DIAGNOSTIC ACCURACY OF ALVARADO SCORE IN ACUTE APPENDICITIS IN LOW RESOURCE SETTING

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ABSTRACT

Background: Acute appendicitis is one of the most common causes of acute abdomen in surgical patients. **Objective:** To assess the diagnostic accuracy of the Alvarado score (AS) in determining acute appendicitis. **Methodology**: A total of 180 patients of suspected acute appendicitis were included in this study. Patients of both sexes and age groups 12 years and above were included in the study and their Alvarado scores were calculated. Patients were divided into three groups according to the AS, as AS 1-4, AS 5-6 and AS 7-10. Acute appendicitis (AA) and normal appendix (non AA) rates were compared according to the different parameters. The signs, symptoms, laboratory values, surgical interventions, and pathology reports of each patient were evaluated. Diagnosis was confirmed by histopathological examination. Sensitivity, specificity, positive and negative predictive values and diagnostic accuracy were calculated. SPSS version 16 was used for data analysis. **Results:** This study included 180 patients which comprised of 72 males (40%) and 108 females (60%). 129(76.6%) patients were less than 30 years of age. Acute appendicitis rate diagnosed on histopathology reports, was 20% in patients with Alvarado score 1-4. 35.29% in Alvarado score 5-6 and 96% in Alvarado score 7-10. The negative appendicectomy rate decreased with the increase of AS. The overall diagnostic accuracy of AS in detecting acute appendicitis was 90%. The present study found no significant difference between genders, age and BMI in terms of the reliability of the AS. **Conclusion:** Alvarado scoring system is a useful tool in pre operative diagnosis of acute appendicitis and can work effectively in routine practice especially in resource limited settings.
Key words: Alvarado scoring, Appendicitis, Histopathology.

INTRODUCTION

Acute appendicitis (AA) is the most common cause of acute abdomen.[1] Its incidence is 1.5-1.9/1000 in male and female population respectively.[2] The condition is difficult to diagnose especially during the early stages when the classical signs and symptoms are usually subtle.[1,3] Different disease processes mimic the diagnosis of acute appendicitis as there are a number of causes leading to pain in the right iliac fossa particularly in female patients.[4,5] It has been observed that many patients undergoing appendectomy prove to be negative on histopathology of the surgically removed appendix.[6] Alvarado constructed a 10-point clinical scoring system, also known by the acronym MANTRELS, for the diagnosis of acute appendicitis based on symptoms, signs and diagnostic tests in patients presenting with suspected acute appendicitis.[7] The Alvarado score (AS) enables risk stratification in patients presenting with abdominal pain, linking the probability of appendicitis to recommendations regarding discharge, observation or surgical intervention.[7] Further investigations, such as MRI and computed tomography (CT) scanning, are recommended when probability of appendicitis is in the intermediate range.[8] However, the time lag, high costs and variable availability of imaging procedures mean that the Alvarado score may be a valuable diagnostic aid when appendicitis is suspected to be the underlying cause of an acute abdomen, particularly in low-resource countries, where imaging is not an easily available option. The AS for the diagnosis of AA comprises of many components, Many studies have recommended that patients with AS <4 can be discharged, while those with scores of 5-7 should be followed, and those with scores >7 should undergo surgery.[9,10] A score of 7 or more is strongly predictive of acute appendicitis.[1] Furthermore, the often atypical presentation and delay in seeking medical help have been associated with delay in diagnosis and treatment resulting in high morbidity and mortality rates.[11,12] The prognosis of uncomplicated appendicitis in both young and old age groups is nearly equal. However, perforation worsens the condition dramatically resulting in higher rates of morbidity and mortality.[13-16] This study was planned to determine the diagnostic accuracy of the Alvarado score in detecting acute appendicitis.

METHODOLOGY

This cross sectional study was conducted in the Department of Surgery of Sheikh Zayed Medical College/ Hospital Rahim Yar Khan from 1st January to 31st December 2016 . 180 randomly selected

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consecutive patients admitted in that period with pain in the right lower abdomen were included in this study. Patients of age 12 years and above of either sexes were included in the study. Patients with urological, gynecological or surgical problems other than appendicitis and especially patients with mass in right iliac fossa or those patients with incomplete documentation in the case sheets were excluded from the study. Treatment was planned by the attending surgeon. Patients were divided into three groups according to the AS, as: 1-4 (low risk), 5-6 (moderate risk) and 7-10 (high risk).

Patients having AS more than 6 underwent appendicectomy. This was correlated and analyzed with operative notes and histopathologic examination of the specimen. Negative appendicectomy rate, positive predictive value, negative predictive value, sensitivity and specificity were calculated in order to assess the reliability of Alvarado scoring system. The groups were compared in terms of age ($\leq$30 and >30 years), gender (male/female), BMI ($\leq$25 and >25 and symptom duration ($\leq$24 and >24 hours). Management of patients, as discharged, monitored or operated, was recorded. Patients who underwent surgery were grouped as AA(acute appendicitis) or non-AA (normal appendix). We investigated whether or not the AS was influenced by age, gender, BMI, or symptom duration as well as its diagnostic accuracy in detecting AA. The Statistical Package for the Social Sciences (SPSS) for Windows 16.0 program was used for the statistical analyses of the study data. P value was taken 0.05 as significant.

RESULTS

A total of 180 patients were included in the study, which comprised of 72 male (40.%) and 108 females (60%). Patients were divided into 5 groups as shown in Table III. Mean age was 26.4$\pm$10 years . 44 (24.44%) patients were placed within the 1–4 score range, 58 (32.22%) were categorized as within 5–6 and 78 (43.34%) in score range of 7–10. The sex distribution was 14 (7.78%) males and 30 (16.67%) females within 1–4 range, 30 (16.67%) males and 28 (15.56%) females in the group score range of 5–6, 28 (15.56%) males and 50(27.78%) females in the last group. Distribution of patients according to scoring pattern in both male and females is shown in Table IV.

Table I : Age distribution of patients.

Age group (years)	Frequency	Percentage
13-20	78	43.33%
21-30	51	28.33%
31-40	38	21.11%
41-50	7	3.8%
>51	6	3.43%
Total	180	100%

Table II: Distribution of patients according to alvarado score

Score	Male	%age	female	%age	Total	%age
1-4	14	7.78%	30	16.67%	44	24.44
5-6	30	16.67%	28	15.56%	58	32.22
7-8	28	15.56%	50	27.78%	78	43.34
Total	72		108		180	(100%)

Cut off value for appendicectomy was 6. Further analysis of the data revealed that all the 78 patients (28 male and 50 females) patients categorized in the score range of $\geq$7 underwent appendicectomy. Histopathological examination of the specimens confirmed acute appendicitis in 75 patients. Of the 58 patients with in the score of 5–6, 17 (9.44%) (5 males and 12 females) underwent appendicectomy within 36 hours of admission after reassessment. It was noted that those patients who underwent delayed appendicectomies were either due to increased severity of symptoms and clinical deterioration or on revised computation of the scoring they were categorized as of $\geq$7. In this group there were 11 patients (Male 4 and Female 7) in whom histology showed removed appendix was normal and in 6(35.29%) it was acutely inflamed. 44 patients in the first group within the range of 1–4 score were discharged within 24 hours of admission. 5 patients from this group were readmitted within 24 hours of discharge with complaints of increased severity of symptoms and underwent appendicectomy. They were found to have a score more than >6 on readmission with complaint of persistent pain in right iliac fossa. Histopathology after surgery confirmed acute appendicitis in 1 patient.

On statistical analysis of the collected data, it was found that there were 35 males and 65 females who underwent appendicectomy; appendicitis was confirmed in 29 males and 53 females giving a negative appendicectomy rate of 17.14% in males and 18.46% in females with an overall negative appendicectomy rate of 18%. Operative note findings and histology reports confirmed appendicitis in 82 out of 100 patients undergoing appendicectomy (82%). In males the sensitivity and

specificity were 93.13% and 83.33% where as the positive and negative predictive values were 96.4% and 71.42 %. Females has sensitivity 90.56% and specificity 83.33%, positive predictive value of 96% and where as the negative predictive value was 66.66%. The overall positive predictive value of Alvarado score was 96.15%, negative predictive value of 68.18% and sensitivity and specificity of 91.46% and 83.33% respectively. Diagnostic accuracy was 90 % in predicting acute appendicitis. There was no significant difference between AS and AA diagnosis according to sex as shown in table III.

Table III: Distribution of patients according to gender and Alvarado Score

Score	Gender	Acute Appendicitis	Normal Appendicitis	Total	P-Value
1-4	Male	1 (7.1%)	13 (92.9%)	14 (100%)	0.318
	Female	0	30 (100%)	30 (100%)	
5-6	Male	1 (3.3%)	29 (96.6%)	30 (100%)	0.082
	Female	5 (17.8%)	23 (82.2%)	28 (100%)	
7-10	Male	27 (96.5%)	1 (3.5%)	28 (100%)	0.709
	Female	48 (96%)	2 (4%)	50 (100%)	
Total	Male	29 (40%)	43 (60%)	72 (100%)	0.157
	Female	53 (49%)	55 (51%)	108 (100%)	

There was no significant difference between Alvarado score (AS) and acute appendicitis (AA) diagnosis according to the patient's age as shown in table IV.

Table IV: Distribution of patients according to age and alvarado score

Score	Age group	Acute Appendicitis	Normal Appendicitis	Total	P Value
1-4	≤30	1 (3.1%)	31 (96.9%)	32 (100%)	1
	>30	0 (0%)	12 (100%)	12 (100%)	
5-6	≤30	4 (10.5%)	34 (89.5%)	38 (100%)	1
	>30	2 (10%)	18 (90%)	20 (100%)	
7-10	≤30	58 (98.3%)	1 (1.7%)	59 (100%)	0.430
	>30	18 (94.7%)	1 (5.3%)	19 (100%)	
Total	≤30	63 (48.9%)	66 (51.1%)	129 (100%)	0.252
	>30	20 (39.2%)	31 (60.8%)	51 (100%)	

In the comparison of BMI in the patient groups , there was no significant difference between AS and diagnosis of acute appendicitis.

Table V: Distribution of patients according to BMI and alvarado score

Score	BMI	Acute Appendicitis	Normal Appendicitis	Total	P Value
1-4	≤25	0 (0%)	29 (100%)	29 (100%)	0.341
	>25	1 (6.6%)	14 (93.4%)	15 (100%)	
5-6	≤25	4 (10.3%)	35 (89.7%)	39 (100%)	1
	>25	2 (10.5%)	17 (93.4%)	19 (100%)	
7-10	≤25	66 (95.6%)	3 (4.4%)	69 (100%)	1
	>25	9 (100%)	0 (0%)	9 (100%)	
Total	≤25	70 (51%)	67 (49.9%)	137 (100%)	0.009
	>25	12 (29.9%)	31 (72.1%)	43 (100%)	

There was no difference between groups in the comparison of the diagnosis of appendicitis by the AS according to the variation in symptom duration as more or less than 24 hours.

Table VI: Distribution of patients according to symptoms duration and avarado score

Score	Symptoms	Acute Appendicitis	Normal Appendicitis	Total	P Value
1-4	≤24 hours	1 (4.1%)	23 (95.9%)	24 (100%)	1
	>24 hours	0 (0%)	20 (100%)	20 (100%)	
5-6	≤24hours	2 (7.7%)	24 (92.3%)	26 (100%)	0.68
	>24 hours	4 (12.5%)	28 (87.5%)	32 (100%)	
7-10	≤24hours	29 (96.6%)	1 (3.33%)	30 (100%)	1
	>24 hours	46 (95.8%)	2 (4.2%)	48 (100%)	
Total	≤24 hours	32 (40%)	48 (60%)	80 (100%)	0.228
	>24 hours	50 (50%)	50 (50%)	100 (100%)	

DISCUSSION

Acute appendicitis (AA) is the most common cause of acute abdomen in all age groups. Accurate and prompt diagnosis in those admitted to the emergency room with the preliminary diagnosis of AA remains problematic.[17] Epidemiological studies have shown that appendicitis is more common in the age 10-20 years group. Our study also revealed high incidence in the age <20 years group, in concordance with Limpawattanisiri C et al.[18] Females were more frequently affected than males in our study, similar findings were found in other studies.[2,19]The diagnosis of acute appendicitis still represents one of the most controversial tasks in general surgery, and can humble even the most experienced medical practitioner.[18] This may be due to variable presentations of the disease and lack of a reliable diagnostic test.[20] The Alvarado scoring system is a convenient and inexpensive decision making tool

which helps the surgeons to clinically diagnose a case of suspected acute appendicitis.[21]

Studies in the literature have recommended hospital discharge for patients with AS ≤4.[10,22] In the study of Khan et al,[2] when patients with AS ≤4 were divided into two groups as those discharged after monitoring (emergency room and surgery clinic) and those who underwent surgery, 17 of 100 patients were in the first group, and were discharged. Three of the patients returned within 48 hours and the new AS was calculated as 7. They underwent surgery and AA was detected in (17%). Winn et al,[22] discharged 12 patients (9.8%) and offered no medical follow-up; 4 patients were re-admitted and 2 underwent surgery, but appendicitis was not found. In the present study, 44 patients with AS ≤4 were discharged; 5 of them underwent surgery due to re-admission, and AA was detected in one patient (20%).

Patients with AS ≤4 should be monitored and discharged patients should be informed about abdominal pain and asked to revisit to the hospital if their pain increases. If a patient is coming from a remote distance, patients with AS ≤4 should be hospitalized and monitored, and their AS should be calculated regularly. With regard to the patients with AS 5-6, 17 patients underwent surgery after observation. In 6 patients (35.30%) acute appendicitis was diagnosed who underwent surgery after observation and negative appendicectomy rate was 64.70 %. This is in concordance with Shah et al,[23] who reported 71.4%versus 11.1% negative appendectomy rates was Groups(A alvarado<6 and B alvarado>/7. With regard to the patients with AS 7-10, AA was detected in 96% (75) and negative appendicectomy rate was 4%. This is in accordance with Shah et al,[23] who reported 11.1% negative appendectomy rates in Groups B alvarado ≥7. The results were consistent with the literature.[24,27] In our study, negative appendectomy rates were found as 80% for AS ≤4, 64.71% for AS 5-6 and 4% for AS 7-10, respectively. This signifies that for high Alvarado scores the chances of having false positive cases are reduced, implying the need for further evaluation and observation in the <6 score group. [24] When cross-tabulated, there were 75 true positive cases, 3 false positive cases, 7 false negative cases and 15 true negative cases. It yielded 91.46% sensitivity, 83.33% specificity, 96.15% positive predictive value, 68.18% negative predictive value and 90%

daignostic accuracy for Alvarado score in predicting acute appendicitis taking histopathology as gold standard. Our results match with those of Kanumba et al, in 2011 who observed the sensitivity, specificity, positive predictive, negative predictive values and accuracy of Alvarado score to be 94.1%, 90.4%, 95.2%, 88.4% and 92.9% respectively.[25] The results of the present study are also comparable with a number of other studies apart from Jalil et al,[26] in 2011 (SN=66%, SP=81%) (26) and Memon et al,[27] in 2009 (SN=58.2%, SP=88.9%) who observed quite lower sensitivity and specificity of Alvarado Score. This variation can be due to difference in surgeon's ability to properly perform and interpret the Alvarado score. When stratified, sensitivity of Alvarado score was higher in males; male vs female (93.43% vs. 90.56%) our observation is in line with that of Jalil et al[26] in 2011 ((97% vs. 92%)(26), Talukder et al,[28] in 2009 (93% vs. 84%) and Kanumba et al,[25] in 2011 (95.8% vs. 88.3%),(25) who also observed similar difference in the sensitivity of Alvarado score between male and female patient.

The present study evaluated the efficacy of AS (≤4, 5-6,7-10) according to age, gender and BMI. The present study found no significant difference between genders, age and BMI in terms of the reliability of the AS.

CONCLUSION

Alvarado scoring system is useful tool in pre operative diagnosis of acute appendicitis and can work effectively in routine practice. Scores more than 6 definitely warrant a virtual confirmed diagnosis of acute appendicitis and early operation is indicated to avoid complications like perforation. Patients with in the score range of 5–6 require admission and need re-evaluation for possible deterioration of clinical condition and earliest possible intervention.

Conflict of interest
There is no conflict of interest among all authors.

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