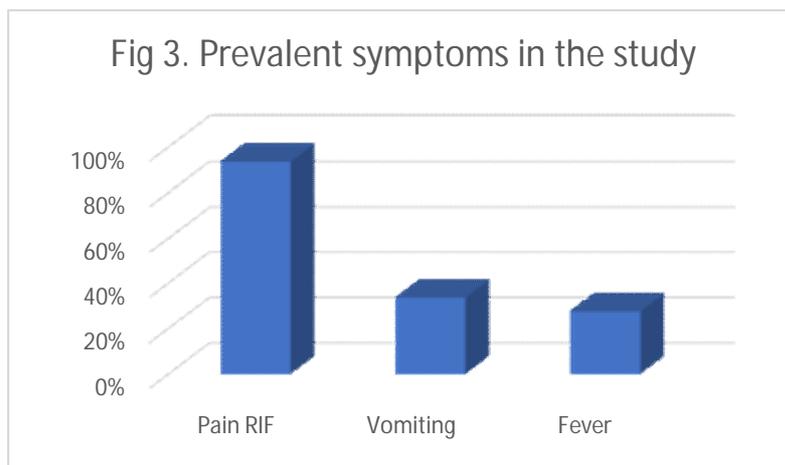
When statistically checked, vomiting was the only symptom found to be statistically significant (p=0.001) (Table 3).

Table 3. Analysis of symptoms of patients in our study (n=100)

Symptoms		Appendicitis	No appendicitis	P-Value
Pain RIF	Yes	55	39	
	No	4	2	1.00
Vomiting	Yes	29	7	
	No	30	34	0.001
Fever	Yes	20	8	
	NO	39	33	0.174

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 4).

Table 4. Comparison between ultrasound report and biopsy proven cases of acute appendicitis

Ultrasound Findings	Actual Condition		Total
	Appendicitis	No appendicitis	
Yes (Appendicitis)	39	1	40
No (No appendicitis)	20	40	60
Total	59	41	100

*P-Value=0.0001

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 4.

Table 4. Analysis of ultrasound parameters for statistical significance

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

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 5).

**Table 5.** 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 (No appendicitis)	14	38	52
Total	59	41	100

*P-Value=0.0001

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% (Figure 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).

Figure 4. Receiver operating characteristic curve for the performance of Alvarado score
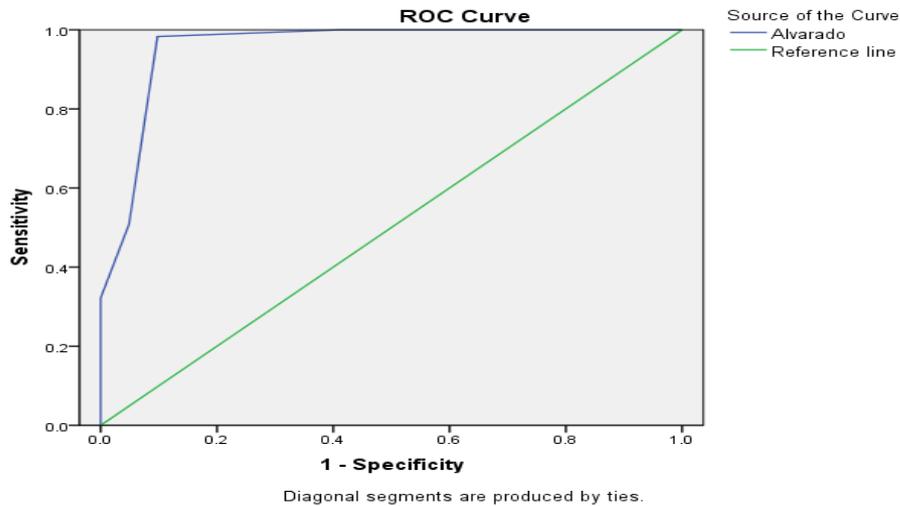
Note: Area under curve (95% confidence interval) = 0.956 (0.912-1.000)

Table 5. Sensitivity and specificity of Alvarado score values of all cases in accordance to final diagnosis

Cutoff value	Sensitivity	Specificity
≤ 4.5	98%	46%
≥5.5	76%	93%
≥6.5	42%	97.8%

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.

	Ultrasound (n=100)	Alvarado score ≥5.5 (n=100)
Sensitivity	66%	76%
Specificity	97.6%	93%
Accuracy	79%	83%
Positive Predictive value	98%	94%
Negative Predictive value	67%	73%

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 ≥5.5 and positive ultrasound findings.

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[4]. 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 suggestthat 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[7]. However Pinto et al reported variations in diagnostic accuracy ranging from 44% to 100%[8]. 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 1st imaging scan and decrease

in CT scan concomitantly[9]. 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[10].

Various scoring systems have been formulated to be used as diagnostic tool in cases of suspected acute appendicitis[11]. Alvarado in his original article reported a cut-off value of 7[6]. Sun et al reported that use of 6 as cut-off value has higher sensitivity and is more compatible with diagnosis of acute appendicitis[12]. In this study, a cut-off point of ≥ 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 ≥ 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[13]. 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%[14,15]. 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 1st investigation of choice, a case of acute appendicitis is not only diagnosed correctly but also radiation hazards of CT scan can be eliminated.

Author contribution

All ultrasounds were done by Dr. Tayyiba Akhter. All surgeries were done by Prof. Asim Malik. Dr. Junaid Khan Lodhi and Dr. Saba Tahir Bokhari collected data and computed the results. Dr. Junaid Khan Lodhi is the principal investigator.

Conflict of interest: No any conflict of interest declared.

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