

## Evaluation of Sensitivity And Specificity of Alvarado score In Adults With Acute Appendicitis : A Pilot Study

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### Abstract

Appendicitis is defined as inflammation of the appendix, it is one of the most commonest presentations of gastrointestinal tract in younger age group. Although the incidence can be identified in adulthood. It is clinically identified by presentations such as fever, lower abdominal pain, nausea, and vomiting. These are considered as clinical triads of diagnosing appendicitis. Till date the exact cause for the occurrence of the disease is not specified and it is believed due to the obstruction of lumen of the appendix by fecal material adds to the pathology. Among various treatment modalities, administration of broad spectrum antibiotics, non-steroidal, anti-inflammatory drugs as well as antipyretics are used affectively in management but surgical excision of appendix is the standard procedure as it is a vestigial organ. Hence the current study will be oriented towards specifying the causative factor as well as to identify better line of management of appendicitis. In this study sensitivity of Alvarado score was 0.36. However the specificity of the test was excellent. Positive predictive value (PPV) of Alvarado score was 1. But negative predictive value (NPV) of the score was 0.61. ROC curve on the left side of the diagonal line area under curve 0.880 was obtained. It is suggestive that Alvarado score is good marker to predict appendicitis. However, the sensitivity and specificity obtained in the graph are matching with that obtained by calculation accordingly Alvarado score > 7 can be specific but may not be a sensitive marker for appendicitis. Alvarado score can be a good tool to diagnose acute appendicitis as it has an acceptable AUC (0.880). The score also has a good specificity and positive predictive value. It may be an additional diagnostic tool which is at par with other diagnostic tools, cost effective as well.

**Keywords:** Alvarado score, appendicitis, diagnostic approach

## Introduction

Appendicitis is one of the commonest presentation of gastrointestinal tract in younger age group, although the incidence can be identified in adulthood. It is clinically identified by presentations such as fever, lower quadrant pain, nausea and vomiting. These are considered as clinical triads of diagnosing appendicitis. Symptoms of appendicitis overlap with a number of other conditions making diagnosis a challenge, particularly at an early stage of presentation. Till date the exact cause for the occurrence of this disease is not specified and it is believed that due to the obstruction of the lumen of the appendix by fecal material adds to the pathology. Among various treatment modalities, administration of broad spectrum antibiotics, non-steroidal anti-inflammatory drugs as well as antipyretics are used effectively in the management of appendicitis, but surgical excision of appendix is the standard procedure as it is a vestigial organ. The current study will be oriented towards identifying the better diagnostic approach for acute appendicitis so as to minimize false appendectomy rates.

Prevalence of appendicitis in India

India, being the second largest populated country with nearly 60% of the population fall under the category of younger age group. Incidentally occurrence of this vulnerable disease is also common in younger age group.

### Rationale of the study:

Acute appendicitis is the most common abdominal emergency requiring emergency surgery. However, the diagnosis is often challenging and the decision to operate, observe or further work-up a patient is often unclear. The utility of clinical scoring systems, laboratory markers and the development of novel markers in the diagnosis of appendicitis remains inconclusive. So, this study may reflect on the effectiveness of Alvarado score in diagnosing acute appendicitis.

## Review of literature:

Acute appendicitis is the most common surgical condition presented in emergency departments worldwide [1]. It is one of the most common abdominal pain requiring immediate surgical attention. The diagnosis of acute appendicitis remains an on-going challenge for most surgeons, because acute appendicitis presents with atypical

symptoms in 50% of the cases[1]. The diagnosis for acute appendectomy is based on patient's medical history, symptoms and laboratory investigations. A negative appendectomy rate of 20%–30% has been previously accepted worldwide[2]. Clinical scoring system like Alvarado score is useful in some surgical conditions. In the past few years different scoring systems have been developed to help the diagnosis of acute appendicitis [3]. Although,

many scoring systems have been advocated but most are sophisticated and hard to implement in the real clinical situation [3]. Alvarado scoring system on the other hand is simple that can be used easily in emergency medicine [4].

### Alvarado scoring system

The Alvarado score is a clinical scoring system used to stratify the risk of appendicitis in patients presenting with abdominal pain. Alvarado's original work was published in 1988 and is based on his retrospective data analysis of 305 patients presenting with abdominal pain suggestive of acute appendicitis. This study found eight predictive factors of diagnostic value in acute appendicitis and assigned each factor a value of 1 or 2 based on their diagnostic weight. Alvarado scoring system is shown in fig 1.

A score of 1 was given for each of the following: elevated temperature  $>37.3^{\circ}\text{C}$ , rebound tenderness, migration of pain to right lower quadrant (RLQ), anorexia,

nausea or vomiting, and leukocyte left shift. A score of 2 was given for RLQ tenderness and leukocytosis >10 000. The likelihood of appendicitis and specific management recommendations are given based on the total score. A score of 5 or 6 is “compatible” with the diagnosis of acute appendicitis and recommends the clinician observe or serially examine the patient. A score of 7 or 8 is “probable” appendicitis and a score of 9 or 10 is “very probable” appendicitis and recommends surgical intervention[5]

Ironically, the results in subsequent validation studies of the Alvarado score largely outperform the original study’s findings and provide the major support for consideration of the rule in clinical practice. In a meta-analysis by Ohle et al. conducted in 2011, a review of 29 studies including 5,960 subjects revealed that for a cutoff of 5 (criteria to observe/ admit) there was a sensitivity of 99% (95% CI: 97-99%) and specificity of 43% (36-51%)[6]. At a cutoff of 7 (criteria to proceed directly to surgery) sensitivity was 82% (76-86%) and specificity was 81% (76-85%). Based on these results, the authors argue that using a cutoff score of 5 or lower provides a good “ruling out” score, while a cutoff of 7 is not sufficiently specific enough to provide an adequate “ruling in” score[6].

However, several other smaller studies did not find such a high sensitivity. A 2007 retrospective study of 150 patients aged 7 and older who presented to the ED with abdominal pain found that 5% of patients with a score of 3 or less had appendicitis, as did 36% of patients with a score between 4-6[7]. Similarly, in a retrospective study of 215 adults and children who presented with acute abdominal pain, Gwynn et al found that 8.4% (12 of 143) of subjects with appendicitis had an Alvarado score below 5[8]. Another retrospective study of 156 children found that 9% of subjects with complicated

appendicitis would have been overlooked with the use of the Alvarado score[9].

Application of the Alvarado score in women over-predicts the probability of appendicitis across all strata of risk and should be used with caution. The validity of the Alvarado score in children was inconclusive; the calibration analysis showed high levels of heterogeneity across all risk strata. Further validation studies are required before clinical implementation of the Alvarado score for this age group could be recommended. The Alvarado score may be found useful in low-resource settings where advanced diagnostic techniques is limited .

#### **Hypothesis :**

We hypothesize, that the Alvarado score can be a sensitive and specific score to differentiate appendicitis from the other causes of abdominal pain.

#### **Aims and Objectives:**

1. To compare the Alvarado scores of patients with acute appendicitis and those with abdominal pain due to other causes
2. To evaluate the sensitivity, specificity, positive predictive value and negative predictive values of Alvarado scores
3. **Methodology:**
4. **Study Design**
5. **Type of study:** case-control
6. **Study setting:** Dept. of surgery, KS Hegde Medical Academy, Mangalore
7. **Study Population:**
8. **Cases:** Thirty subjects with acute appendicitis diagnosed by clinical evaluation
9. **Exclusion Criteria** for both cases and controls : acute and chronic infections, inflammatory disorders, pregnancy
10. **Controls:** Thirty age and gender matched patients with abdominal pain due to some other cause other than appendicitis
11. Institutional Ethics Committee approval

will be sought before starting the study. Informed consent will be obtained from the subjects.

12. **Clinical data Collection** : Subjects fulfilling the inclusion criteria will be recruited in the study. Patients who are admitted in the department of surgery will be evaluated. Patient details such as age, gender, socio-economic status and clinical details like symptoms, signs and laboratory investigations will be entered in the proforma. Alvarado score will be evaluated as per the criteria as per the table 1.

13. **Study Period:**

**Statistical Analysis:**

The data was analyzed using the graph pad software .The entered data was verified and checked for data errors during coding and data entry. Comparison of Alvarado scores between the groups were carried out using Mann Whitney U test. Sensitivity, specificity, positive predictive value and negative predictive values were calculated using the following formula:

$$\text{Sensitivity} = \frac{a}{a+c}$$

$$\text{specificity} = \frac{d}{b+d}$$

Table 1: 2x2 Contingency table for cases & control:

Alvarado score	Appendicitis positive(cases)	Appendicitis negative(controls)
>7	11(a)	0(b)
<7	19(c)	30(d)

ROC curve was constructed, to assess whether Alvarado score can be a good predictor for appendicitis.

**Discussion:**

Alvarado score in acute appendicitis cases was higher than controls. It is also noted in the study that AS has a good specificity (value of 1) & PPV. However

the drawback of the AS was the low sensitivity and negative predictive value.

In many studies Alvarado score was useful in predicting the appendicitis but there was no sufficient positive predictive value (10,11,12). In our study Alvarado score was useful in predicting appendicitis and the positive predictive value is found to be 1.

In a study done by wilasrusmee et al the rebound pain was the most common sign which was 76.9% and the right lower quadrant tenderness was 61.5%. eight signs of Alvarado score had a sequence co-efficient of 1.0 which is a good indicator(13).

In a study by Frountzas et al found that Alvarado score (77%) was more specific than RIPASA score (55%)(14).

In a study by Hosseiny et al in 36 female and 20 male patients the Alvarado score gave the sensitivity and specificity as 65 .2% and 100%. In the same study the PPV and NPV were 100 % and 33% this study concluded that the negative appendectomy rate was 0% for the Alvarado score thus proving that Alvarado score is more specific and can avoid negative appendectomy rate(15).

Goel et al concluded that Alvarado score was more specific and can reduce unnecessary admissions .the area under the curve for the Alvarado score was slightly higher than the RIPASA score(0.926 vs 0.914)(16).

In the comparative prospective study done by singla et al the Alvarado score and RIPASA score were equally good in predicting the appendicitis .the sensitivity for Alvarado score was 64.4% and specificity was 100%. In this study singla et al observed that PPV(Precision value) of Alvarado score was 100% and that of RIPASA score was 70.7%.(17).

The sensitivity of Alvarado score was found to be 78.41% which indicated that the specificity of Alvarado score was 100% in a study done by Karami et al. He also observed that PPV was 100% for Alvarado score the AUC of ROC was 0.906 for the Alvarado score.(18).

Erdem et al in a study found that Alvarado score had a sensitivity of 82% and had a specificity of 75% as compared to other scoring systems. In the same study the positive predictive value was 88%.(19).

In a retrospective study by xingyie et al in 179 patients in a age group between 13 to 87 years , a sensitivity of Alvarado score was up to 92.7 %. For score>8 alvarado score gave a sensitivity of 33.3 % and the specificity of 97.96% as compared with AIR score.(20)

Alvarado score is confirmed in many studies worldwide as it is able to generate a low negative appendectomy (21)

In a pediatric study by Menon et al found a negative appendectomy rate of 1.8% when using an Alvarado score of 7 points or more(21).

In a study by Ricci et al the Alvarado score was 7 or more negative appendectomy rate gets close to 5% and with a score of less than 5 the negative appendectomy rate raises to 30%.(22).

Diagnosis of appendicitis reduce negative appendectomy rates, avoid perforation, and protects the patients from unnecessary surgical intervention. A metaanalysis study revealed that it is essential to make an exact diagnosis and avoid any delay.

In a study done by van st et al reported that non operative management through the antibiotic treatment is safe only in cases of uncomplicated appendicitis(23).

According to the study by baris m et al evaluated the extent to which the scoring methods are suitable for diagnosis of appendicitis(24).

Diagnosis of appendicitis is based on clinical and laboratory findings, including the results of imaging.(25).

There is a high diagnostic value of radiological examination for acute appendicitis.(26).The main disadvantages of computed tomography are its high cost and its effect (27,28).If there is delay in diagnosis and treatment of appendicitis may cause complicated illness .(29).

## Conclusion:

Alvarado score can be a good tool to diagnose acute appendicitis as it has an acceptable AUC (0.0880).the score also has a good specificity and positive predictive value .It may be an additional diagnostic tool which is at with other diagnostic tools ,cost effective as well

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### Results:

Gender	Cases	controls
Male	17	19
Female	13	11

Table 2: Demographic profile of cases and controls:

	Cases(mean±SD)	Controls(mean±SD)
Age in years	28.4±14.6	41.3±15.56

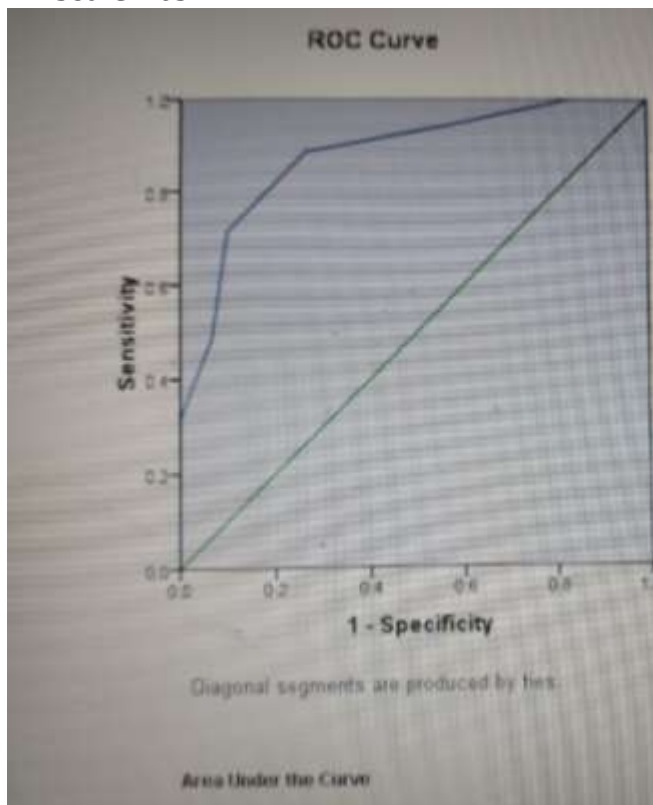
Alvarado score was significantly higher ( $P < 0.00001$ ) in cases as compared to

controls. the values are depicted in table 3

Table 3: comparison of Alvarado score in two groups

	Mean $\pm$ SD	P value
Cases(n=30)	5.93 $\pm$ 1.86	<0.0001
Controls(n=30)	2.77 $\pm$ 2.19	

It was observed in our study that sensitivity of Alvarado score was 0.36. However the specificity of the test was excellent. positive predictive value (PPV) of Alvarado score was 1. But negative predictive value (NPV) of the score was 0.61.



ROC curve on the left side of the diagonal line area under curve 0.880 was obtained. It is suggestive that Alvarado score is good marker to predict appendicitis. However, the sensitivity and specificity obtained in the graph are matching with that obtained by calculation accordingly Alvarado score > 7 can be specific but may not be a sensitive marker for appendicitis. However with a cut

off of 3.5, Alvarado score is quite a decent marker with sensitivity & specificity being 0.7 & 0.8 respectively.

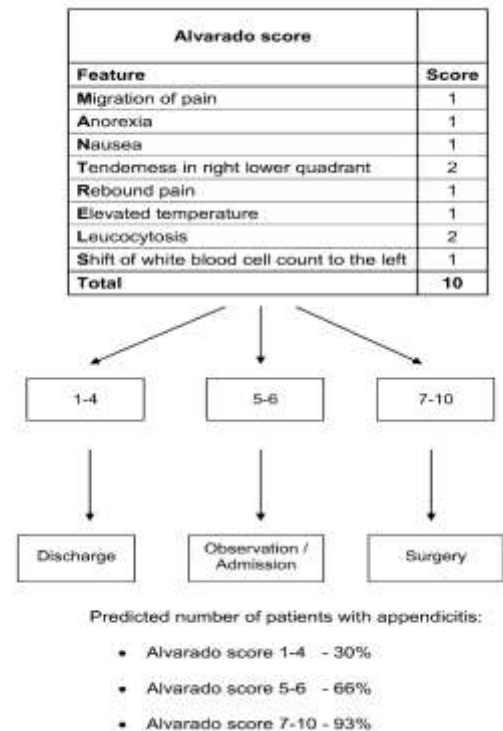


Fig 1: Alvarado scoring system