

Evaluation of the Role of Alvarado Score in the Diagnosis of Severity of Acute AppendicitisVishal S. Shah¹, Vikrant Akulwar², Parth S. Patel³, Kalpesh A. Parmar⁴¹Associate Professor, Department of General Surgery, Dr. N. D. Desai Faculty of Medical Science and Research, Dharmsinh Desai University, Nadiad, Gujarat²Associate Professor, Department of General Surgery, Government Medical College and Cancer hospital, Aurangabad, Maharashtra.³Associate Professor, Department of General Surgery, Dr. N. D. Desai Faculty of Medical Science and Research, Dharmsinh Desai University, Nadiad, Gujarat⁴Associate Professor, Department of General Surgery, Dr. N. D. Desai Faculty of Medical Science and Research, Dharmsinh Desai University, Nadiad, Gujarat

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Corresponding Author: Dr. Kalpesh A. Parmar

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Abstract

Background: Acute Appendicitis (AA) stands out as the most frequently encountered surgical issue within the abdominal area. Throughout the last century, there has been notable progress in diminishing the morbidity and mortality rates linked to this condition. Several scoring systems have been used to help diagnose acute appendicitis early and manage it promptly. These systems are accurate and reliable tools for distinguishing between acute appendicitis and other types of abdominal pain. The current study aimed to evaluate the efficacy of Alvarado scores in cases of acute appendicitis.

Methods: Based on the inclusion and exclusion criteria a total of 80 cases of acute appendicitis were included in the study. Based on the total Alvarado scores, the patient groups were defined as follows: Total Score 7 – 10 (Group I) Total Score 5 – 6 (Group II), and Total Score 1 – 4 (Group III). The data details related to the surgical procedure, and the surgical grading of appendicitis. Histopathological (HP) grading data was also included.

Results: the distribution of cases between age groups and Alvarado scores. The Alvarado score is a clinical scoring system used to predict the likelihood of acute appendicitis. A score of 5 or more is considered to be highly suggestive of appendicitis, while a score of 0 or 1 is considered to be very unlikely. The table shows that the majority of cases (48 out of 80) occurred in patients under the age of 20. Of these cases, 26 had an Alvarado score of 5 or more, 14 had a score of 2 to 4, and 9 had a score of 0 or 1. The P value of 0.268 indicates that there is no statistically significant difference in the distribution of Alvarado scores between age groups.

Conclusion: The Alvarado scoring system emerged as a straightforward, rapid, dependable, and user-friendly tool. It significantly enhances the diagnostic confidence associated with clinical assessments of acute appendicitis. This scoring system exhibits a high level of sensitivity and positive predictive value. It remains a flexible tool, allowing for ongoing observation and critical re-evaluation of the clinical presentation's progression.

Keywords: Acute appendicitis (AA), Alvarado Score, severity of acute appendicitis.

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Introduction

Globally, acute appendicitis is a common surgical emergency with a lifetime risk of 1 in 7 [1-4] and 8.6% for males and 6.7% for females in the United States.[5] which means that 6% of individuals suffer an attack during their lifetime.[6,7]The condition is difficult to diagnose, especially during the early stages when the classical signs and symptoms are usually subtle. [1,6]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.[8,9] It has been observed that many patients undergoing appendectomy prove to be negative on histopathology of the surgically removed appendix, which is the gold standard for diagnosis of appendicitis.[10] Removing a normal appendix is a burden both on patients and health resources.[2] However, early recognition of the condition and prompt operation have been the most important factors in reducing morbidity and possible mortality, length of stay, and cost of treatment.[11] The diagnosis of appendicitis is

typically straightforward, but identifying acute appendicitis can be challenging due to the difficulties encountered in making a clinical diagnosis. Acute appendicitis, a common surgical emergency, requires accurate and early diagnosis to minimize the associated health risks. It is frequently encountered in day-to-day practice in the emergency department, often presenting in ways that can perplex healthcare practitioners. The delay or failure to diagnose it promptly can occur frequently, negatively affecting the disease's prognosis and resulting in increased patient morbidity and, occasionally, mortality.

Despite advancements in diagnostic methods, the mystery surrounding the diagnosis of acute appendicitis persists, leading to an increased likelihood of surgery due to concerns about potential complications. Literature reports indicate a notable 20% rate of negative appendectomy. Several scoring systems have been used to aid in early diagnosis of acute appendicitis and its prompt management. These systems are valuable and valid instruments for discriminating between acute appendicitis and nonspecific abdominal pain.[6] An example is the Alvarado scoring system, which is based on histopathology, physical examination, and a few laboratory investigations and is very easy to apply. [6,9] Definitive diagnosis can, however, be reached at surgery and after histopathology. [9]The Alvarado scoring system, when applied to patients with a pre-operative clinical suspicion of appendicitis, has proven to be a valuable tool for early diagnosis, as demonstrated by various studies. It has also contributed to a reduction in the incidence of unnecessary appendectomies, all while maintaining patient safety by not increasing morbidity and mortality rates. Our study aimed to evaluate the usefulness of the Alvarado scoring system in reducing the percentage of negative appendectomy in our setup.

Material and Methods

This cross-sectional study was conducted in the Department of General Surgery. Written permission was obtained from all the participants of the study.

Inclusion Criteria

1. Patients aged 18 years and above.
2. Those admitted with suspected acute appendicitis.
3. The availability of postoperative histopathology reports.
4. Voluntarily willing to participate in the study.

Exclusion Criteria

1. Features of Peritonitis
2. Features of intestinal obstruction
3. History of trauma to right iliac fossa
4. Patients with genitourinary complaints

5. Pregnant females
6. Patient with a previous history of abdominal surgeries

Based on the inclusion and exclusion criteria a total of 80 cases of acute appendicitis were included in the study. The data collected in this study encompass demographics, medical history, and clinical characteristics, such as age, gender, nationality, presenting symptoms (such as abdominal pain and its duration, fever, anorexia, nausea, vomiting, changes in bowel habits, smoking or alcohol consumption), body mass index (BMI), and the presence of comorbidities like diabetes mellitus (DM), hypertension (HTN), coronary artery disease (CAD), atrial fibrillation (AF), and chronic kidney disease (CKD). It also includes physical examination findings, specifically signs of tenderness, and rebound tenderness, as well as vital signs data (including systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate, and body temperature. The laboratory investigations included the white blood cell count (WBCs), neutrophil count, lymphocyte count, platelet count, hemoglobin level (Hb), international normalization ratio (INR), creatinine levels, blood urea nitrogen (BUN), serum C-reactive protein (CRP) levels, serum lactate levels, serum albumin levels, and serum glucose levels. Radiological findings from CT scans. The data details related to the surgical procedure, any postoperative imaging performed, and Histopathological (HP) grading data are also included.

Based on the total Alvarado scores, the patient groups were defined as follows:

1. Total Score 7 – 10 (Group I): Patients falling into this category were diagnosed with acute appendicitis, and emergency appendectomies were promptly performed.
2. Total Score 5 – 6 (Group II): Patients in this group were considered equivocal, leading to their management through conservative measures. If the patient's general condition and symptoms improved, they were discharged with advice to return if the symptoms reappeared. However, if patients experienced severe pain and their total score increased, surgery was considered an option.
3. Total Score 1 – 4 (Group III): Patients in this category were suspected to have either a less severe form of appendicitis or a different condition altogether. These patients were managed symptomatically and subsequently discharged. They were also advised to return if their symptoms recurred.

Statistical Analysis: All the available data was systematically segregated and uploaded to an MS Excel spreadsheet and analyzed by SPSS version

21 in Windows format. Continuous variables were represented as means, standard deviations, and percentages, and categorical variables were represented as p values calculated by ANOVA analysis. A p-value of (< 0.05) was considered significant.

Results

Out of the total 80 cases included in the study 60 patients underwent surgery, 25 had an open appendectomy and 35 had a laparoscopic appendectomy.

The other 20 cases were managed conservatively. Table 1 below shows the distribution of cases based on the groups and management. The table shows that the majority of patients (48 out of 60) in group I had an open appendectomy, while the majority of patients (10 out of 21) in group II had a laparoscopic appendectomy. There were only 2 patients in group III who underwent surgery, and both of them had a laparoscopic appendectomy.

Table 1: Distribution of cases based on the groups and management

| | Operated | Conservative management | Total |
|-----------|----------|-------------------------|-------|
| Group I | 48 | 00 | 48 |
| Group II | 10 | 11 | 21 |
| Group III | 02 | 09 | 11 |
| Total | 60 | 20 | 100 |

Table 2 shows the age group distribution of 80 people. The largest age group is < 20 years old, with 49 people (61.25%). The second largest age group is 21 to 30 years old, with 16 people (20.00%). The third largest age group is 31 to 40 years old, with 8 people (10.00%). The smallest age groups are 41 to 50 years old and >50 years old, with 3 people (3.75%) and 4 people (5.00%) respectively.

Table 2: Showing the age group-wise distribution of cases

| Age group years | Frequency | Percent |
|-----------------|-----------|---------|
| <20 | 49 | 61.25 |
| 21 to 30 | 16 | 20.00 |
| 31 to 40 | 8 | 10.00 |
| 41 to 50 | 3 | 03.75 |
| >50 | 4 | 05.00 |
| Total | 80 | 100.00 |

In this study, there were 48 females and 32 males. In this study, the Alvarado score is a scoring system used to diagnose acute appendicitis. It is based on eight clinical findings:

- Right lower quadrant tenderness
- Rebound tenderness
- Elevated temperature (>37.3°C or 99.1°F)
- Migration of pain to the right lower quadrant
- Anorexia
- Nausea or vomiting
- Leukocytosis (>10,000 cells/ μ L)

Leukocyte left shift (>75% neutrophils)
Each finding is assigned a score of 1 or 2, with 2 points being given for more severe findings. The total score can range from 0 to 10.

- A score of 0 to 4 is considered low risk for appendicitis (Group I)
- A score of 5 to 6 is considered intermediate risk for appendicitis (Group II).
- A score of 7 to 10 is considered high risk for appendicitis (Group III).

Table 3: Comparison of histopathological reports with Alvarado score groups

| Score Group | Histopathologic examination | | |
|-------------|-----------------------------|--------------------|---------------------|
| | Conservative | Acute Appendicitis | Perforated Appendix |
| 7 – 10 | 00 | 37 | 11 |
| 5 – 6 | 11 | 10 | 00 |
| 1 – 4 | 09 | 02 | 00 |
| Total | 20 | 49 | 11 |

Table 4 shows the distribution of cases between age groups and Alvarado scores. The Alvarado score is a clinical scoring system used to predict the likelihood of acute appendicitis. A score of 5 or more is considered to be highly suggestive of appendicitis, while a score of 0 or 1 is considered to be very unlikely. The table shows that the

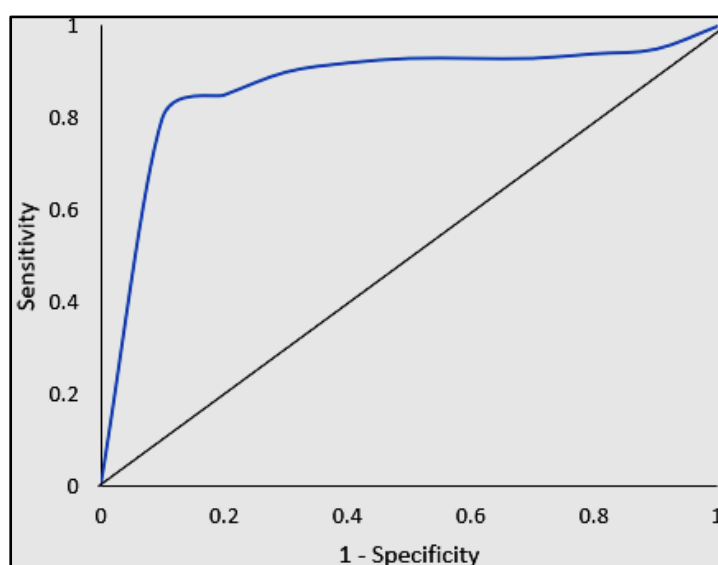
majority of cases (48 out of 80) occurred in patients under the age of 20. Of these cases, 26 had an Alvarado score of 5 or more, 14 had a score of 2 to 4, and 9 had a score of 0 or 1. The P value of 0.268 indicates that there is no statistically significant difference in the distribution of Alvarado scores between age groups.

Table 4: Distribution of cases between age groups and Alvarado scores

| Age group in years | Alvarado Score Group | | | Total | P value |
|--------------------|----------------------|-------|-------|-------|---------|
| | 7 - 10 | 5 - 6 | 1 - 4 | | |
| < 20 | 26 | 14 | 9 | 49 | 0.268 |
| 21 – 30 | 13 | 2 | 1 | 16 | |
| 31 – 40 | 6 | 2 | 0 | 8 | |
| 41 - 50 | 2 | 1 | 0 | 3 | |
| > 50 | 1 | 2 | 1 | 4 | |
| Total | 48 | 21 | 11 | 80 | |

In this ROC curve (Figure 1) is relatively close to the upper left corner of the graph. This indicates that the classifier is performing well. The TPR is about 0.8 and the FPR is about 0.2. This means that the classifier is correctly classifying about 80% of the true positives and about 20% of the false positives. Overall, the ROC curve you sent me

indicates that the classifier is performing well. The classifier is correctly classifying about 80% of the true positives and about 20% of the false positives. The area under the ROC curve (AUC) curve you are 0.85. It is a good AUC, indicating that the classifier is performing well.

**Figure 1: Area under the ROC curve based on Alvarado score.**

Discussion

Acute Appendicitis is the most commonly occurring surgical condition in the abdominal region. Over the past century, there has been a significant reduction in both morbidity and mortality rates associated with this condition. [12] This progress is largely attributed to the recognition of the harmful consequences of appendiceal perforation. Consequently, a universally accepted approach involves an aggressive surgical treatment strategy that emphasizes early intervention, even if it results in a relatively high negative appendectomy rate ranging from 15% to 30%. While negative appendectomies themselves have minimal mortality rates, they do carry a morbidity rate of approximately 10%. [13] Clinical assessments for diagnosing acute appendicitis exhibit varying levels of accuracy, ranging from 50% to 80%. Notably, diagnosing this condition remains particularly challenging in very young patients, the elderly, and women of reproductive

age. [14] Efforts have been made to address this diagnostic challenge by reducing unnecessary appendectomy procedures without increasing the risk of appendiceal perforation. Various methods, including radiological approaches like ultrasonography and computed tomography, as well as invasive techniques like laparoscopy, have been explored. [12] Numerous diagnostic scoring systems have been proposed, but many of them are complex and challenging to apply in clinical practice. The Alvarado score, introduced in 1988, stands out as a simple and easily implementable scoring system. While clinical judgment remains crucial for accurate appendicitis diagnosis, the Alvarado score offers a straightforward and cost-effective tool suitable for use in both outpatient and emergency room settings. A score of 7 or higher on the Alvarado scale indicates a high likelihood of acute appendicitis and aligns with one's clinical suspicion.

In this study, the Alvarado score was utilized to aid in clinical diagnosis, promoting consistency, especially when multiple senior surgical residents were involved in decision-making. The study group comprised 40% men and 60% women. The peak incidence of acute appendicitis occurred in individuals aged 21-30 years, consistent with existing literature. Few similar studies in this field have pointed to the equal distribution of Acute appendicitis (AA) between males and females. [16, 17] The mean age of our cohort was 29.5 years which showed that AA has a relatively far greater predilection for the younger age group individuals. Our results were in concordance with the results of the studies done in the past. [18, 19] Notably, this study found a negative appendectomy rate of 0% for the 11 cases of perforative appendicitis, all of which had Alvarado scores of 7 or higher and were promptly operated on. Two cases initially missed later presented with worsened symptoms and higher Alvarado scores upon reevaluation, leading to subsequent surgical intervention. The possible explanation for these two initial false negatives in our study may be attributed to the very early stage of acute appendicitis at their initial presentation, making clinical diagnosis challenging. Some studies have reported that the rate of Negative appendectomies was relatively higher in female patients as compared to males with acute appendicitis. [20, 21] The Alvarado score components that appeared most frequently were tenderness of the right iliac fossa, with a prevalence of 98.75%. This was followed by rebound tenderness and leukocytosis, and these findings align with similar results reported in previous studies. [22, 23] However, it is worth noting discrepancies between our findings and those of Swami et al. [24], who observed a lower incidence of leukocytosis, and Rodrigues et al. [25], where an elevated temperature was the most prevalent symptom. We believe that these variations in frequency can be attributed to differences in the patient's clinical condition during examinations and disparities in the demographic characteristics and gender distribution of the study populations. In this study, the Alvarado scoring system demonstrated a sensitivity of 88.53%, a specificity of 70.12%, and a positive predictive value of 76.98%. This study underscores the effectiveness of the Alvarado scoring system in diagnosing acute appendicitis, particularly in achieving a high positive predictive value and thus enhancing diagnostic accuracy. The positive predictive value observed in this study is in line with the findings of previous research conducted by M. Kalan et al., [26] and K.A. Malik et al., [27]

We evaluated the sensitivity and specificity of the Alvarado score using two different cutoff points, namely 5 and 7. Our findings indicated that at a cutoff of 5, the sensitivity, specificity, positive

predictive value (PPV), and negative predictive value (NPV) were 90.05%, 25.64%, 95.35%, and 9.5%, respectively. On the other hand, when using a cutoff point of 7, the sensitivity, specificity, PPV, and NPV were 65.92%, 67.68%, 97.33%, and 8.3%, respectively. These results are in line with recent studies. Pifeleti et al. [28] reported similar outcomes, with sensitivity, specificity, PPV, and NPV of 91.97%, 50%, 98.44%, and 15.38%, respectively, for an Alvarado score ≥ 5 , and 63.5%, 75%, 98.86%, and 5.66%, respectively, for an Alvarado score ≥ 7 . In addition, do Nascimento et al. [23] found a sensitivity of 88.17%, specificity of 37.5%, PPV of 94.25%, and NPV of 21.43% for an Alvarado score ≥ 5 , and a sensitivity of 38.71%, specificity of 87.5%, PPV of 97.3%, and NPV of 10.94% for an Alvarado score ≥ 7 . Notably, increasing the cutoff point led to a decrease in sensitivity but an increase in specificity. Another study, which validated the Alvarado score at a cutoff value ≥ 7 , reported lower sensitivity (54%) and higher specificity (75%), with a PPV of 90% and NPV of 29%. This study concluded that the Alvarado score may not be a reliable method for diagnosing acute appendicitis. [29]

Conclusion

In this study, the Alvarado scoring system emerged as a straightforward, rapid, dependable, and user-friendly tool. It significantly enhances the diagnostic confidence associated with clinical assessments of acute appendicitis. This scoring system exhibits a high level of sensitivity and positive predictive value. It remains a flexible tool, allowing for ongoing observation and critical re-evaluation of the clinical presentation's progression. Its applicability and effectiveness in decision-making apply equally to both male and female patients. The Alvarado scoring system, when applied to patients with a pre-operative clinical diagnosis of appendicitis, has consistently proven its utility in achieving early detection of acute appendicitis. This has been corroborated by various studies and has played a valuable role in reducing the incidence of unnecessary appendectomies, without compromising patient safety in terms of morbidity and mortality.

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