

# Diagnostic Accuracy of Modified Alvarado Score (MAS) and Ohmann Scores (OS) in Diagnosing Acute Appendicitis

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## ABSTRACT

In the field of General Surgery AA is the frequent clinical condition for which patients who need emergency surgery present with abdominal pain.<sup>1</sup> Diagnosis of this pathology is made with the help of history, patient symptoms, and clinical exam and lab investigations. Ultrasonography (USG) and computed tomography (CT) images for acute appendicitis should be considered.<sup>2</sup>

**Methodology:** The purpose of the study is to compare the diagnostic accuracy of Modified Alvarado Score (MAS) and Ohmann Scores (OS) in diagnosing the pathology of Acute Appendicitis, while retaining histopathology as the basis for final diagnosis. A total of 411 patients were admitted via the Accidents & Emergency Department of Mayo Hospital Lahore, meeting the inclusion and exclusion requirements having the clinical diagnosis of acute appendicitis. For each patient, both Modified Alvarado and Ohmann scores were assessed prior to undergoing the procedure, i.e. open appendectomy. Abdominopelvic assessments and laboratory results were assessed and abdominal USG was performed in all patients. Biopsy of the removed appendix was sent for histopathology to Pathology Department of King Edward Medical University.

**Results:** For the modified Alvarado and Ohmann score; sensitivity and specificity of was 89.74%, 90.48%, 85.13% and 80.95% respectively. The positive predictive value (PPV) and negative predictive value (NPV) for "modified Alvarado score" was 99.43% and 32.2% and for "Ohmann score" it was 98.81% and 22.67% respectively.

**Conclusion:** Both scoring system are sensitive and specific enough for diagnosis of acute appendicitis. However, sensitivity and specificity of modified Alvarado score is higher as compared to Ohmann score.

**Keywords:** Acute Appendicitis, Diagnostic Accuracy, Modified Alvarado Score, Ohmann Score, Histopathology.

## INTRODUCTION

In the field of General Surgery, Acute Appendicitis (AA) is the frequent clinical condition for which patients who need emergency surgery present with abdominal pain.<sup>1</sup> Diagnosis of this pathology is made with the help of history, patient symptoms, and clinical exam and lab investigations.<sup>2</sup>

Early diagnosis and prompt surgery remain of paramount importance for the effective management of acute appendicitis. That being said the presentation of acute appendicitis sometimes is not straightforward and in such circumstances it has been noted that strategy of early intervention can lead to high negative appendectomy rate.<sup>3</sup>

Despite the negative appendectomy estimate of 20-40% which was revealed in literature, many surgeons still recommend early surgical intervention in the hopes of preventing perforation, hence accepting a "negative appendectomy rate" of about 15-20%.<sup>4</sup> It is worth mentioning that the removal of the normal appendix creates an economic burden on both patients and health services. This of course has to be balanced against the risk of a misdiagnosis thus delayed operation and repercussion of complications such as perforation and eventually peritonitis.<sup>5</sup>

Therefore, a scoring system was required to solve above mentioned problems with appropriate sensitivity, negative incidence of appendectomy and specificity. By combining findings on physical examination with the laboratory results the scoring system can be calculated. These various scoring systems have been identified with the intention of facilitating a more accurate diagnosis of acute appendicitis.<sup>6</sup>

Primary principle always remains obtaining an early diagnosis, since failure to do so will give rise to an increase in morbidity, mortality and cost of treatment as well as reducing the negative incidence of appendectomy.<sup>7</sup> Various protocols have been implemented and tested by various researchers over the last two decades, but there is no agreement on which of the scoring systems has a better rate of true diagnosis.<sup>8-12</sup>

In the Modified Alvarado score system, a score  $\geq 7$  is significant for AA and implies that there is a need for surgical

intervention.<sup>9</sup> Studies have reported that sensitivity; positive predictive value, specificity and negative predictive value of MAS range from 50.6-94.2%, 23-94.5 %, 77-98% and 69.8-98 % respectively.<sup>13-17</sup> Ohmann et al.,<sup>5</sup> presented as an easy to apply and useful diagnostic tool.<sup>5, 18</sup> Kiyak et al. stated in their review that the OS could be more effective to exclude acute appendicitis as diagnosis.<sup>18</sup>

In another study Zielke et. al. highlighted that the Ohmann score system reduced the negative appendectomy rate by 14.3% while it was unsuccessful to diagnose appendicitis in just 6 (0.9%) patients and thus supported the effectiveness of this scoring system recommending that it would be beneficial to use in clinical guides.<sup>19</sup> Eyüp Murat Yılmaz and his team members reported in their analysis that the MAS successfully predicted the diagnosis of acute appendicitis, even better than OS.<sup>20</sup> Pejana Rastović in his study compared the accuracy of MAS, OS and Eskelinen score for diagnosing acute appendicitis. The diagnostic accuracy of Ohmann score was higher compared to the Modified Alvarado score, according to his results.<sup>21</sup>

We wanted to evaluate the diagnostic accuracy of the Modified Alvarado and Ohmann Scores for diagnosing the Acute Appendicitis. As is evident from literature search no local studies have compared both these scores and international data has reported variable and contradictory results regarding sensitivity and specificity of both these scores. Results of this study will help in decision making which score should be adopted for effective and timely management of patients presenting with acute appendicitis as well as it can also be helpful in decreasing rate of negative appendectomies as in third world countries.

## METHODOLOGY

In this cross-sectional validation study, a total of four (4) surgical wards involved in this study, which lasted for a total of six months after the acceptance of the study's synopsis in Jan, 2020. Non-probability sampling was utilized since it was the most practical method for our study. Participants ranged in age from 14 to 50, presented with complaints of stomach discomfort or pain in the

right iliac fossa, were equally split across sexes, and were clinically suspected cases of acute appendicitis. Patients with a history of mental illness, Appendicular Abscess or Phlegmon diagnosed on history, Patients requiring CT abdomen for the confirmation of diagnosis, and Patients with generalized peritonitis due to perforated appendicitis, gastric/duodenal perforation, enteric perforation, complicated diverticulitis, mesenteric ischemia, intestinal obstruction, biliary peritonitis, etc. were excluded from the study.

A total of 411 cases were enlisted via the Accidents & Emergency Department of Mayo Hospital Lahore, meeting the inclusion and exclusion requirements and clinical diagnosis of acute appendicitis data was collected from each patient. Both the "Modified Alvarado" and "Ohmann scores" were determined for every sufferer prior to surgery, i.e. open appendectomy. Abdominopelvic examinations and laboratory results have been reviewed and all patients underwent abdominal Ultrasound. After appendectomy, a biopsy of the removed appendix was sent to the Department of Pathology of King Edward Medical University for histopathology in a container containing formalin.

"SPSS-23" was used for recording data of the patients. "Quantitative variables" such as age, duration of pain will be introduced as "mean± SD". "Qualitative variables" for example sex will be showed as "frequency and percentages". "Sensitivity", "specificity", "positive predictive value" and "negative predictive value" tests and overall "diagnostic accuracy" for Modified Alvarado score and Ohmann score were calculated as per operational definition. To determine diagnostic accuracy, a 2 x 2 table was made and by taking findings of histopathology in column and Modified Alvarado Score and Ohmann Scores in rows. Data was stratified for "age and gender" to label "effect modifiers". And post stratification chi square test was applied with "P value ≤0.05" was taken as significant.

## RESULTS

Histogram shows that age distribution of patients included in the study. Figure-1

"Mean age" was 25.05±9.49 years. Minimum and maximum age of patients was 13 and 60 years respectively. In this study 207(50.36%) were male and 204(49.64%) females.

Mean modified Alvarado score was 7.15±1.17. Minimum and maximum score was 2 and 10 respectively. Mean Ohmann score for patients was 13.45±1.79. Minimum and maximum score was 5 and 16 respectively. As per modified Alvarado score appendix was diagnosed in 352(85.64%) patients.

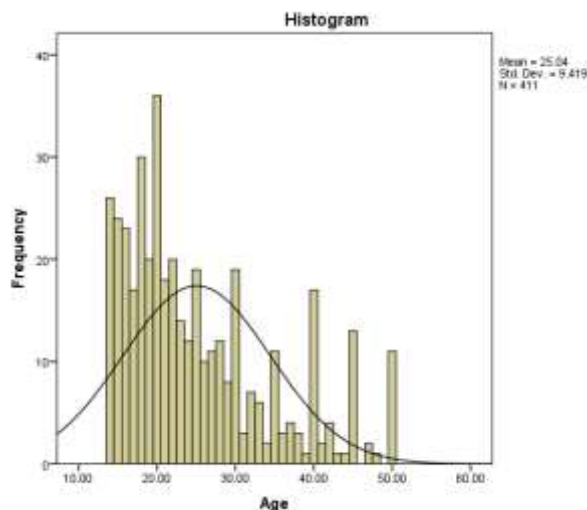


Figure 1: showing the range of the age of the patients enrolled in this study. (n=411)

As per Ohmann score Appendix was diagnosed in 336(81.75%) patients. As per histopathology findings appendix was diagnosed in 390(94.89%) patients. "Sensitivity and specificity" of "Modified Alvarado score" was 89.74% and 90.48%. While PPV predictive and NPV was 99.43% and 32.2% respectively. Diagnostic accuracy was 89.78%. For Ohmann score sensitivity and specificity was 85.13% and 80.95%. While "PPV" and "NPV" was 98.81% and 22.67%. Overall diagnostic accuracy of Ohmann score was 84.91% respectively.

Table-1: Diagnostic Accuracy of Modified Alvarado Score by taking Histopathology as Diagnostic Criteria

|                           |          | "Histopathology" |               | Total |
|---------------------------|----------|------------------|---------------|-------|
|                           |          | "Positive"       | "Negative"    |       |
| Modified Alvarado Score   | Positive | 350(89.7%)       | 2(9.5%)       | 352   |
|                           | Negative | 40(10.3%)        | 19(90.5%)     | 59    |
| Total                     |          | 390              | 21            | 411   |
|                           |          | Value            | 95% CI        |       |
| Sensitivity               |          | 89.74%           | (86.33-92.38) |       |
| Specificity               |          | 90.48%           | (71.09-97.35) |       |
| Positive Predictive Value |          | 99.43%           | (97.95-99.84) |       |
| Negative Predictive value |          | 32.2%            | (21.69-44.9)  |       |
| Diagnostic Accuracy       |          | 89.78%           | (86.47-92.35) |       |

Table-2: Diagnostic Accuracy of Ohmann Score by keeping "Histopathology as Criteria"

|                           |          | "Histopathology" |               | Total |
|---------------------------|----------|------------------|---------------|-------|
|                           |          | Positive         | Negative      |       |
| Ohman Score               | Positive | 332(85.1%)       | 4(19%)        | 336   |
|                           | Negative | 58(14.9%)        | 17(81%)       | 75    |
| Total                     |          | 390              | 21            | 411   |
|                           |          | Value            | 95% CI        |       |
| Sensitivity               |          | 85.13%           | (81.25-88.32) |       |
| Specificity               |          | 80.95%           | (60-92.33)    |       |
| Positive Predictive Value |          | 98.81%           | (96.98-99.54) |       |
| Negative Predictive value |          | 22.67%           | (14.66-33.34) |       |
| Diagnostic Accuracy       |          | 84.91%           | (81.13-88.05) |       |

## DISCUSSION

In this study, the "diagnostic accuracy" of "Modified Alvarado score" and Ohmann score were compared with histopathology findings. Results showed that "sensitivity and specificity" of modified Alvarado and Ohmann score was 89.74%, 90.48%, 85.13% and 80.95% respectively. While PPV and NPV for MAS was 99.43% and 32.2% and for Ohmann Score was 98.81% and 22.67% respectively.

The mean age of patients included in this study was 25 years. Minimum and maximum age of patients was 13 and 60 years respectively. Out of 411 patients 207 (50.36%) were males and 204 (49.64%) were females.

Mean Modified Alvarado score for patients was 7.15 points out of 9. Minimum and maximum scores were 2 and 9 respectively. As per MAS acute appendicitis was diagnosed in 352 (85.64%) out of 411 patients. The MAS was not able to diagnose acute appendicitis in 59 (14.36%) patients. Out of 352 patients that were diagnosed as AA, 350 (89.7%) patients were having acute appendicitis on histopathology findings and 2 (9.5%) patients were having negative findings. Out of 59 not having acute appendicitis as per MAS, patients 40 (10.3%) were positive on histopathology and 19 (90.5%) were negative. The sensitivity and specificity for MAS was 89.74% and 90.48% while the positive predictive value and negative predictive values were 99.43% and 32.2% respectively. The diagnostic accuracy of Modified Alvarado score was 89.79%.

Mean Ohmann score for patients was 13.45 points out of 16 points. Minimum and maximum score was 5 points and 16 points respectively. As per Ohmann score, acute appendicitis was diagnosed in 336 (81.75%) patients and 75 (18.25%) patients were not diagnosed with acute appendicitis when Ohmann score was applied. Out of 336 patients 332 (85.1%) were having positive histopathological findings with 4 (19%) negative appendectomies. Out of 75 patients that were not diagnosed by Ohmann score, 54

(14.9%) were positive for acute appendicitis on histopathology and 17 (81%) were negative. The sensitivity and specificity for Ohmann score was 85.13% and 80.95% respectively while positive predictive value (PPV) and negative predicted values (NPV) were 98.81% and 22.67% respectively. The diagnostic accuracy of Ohmann score was 84.91%.

## CONCLUSION

Our study concluded that both scoring systems are sensitive and specific enough for the diagnosis of acute appendicitis. Our results show that the Modified Alvarado score has higher sensitivity and specificity than the Ohmann score, which is in line with the findings of other large research. Further studies should be done in multiple centers to reach a conclusion regarding which is better.

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