

Diagnostic accuracy of modified Alvarado score in the prediction of acute appendicitis

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Abstract

Objective: To evaluate diagnostic accuracy of the Modified Alvarado Scoring to predict acute appendicitis among patients admitted in a tertiary care hospital.

Design: Cross sectional study.

Setting and Duration: Surgical Unit-I of the Sandeman Provincial Teaching Hospital Quetta from 1st July 2012 to 31st December 2012.

Methodology: A sample of 160 patients was collected by non- probability purposive sampling technique. Patients presenting with right iliac fossa Pain admitted in emergency department of a tertiary care hospital were clinically evaluated for need of surgery. They were assessed by a senior consultant of the surgical department. Modified Alvarado Score was recorded but its result was not disclosed to effect the decision of Surgery. After appendicectomy the appendix was sent for histopathology which was taken as gold standard. The results of histopathology and Alvarado Scoring were compared to assess the diagnostic accuracy of the Modified Alvarado Score. The data was compiled and analyzed by SPSS. 16

Results: The calculated sensitivity and specificity of Modified Alvarado Scoring with cut-off value of 7 in our study was 53.8% and 50% respectively. The positive predicted value and negative predictive value of Modified Alvarado Scoring with cut-off value of 7 was 97.6% and 2.7% respectively. The percentage of false positivity (FP) according to the formula was 50% and that of false negativity (FN) was 46.16%. Hence the accuracy of Modified Alvarado Scoring according to the formula was 53.7%.

Conclusion: Modified Alvarado Scoring is less reliable in the diagnosis of Acute Appendicitis.

Keywords: Acute Appendicitis, Modified Alvarado Score, Appendicectomy

Introduction:

Acute Appendicitis is the most common cause of acute abdominal pain and appendicectomy is the most frequently performed emergency surgery in the world¹, with life time occurrence of 7%. The peak incidence occurs between 10-30 years of age and no age is exempted. A male to female ratio is 1.4:1 with overall lifetime risk is 8.3% and 6.7% respectively in the USA. Approximately 280,000 appendicectomies are performed in the USA every year and more than 40,000 cases of appendicitis are admitted to hospitals in England per year.² Approximately 6% of the population will suffer from acute appendicitis during their life time.³

Although acute appendicitis has been recognized as a clinical entity for 100 years, the differential diagnosis between Acute appendicitis and non specific abdominal pain may be still challenging. The clinical presentation of acute appendicitis is mid abdominal pain or right lower abdominal pain that progressively worsens. Classically, early diagnosis and prompt operative intervention is the key for successful management of acute appendicitis⁴. There are similarities in the clinical presentation, so that many appendicectomies are performed for non appendiceal pathologies, so-called unnecessary or negative appendicectomies, especially in young women.⁵

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Traditionally, the most effective way to decrease rate of perforation is to have a lower threshold for operating at the expense of increasing negative appendectomy rate⁶. From the beginning of abdominal complaints to admission in a hospital, delays of a few hour to a few days may occur. Furthermore, in infants with a typical clinical progression, establishing a diagnosis is much more difficult, leading to perforation and unnecessarily high negative appendectomy rates. Accurate and prompt diagnosis reduces the risk of perforation and negative appendectomy rate⁷.

Although acute appendicitis mortality is low, morbidity remains high. Immediate appendectomy has long been recommended treatment of appendicitis because of the known risk of progression to perforation. Rate of appendiceal perforation increases from less than 2% when appendectomy is performed within 36 hours of symptom onset to 5% after this time period⁸.

Diagnosis of acute appendicitis is established primarily on patient's history and physical examination supported by laboratory and imaging examination. Delay in diagnosis and treatment is by far the main cause of appendiceal perforation⁹. Appendiceal perforation increases 10 times the rate of postoperative complications.^{10,11}

Appendicitis is now not generally thought to be an interesting subject for research, but it remains an important disease. It is important because it is a common surgical emergency. There is no medical treatment for it and timely surgery is mandatory to prevent morbidity and mortality, which is about 2% associated with perforation.¹² Early diagnosis of Acute appendicitis is important for reducing morbidity rates. Acute appendicitis remains a difficult diagnosis. Despite many advances in diagnostic system, Acute appendicitis is still a diagnostic dilemma at times.¹³

An accurate diagnosis can only be obtained at surgery and after histopathological examination of surgical specimen.¹⁴ Accurate identification of patients who require immediate surgery as opposed to those who will benefit from active

observation is not always easy.¹⁵ Several authors have created diagnostic scoring systems in which a finite number of clinical variables are elicited from the patients and every one is given a numerical value. The sum of these values has been used to predict the likelihood of Acute appendicitis. Clinical scoring systems for adults have been developed to increase the diagnostic accuracy and decrease the unnecessary appendectomy rate. Some developers of the diagnostic scores have suggested a decrease of unnecessary appendectomy rate of up to 50%.¹⁶

In case of acute appendicitis, it is important to obtain an early correct diagnosis before complication occur. Another important issue is decreasing the negative appendectomy rate (the prevalence of normal appendixes should be reduced without increasing the perforation rate)¹⁷.

Various scoring system such as Madan score, Ohmann score, Eskelinen score, DeDombal score and Alvarado score has been devised to aid diagnosis of acute appendicitis.¹⁸

All the previous studies on determining sensitivity and specificity of Modified Alvarado Score has a common flaw that they operated only those patients with score of 7 or above, and patients having lower scores were kept under observation and discharged home without follow up. So the calculated sensitivity and specificity of Modified Alvarado Score in those studies cannot be reliable. This has led us to conduct a study to determine the diagnostic accuracy of Modified Alvarado Score in the prediction of acute appendicitis by operating all those patients with strong clinical suspicion of acute appendicitis regardless of their Modified Alvarado Score considering histopathology as gold standard and then calculate sensitivity and specificity of Modified Alvarado Score.

The aim was to found the reliability of Modified Alvarado Score which can be than used for the diagnosis of acute appendicitis or if converse is true then surgeon must evaluate each patient individually and operate only those patients with strong clinical suspicion for acute appendicitis.

Material and Methods:

A cross sectional study was conducted for 6 months from 1st of July 2012 to 31st December 2012 in the Surgical Unit-I of the Sandeman Provincial Teaching Hospital Quetta which provides all necessary requirements for diagnosis and treatment of surgical patients.

A sample of 160 patients was collected by Non probability purposive sampling technique.

The inclusion criteria was all patients age above 12 years; both male and female patients; patients with acute abdominal pain suspicious of acute appendicitis.

The exclusion criterion was palpable mass in right iliac fossa.

Patients included in the study were explained about their illness and nature of study. Detailed history was taken. In history, special attention paid to symptoms included in Modified Alvarado Score as shown in Figure 1.

The patients were properly examined giving privacy especially to female patients. In general physical examination, temperature was especially recorded as required for Modified Alvarado Score. Clinical mercury thermometer was used in all cases to measure the temperature. Oral sub lingual temperature was taken when patient was in bed for 30 minutes to vanish the effect of dry hot weather of Quetta during July and August. Temperature 100.4°F or above were considered as raised. In general physical examination and tongue was examined for coating. In systemic

examination, respiratory, central nervous system, peripheral nervous system and cardiovascular system were examined to exclude infection and any other disease as differential diagnosis of acute appendicitis.

Abdomen was systematically examined. Inspection, percussion, palpation and auscultation were done. In palpation, mass Right Iliac Fossa (RIF) is especially looked for and if found, patients were excluded from study. On palpation, tender RIF, rigidity and rebound tenderness were noted as they were also required for Modified Alvarado Score. In extra signs, Roving's sign, Copes Psoas test, The obturator test. Cough sign and rectal tenderness was also seen.

Routine investigations were sent to hospital laboratory; for total leukocyte count (TLC) a technician was requested to do the count carefully as it is required for Modified Alvarado Score. A proforma (Figure 2) was attached to the history sheet. It includes the preliminary information such as name, sex, age, address and hospital registration number, and Modified Alvarado Score of each patient was recorded in proforma very carefully.

The patient as per departmental protocol was re-evaluated by senior registrar or consultant. The final decision to operate was made by them on their clinical judgment alone. The preoperative score was not intimated to them and thus played no part in their decision. The proposed plan of the treatment of the acute appendicitis according to Modified Alvarado Score is shown in Figure 3. Our study included the range of score from 9 to 4.

After appendicectomy, all specimens were sent for histopathology and reporting was done from histopathology lab of Sandeman Provincial Hospital Quetta. Histopathological criteria for inflamed appendix were polymorphonuclear infiltration of muscle layer or crypts abscess or mucosal ulceration. The histopathology report of all specimens dispatched were followed through the case number and recorded on proforma. The data was analyzed by SPSS version 16.0. Mean

Figure 1: Modified Alvarado scoring system (MASS)

Symptoms	Score
Migratory right iliac fossa pain	1
Nausea/Vomiting	1
Anorexia	1
Signs	
Tenderness in right iliac fossa	2
Rebound tenderness in right iliac fossa	1
Elevated temperature	1
Laboratory findings	
Leukocytosis	2
Total score	9

Figure 2: Proforma - Diagnostic accuracy of modified Alvarado score in the prediction of acute appendicitis

Name:	Age:	
Sex:	Address:	
Hospital registration number:		
MODIFIED ALVARADO SCORE		
History And Clinical Examination		
SYMPTOMS: ALLOCATED SCORE PATIENT SCORE		
Migratory Right Iliac fossa Pain	1	
Nausea/Vomiting:	1	
Anorexia:	1	
SIGNS:		
Tenderness Right Lower Quadrant:	2	
Rebound Tenderness RIF:	1	
Pyrexia > 37.5° C:	1	
LABORATORY TEST:		
Leukocyte count > 10x10 ⁹ /L:	2	
Total Modified Alvarado Score:	9	Patient's Score:
Conclusion:		
Acute Appendicitis:	Present	Absent
SURGERY:		
On Histopathology		
Acute Appendicitis:	Present	Absent

age with the standard deviation, male to female ratio, sensitivity, specificity, positive predictive value (PPV) , negative predictive value (NPV), true positive(TP), false positive(FP) and accuracy were determined by taking histopathology as gold standard.

Results:

Total number of 160 patients was included in our study. It was seen that female outnumbered males, with 85(53.1%) females and 75(46.9%) male. The female to male ratio is 1.13:1. The majority of the patients were between the ages of 20-40 years. The mean age was 20.9 with standard deviation 6.37. Total score of all parameters included was 9. Range of score in our study was from 9-4. Tenderness right iliac fossa was

the commonest sign present in all 160 patients (100%). This was followed by rebound tenderness 154(96.2%). complains of anorexia was reported by 43(89.3%) patients indicating that it is the most important symptom in patients with acute appendicitis. This was followed by nausea/vomiting among 132(82.5%), raised TLC in 94(58.7%) patients. Migrating pain was present in 72(45%) patients and only 43(26.8%) had raised temperature.

All the patients in our study underwent appendicectomy on the basis of clinical judgment, and their appendices sent for Histopathological examination, which is taken as gold standard. The patients with Modified Alvarado Score 9, 8 and 7 were 86. Out of these 86 only 02 patients with Modified Alvarado Score 7 had normal appendix on histopathology, remaining 84 had acutely inflamed appendix, making 84 cases as True Positive (TP) and only 2 cases were labeled as False Positive (FP) as shown in Table-1 and 2. Patients with the Modified Alvarado Score 6, 5 and 4 who make a total of 74 patients were operated, of which 72 patients had inflamed appendix on Histopathological examination. Patients with score 6 were 02 and they had normal appendix on histopathology thus 72 patients with inflamed appendix are labeled False Negative (FN) and 2 patients whose appendices were normal are labeled True Negative (TN) as shown in table- 1 and 2. Out of 160 patients, 156(97.5%) had histopathological proven inflamed appendix. There were only 4(2.5%) patients only who had normal appendix.

There were total 86 patients who had a high score of 9, 8 and 7, of which 11 patients had Modified Alvarado Score 9 while 31 patients fell in the score 8 and 44 patients had Modified Alvarado Score 7. There were 2 patients only with score 7 having normal appendix were as patients with under Modified Alvarado Score 6, 5 and 4 were 74. In score 6, total 32 patients were operated. Out of which, 30 patients had inflamed appendix and only 2 had normal appendix. At score 5, total 30 and at score 4, total 12 patients underwent appendicectomy. Histopathology revealed that all these patients had inflamed ap-

Figure 3: Proposed management plan for patients with suspected acute appendicitis

Initial Score	Disposal of the Patient
0-3	Unlikely to have acute appendicitis. Admit and observe. Discharge if condition resolves. Continue to observe if score does not increase.
4-6	Admit and review after 12 hours. If no improvement in the score or score >6, perform appendicectomy.
7-9	Acute Appendicitis. Proceed to appendicectomy.

Table 1: Frequency distribution table of scores correlated with histopathology results of all patients

Scores	MAS 4	MAS 5	MAS 6	MAS 7	MAS 8	MAS 9	Total Patients
Number of Patients (%Age)	12 (7.5%)	30 (18.7%)	32 (20%)	44 (27.5%)	31 (19.3%)	11 (6.8%)	160
Positive Histopathology	12	30	30	42	31	11	156
Negative Histopathology	0	0	2	2	0	0	4

pendix as shown in table-1

The calculated sensitivity and specificity of Modified Alvarado Score with cut-off value of 7 in our study is 53.8% and 50% respectively as shown in table no-2. The PPV and NPV of Modified Alvarado Score with cut-off value of 7 is 97.6% and 2.7% respectively as indicative in table no-2. The percentage of FP according to the formula is 50% and that of FN is 46.16%. Hence the accuracy of Modified Alvarado Score according to the formula is 53.7%.

Discussion:

The time period of our study was 6 months. During these 6 months we collected the data of 160 patients and in our study the female preponderance was seen. It was seen that 85(53.1%) were females and 75(46.9%) were male which is in agreement with other studies¹⁴. Studies in Kenya, Ethiopia and Nigeria found a male dominance¹⁹. The reason for the difference in sex distribution in these studies may be attributed to the fact that female patients with RIF pain have a wide range of Differential diagnosis as a result, Acute appendicitis may be over diagnosed in this gender group. We also noted that the age distribution in our study was similar to other studies¹⁹. Mean age in our study was 20.93 with the standard deviation of 6.37.

In our study, the strongest clinical feature for appendicitis was tenderness in the RIF present in all 160 patients, rebound tenderness found in 157 patients and anorexia which is the 3rd important finding in 143 out of total 160 patients.

Raised TLC was found in 95 patients. It is in line with the study performed by Lameris et al. that the strongest clinical features were tenderness in the RLQ, rigidity, migration to RLQ and inflammatory laboratory parameters²⁰.

In our study the calculated sensitivity and specificity of Modified Alvarado Score with cut-off value of 7 is low, i.e. 53.8% and 50% respectively. The PPV and NPV of Modified Alvarado Score with cut-off value of 7 is 97.6% and 2.7% respectively. The percentage of FP according to the formula is 50% and that of FN is 46.16%. Hence the accuracy of Modified Alvarado Score according to the formula is 53.7%. In a study performed at surgical unit of Govt. Medical College, Jammu, 74 patients were operated. The negative appendectomy rate was 16.12%. PPV of Alvarado scoring system in that study was 83.79%²¹.

Khan et al.¹⁴ applied the Alvarado scoring system in an Asian population and only achieved a sensitivity and specificity of 59% and 23% respectively, with a negative appendectomy rate of 15.6%. Another study by Al Hashemy et al.²² using the modified Alvarado score system in a Middle Eastern population reported a similarly low sensitivity of 53.8% and specificity of 80%.

The sensitivity of the Alvarado score achieved when applied in an oriental population, at the suggested cut-off threshold of 7, was similarly low at 50.6%, but achieved a high specificity of 94.5%. However this is improved when the cut-off threshold was lowered at 6, with a sensitivity and specificity of 88.3% and 94.5% respectively²³.

In a study conducted by Khan et al.¹⁴ revealed that Alvarado scoring system is more helpful in male patients by showing lower negative appendectomy rate and high positive predictive value for male patients as compared to females.

Table 2: TP, TN, FP, FN (Histopathology gold standard)

MSA	Positive Histopathology	Negative Histopathology	Total
MSA 7, 8 and 9	TP (84)	FP (2)	86
MSA 4, 5 and 6	FN (72)	TN (2)	74
Total	156	04	160

In females, additional investigations may be required to confirm the diagnosis. Literatures also support this observation.

Both Alvarado and modified Alvarado scores lack parameters that have been shown to be important determinants in the diagnosis of acute appendicitis, such as age, gender and the duration of symptoms. Wani et al.²⁴ have shown that the sensitivity and specificity of the Alvarado scoring system vary with age, gender and the duration of symptoms.

Therefore Alvarado score cannot be Reliably trusted for the diagnosis of acute appendicitis and close accurate clinical judgment is required for diagnosis of Acute appendicitis.

Conclusion:

We concluded that Modified Alvarado Score is less reliable in the diagnosis of the Acute appendicitis. At the cutoff values of 7 the diagnostic accuracy is just 53 % which can be improved if score is lowered.

Suggestions:

1. Patients with abdominal pain should be evaluated carefully by thorough clinical examination. Modified Alvarado Score do not take into account certain subtle but sometimes relevant and important clinical findings that only a knowledgeable clinician can discern.
2. Further research is required for development of new scoring system in our region for diagnosis of Acute appendicitis.

Limitations:

The data collected was from 160 patients only which is less to establish a firm and reliable decision for not using this old scoring system.

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