

## Original Research Article

# A prospective study for evaluation of Alvarado score in diagnosis of acute appendicitis

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**Received:** 13 April 2022

**Revised:** 04 May 2022

**Accepted:** 06 May 2022

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### ABSTRACT

**Background:** Acute appendicitis is a common cause of abdominal pain for which a prompt diagnosis is rewarded by a decrease in morbidity and mortality. Delay in the diagnosis will lead to an increased morbidity and mortality rate, on another hand overzealous diagnosis may lead to increased negative appendectomy rates. Notwithstanding advances in modern radiographic imaging and diagnostic laboratory investigations, the diagnosis of appendicitis remains essentially clinical. To decrease the negative appendectomy rate and to increase the positive diagnostic rate of appendicitis, various scoring systems were designed. Alvarado score is one of them.

**Methods:** A total of 100 operated cases of appendectomy were studied. Their clinical diagnosis, assessed by the Alvarado scoring is compared with radiological and histopathological diagnoses, to obtain the sensitivity and specificity of the Alvarado score system. NPV, PPV, and percentages of various demographic and clinical data were calculated accordingly.

**Results:** In this study, the positive predictive value of Alvarado scoring is found to be high i.e.; patients will have a high chance of acute appendicitis. On the other hand, the negative predictive value is low. Sensitivity for Alvarado's score is 50% while specificity is 88.9%.

**Conclusions:** In this study, we concluded that the Alvarado score has a very high positive predictive value i.e.; diagnostic accuracy. Also with the help of the Alvarado score, we can reduce the number of negative appendectomies.

**Keywords:** Alvarado score, Acute appendicitis, Positive predictive value

### INTRODUCTION

Acute inflammation of the appendix, termed 'acute appendicitis', is a significant public health problem claiming a lifetime incidence of 8.6% in men and 6.7% in women, mainly occurring in the second and third decade of life.<sup>11</sup>

Even though the rates of appendectomy in developed countries have significantly decreased over the last decades, it remains one of the most emergent abdominal operations in the United States. Appendectomy accounts for 300,000 hospitalization annually.<sup>1</sup> Although appendectomy is frequently the first 'major' case performed by the surgeon in training, the impact of a

timely diagnosis and prompt treatment is as impressive as that of any other major surgical intervention.

Despite its high prevalence in Western countries, the diagnosis of acute appendicitis can be challenging and requires a high index of suspicion on the part of the examining surgeon to facilitate prompt treatment of this condition, thereby avoiding the substantial morbidity and even mortality associated with delayed diagnosis and subsequent perforation and sepsis.<sup>12</sup> Acute appendicitis is a common cause of abdominal pain for which a prompt diagnosis is rewarded by a decrease in morbidity and mortality.<sup>3</sup> Delay in the diagnosis will lead to increased morbidity and mortality rate on another hand overzealous diagnosis may lead to an increased negative appendectomy

rate. In spite of such advances in modern radiology and diagnostic laboratory investigations, the diagnosis of appendicitis still remains essentially clinical, which requires a blend of observation, clinical acumen, and surgical science. To decrease the negative appendectomy rate and to increase the positive diagnostic rate of appendicitis, various scoring systems were designed.<sup>8-10</sup> Appendix has remained a topic of serial research work for various factors ranging from etiology to its management since the time it was described by Reginald Heber Fitz in 1886.

Diagnosis of appendicitis is one of the most researched fields pertaining to appendicitis. For years, various laboratory and radiological investigations are being studied in the hope of finding the most sensitive test which can be used to diagnose acute appendicitis. But in spite of vast advances in the field of medicine, it has been time and again opined by various clinicians and authors that appendicitis is one condition whose diagnosis relies mainly upon clinical features. Appendicitis can be managed easily and adequately with the least chances of a surgical event, while on the other hand when diagnosed late, appendicitis can turn into a disease with great morbidity and mortality.<sup>13</sup> Hence, having understood the importance of the early and right diagnosis, clinical evaluation provides the best and most accurate diagnostic modality for appendicitis, and many scoring systems have been developed over the years. To a certain extent, this has helped the clinician in the right diagnosis and early management of the patient.

A single scoring system gradually evolved into many when people constantly made modifications to the existing scoring systems due to varied local demographics or due to a lack of factors affecting its management. Thus a scoring system with maximum sensitivity and diagnostic accuracy had to be found. As a result, multiple studies have been done with randomized controlled trials comparing various scoring systems in different parts of the world. Alvarado score is one of such scoring systems and is predicted on a sophisticated statistical analysis of symptoms, signs, and laboratory data.<sup>2</sup> A scoring system described by Alvarado was designed to reduce the negative appendectomy rate without increasing morbidity and mortality.<sup>5</sup>

Hence it is necessary to review the usefulness of the Alvarado score and evaluate its feasibility and value as an aid in surgical decision-making in cases of possible appendicitis and also evaluate its use in scaling back the incidences of negative appendectomies.<sup>14</sup>

## METHODS

A prospective observational study was planned in which a total of 100 operated cases of appendicectomy were studied from December 2020 to October 2021. All patients who underwent an appendectomy at Shree Krishna hospital or Anand laparoscopy center were identified.

Their clinical diagnosis was obtained by the Alvarado score which was compared with their radiological diagnosis obtained by ultrasonography, and Histopathology diagnosis to assess the sensitivity and specificity of the Alvarado score. Demographic data and percentages of clinical signs and symptoms seen were calculated. The data were entered in the data collection tool which is STATA 14 and the results were analysed and interpreted accordingly. The patients were categorized according to their Alvarado score as shown in Table 1.

**Table 1: Categorization of patients according to their Alvarado Score.**

Class	Score
<b>Definite (D)</b>	9-10
<b>High probability (HP)</b>	7-8
<b>Low probability (LP)</b>	5-6
<b>Unlikely (U)</b>	1-4

### *Inclusion criteria*

All patients operated for appendicectomy at Shree Krishna hospital and Anand laparoscopy center, which is located nearby Anand city, Gujarat.

### *Exclusion criteria*

Patients with following criterias were excluded: (a) hemodynamically unstable patients; (b) appendicular mass; (c) having associated abdominal Koch's, intestinal obstruction, ulcerative colitis; and (d) appendectomy is done as a part of other surgery.

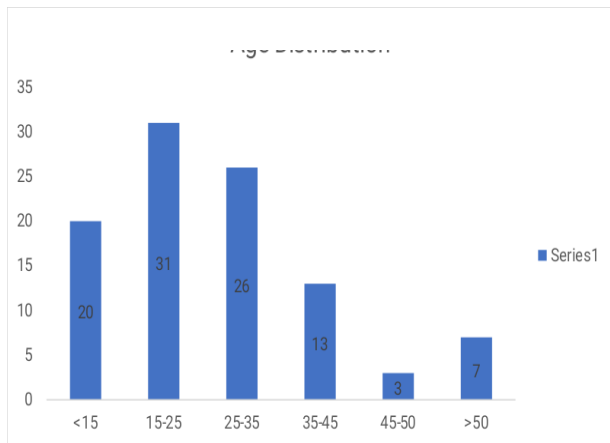
### *Ethical consideration*

Ethical clearance was sought for conducting the research from the research ethics committee before carrying out the study, permission was also sought from the management. Patients themselves and relatives/guardians were informed about the purpose of the study. The data required in the study was a part of the routine investigations and clinical information and consent were also taken from patients and relatives. The data were entered in the data collection tool.

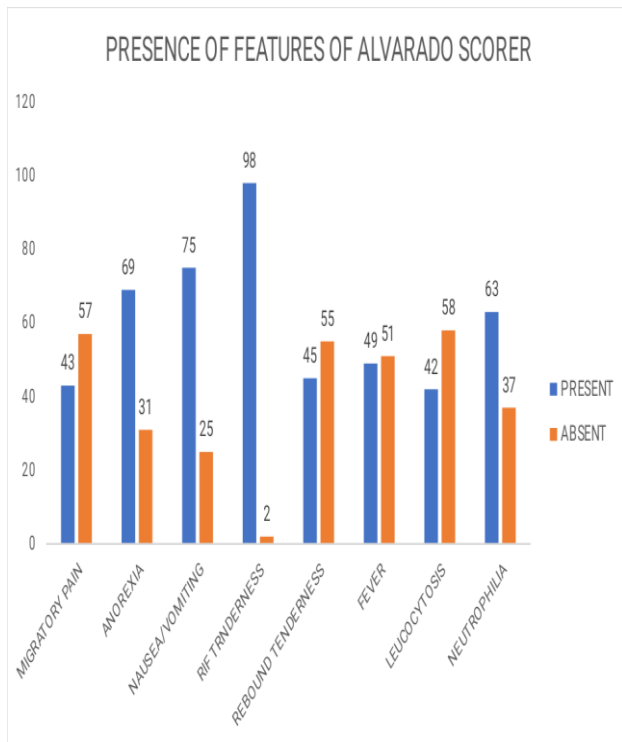
## RESULTS

In the present study, patients under study ranged from 5 to 70 years and Figure 1 shows their age distribution into different categories. Both sexes were affected with a male preponderance (61% males and 39% females). The most prevalent clinical presentation is RIF tenderness, present in 98% of the patients followed by nausea and vomiting accounting for 75%, 69% with anorexia, and 63% with neutrophilia. 43% of the patients have migratory pain, 45% have rebound tenderness and 49% have a fever. Leucocytosis is present in 42% of the patient (Figure 2). Patients were classified according to the final score. 7% with scores of more than 8 fell under D (definite), 36%

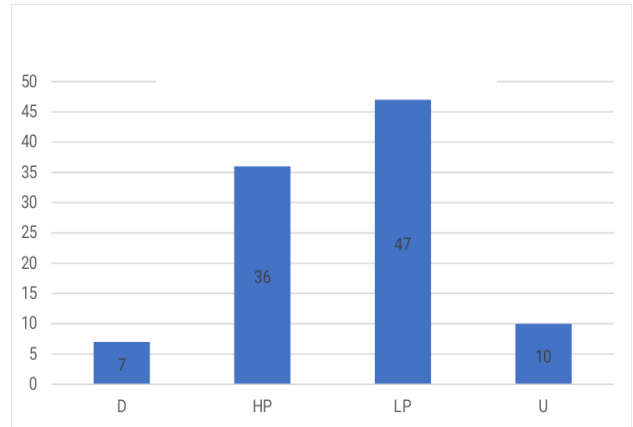
with scores of 7-8 were under HP (high probability), 47% with scores 5-6 were under LP (low probability) and 10% with scores of less than 5 were under U (unlikely) (Figure 3). In this study all the 100 patients underwent appendectomy, and the specimen was sent for histopathological examination. 72% of all histopathological reports were suggestive of acute appendicitis, 18% were suggestive of subacute appendicitis and 10% were perforated appendicitis (Figure 4). So surgical intervention was needed in acute and perforated appendicitis (total 82%) and that will count as positive appendectomy while 18% of subacute appendicitis could have been managed conservatively and hence will be counted as negative appendectomy.



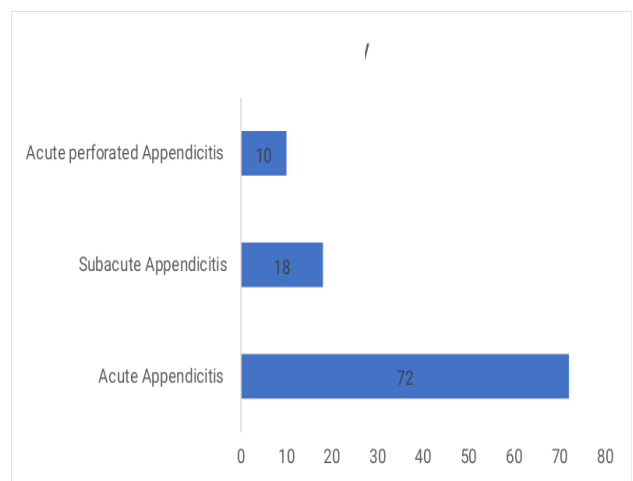
**Figure 1: Age distribution of patients under study. Numbers are in percentages of data found.**



**Figure 2: Clinical presentation of patients who have undergone appendectomy.**



**Figure 3: Categories in the Alvarado score.**



**Figure 4: Histopathology results in the study.**

In this study total of 43 patients have Alvarado scores of 7 and more, meaning they have a very high probability of having acute appendicitis. Out of 43 patients 35 patients have been diagnosed with acute appendicitis on histopathological examination and 6 patients were diagnosed with acute perforated appendicitis while only 2 patients had subacute appendicitis.

57 out of 100 patients had scored an Alvarado score of less than 7, suggesting a clinically very low probability of having acute appendicitis. In spite of scoring less than 7, 37 patients had been diagnosed with acute appendicitis on histopathological examination, 4 patients had been diagnosed with acute perforated appendicitis while only 16 patients had subacute appendicitis (Table 2). This means that the Alvarado score does not help to rule out acute appendicitis in spite of the low score and diagnosis of acute appendicitis can be missed if only relying on clinical diagnosis. Hence alternate radiological modality is needed for confirmation of diagnosis.

We have merged acute appendicitis and acute perforated appendicitis as acute appendicitis case as they have to undergo appendectomy surgery. A score of 7 and more will be counted as a positive test to diagnose acute

appendicitis and less than a 7 score will be counted as a negative test to diagnose acute appendicitis (Table 3). So from the above data PPV of Alvarado score is 95%, suggesting patients having a score of more than 7 are more likely to have acute appendicitis, and NPV is 28.1%

suggesting patients having a score of less than 7 cannot be ruled out for acute appendicitis and alternate investigations should be done to rule out acute appendicitis. Based on this data sensitivity and specificity of Alvarado's scoring for this study is 50% and 88.9% respectively.

**Table 2: Comparison of clinical and histo-pathological diagnosis.**

Score	Acute appendicitis	Acute perforated appendicitis	Sub-acute appendicitis	Total
≥7	35	6	2	43
<7	37	4	16	57
<b>Total</b>	<b>72</b>	<b>10</b>	<b>18</b>	<b>100</b>

**Table 3: Incidence of acute and sub-acute appendicitis.**

Score	Acute appendicitis	Sub-acute appendicitis	Total
≥7 (positive test)	41 (True positive)	2 (false positive)	43
<7 (negative test)	41 (false positive)	16 (true negative)	57
<b>Total</b>	<b>82</b>	<b>18</b>	<b>100</b>

## DISCUSSION

Many clinical scoring systems have been introduced since the concept of a clinical scoring system and many studies have been done to identify the most sensitive, specific, and diagnostically accurate clinical score to aid in the diagnosis of acute appendicitis.<sup>5,8,10</sup> Since the Alvarado score is the most well-known and studied score for acute appendicitis.<sup>3,7,10</sup> As this is the most popular and commonly used scoring system, we planned to find out its diagnostic accuracy, sensitivity, and specificity by comparing it with radiological and histopathological diagnoses.

In the present study conducted on 100 patients (N=100), clinical diagnosis obtained by using the Alvarado score was analyzed in relation to ultrasonography diagnosis and final diagnosis obtained by histopathological diagnosis. It was found that sensitivity and specificity for Alvarado scores in our study are 50% and 88.9% respectively. The positive predictive value is very high around 95%, which suggests that a patient having an Alvarado score of 7 or greater than he is more likely to have acute appendicitis, and negative predictive value is very low around 28.1% which suggests that patients having a score of less than 6 cannot be ruled out for acute appendicitis and other modalities for diagnosis such as ultrasonography, and CT scan can be used for confirmation. While analyzing the Alvarado score, it was found that the Alvarado score was easy to perform as it mainly relied upon clinical examination along with basic laboratory investigations and it did not need elaborate investigations. The time taken to apply the score was minimal and did not cause any undue delay in the management.

Bond et al prospectively studied 187 patients with suspected appendicitis and found Alvarado score to have a sensitivity and specificity of 90% and 72% respectively. Hsiao et al conducted a retrospective study and found that

sensitivity and specificity for an Alvarado score ≥7 were 60% and 61% respectively.<sup>4</sup> Higher sensitivity and specificity 92% and 82% respectively were found in a retrospective study by Rezal et al.<sup>5</sup> This study also suggested that patients with scores of more than 7 were managed directly by appendectomy without CT evaluation, this would have caused a 27% reduction in CT scanning.<sup>6</sup> A prospective evaluation of Owen et al shows sensitivity and specificity of Alvarado score were 93% and 81% respectively.<sup>7</sup> The present study was analyzed category-wise. When we retrospectively analyzed the study data we found that among patients having an Alvarado score of more than 7, 41 cases were positive appendectomy while only 2 cases were negative appendectomy. This suggests that patients having an Alvarado score of more than 7 have a high probability of acute appendicitis and can be taken for urgent surgery without wasting time in the radiological evaluation.

We also found that among patients having an Alvarado score of less than 7, 41 cases were positive appendectomy while 16 cases were negative appendectomy. This suggests that patients having an Alvarado score of less than 7 could have acute appendicitis and can be missed if only relying on clinical diagnosis and will require radiological confirmation for further management.

The limitation of our study was a small sample size compared to other studies, which might have led to the low sensitivity of the results obtained.

## CONCLUSION

The present study concluded that the Alvarado score has a high positive predictive value and diagnostic accuracy for acute appendicitis. It helps clinicians to make appropriate decisions and categorize the patients with right inferior fossa pain for appropriate management, patients in the

HP/D category can straight away be taken for surgery without extra imaging modality. Patients in the LP category will require radiological confirmation, and patients in the U category can be worked up for non-appendiceal diagnoses. Alvarado's score also reduces the rate of negative appendectomy.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Kapadia NM, Rangwala V, Rathod JB, Bhatt R, Patel SR. A prospective study for evaluation of Alvarado score in diagnosis of acute appendicitis. *Int Surg J* 2022;9:1221-5.