

# The Alvarado Score vs Ohmann Score for the Diagnosis of Acute Appendicitis, Calibration with Operative and Histopathological Confirmations

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**Abstract:** Alvarado score and Ohmann Score has been used traditionally in preoperative diagnosis of acute appendicitis. The validity of the score in certain patients groups and at different cut points is still debatable. This study is aimed to assess the calibration performance of Alvarado scores and Ohmann scores with the operative and histopathological reports. **Methods** We assessed the accuracy of the score at cut of point 6 and 12.5 respectively from the above said scores respectively. Calibration was compared with operative findings and histopathological reports. **Results** A total 198 patients (male >18= 128 male< 18= 12 female >18= 49 female <18= 9) after initial assessment with the Alvarado score and Ohmann Score were included in this study. Of the above 187 patients underwent appendectomy, 01 patient underwent drainage of localized collection and 07 patients where managed conservatively after confirmation of lump. In 3 three cases the surgery but was abandoned due to dense adherent lump intraoperatively. Further there operative findings and histopathological confirmations were calibrated with above scoring systems. Group 1-presented within 24hrs since onset of symptoms- (131/ 198 patients-66 %). Group 2 Who presented history > 24hrs since onset of symptoms- (67 patients/33 %). Group 1 Alvarado score ranged up to 6 predicted – 66 % for acute appendicitis. And Ohmann Score ranged up to 12.5 predicted -38 % for acute appendicitis. But operative and histopathological confirmations of this score were consistent with 120/131=91.6 % towards acute appendicitis and around 8.4 % suggestive of normal or other causes in females and children. Group 2 Alvarado score ranged— up to 10 predicted for acute appendicitis-93 % And Ohmann Score > 13.5-predicted for acute appendicitis-74 %. But operative and histopathological confirmations of this score were consistent with complicated appendicitis.

**Keywords:** Acute Appendicitis, Alvarado score, Ohmann score, calibration

## 1.Introduction

Acute appendicitis is the most common general surgical emergency, and the early surgical intervention improves outcomes. Peak incidence of appendicitis is between 10- 30 years of age. Mean age of 31.3 yrs and a median of 22yrs. The life time rate of appendectomy is 12% for men and 25% for women, though there is a slight male: female predominance (1.2 to 1.3: 1).

Obstruction of lumen is believed to be the major cause of acute appendicitis. This may be due to inspissated stools

fecalith or appendicolith, lymphoid hyperplasia, vegetable matter or seeds, parasites or a neoplasm.

The diagnosis of appendicitis can be difficult, occasionally taxing the diagnostic skills of even the most experienced surgeons. Likewise the judgemental decisions in the management of patients with appendiceal inflammation or abscess can be difficult. Delays in diagnosis arise from errors on the part of either patients or physician and delays complicate the illness. Present COVID situations and lock downs has even worsened the diagnostic due to non availability and precautionaries for radiological evaluation. Hence a reliable scoring system was felt essential.

| <i>Alvarado score</i>   | <i>Score</i> | <i>Ohmann score</i>  | <i>Score</i> |
|---|--------------|--|--------------|
| Migration of pain to the right lower quadrant                                       | 1            | Tenderness in the right lower quadrant 4.5   | 4.5          |
| Anorexia  | 1            | Rebound tenderness 2.5   | 2.5          |
| Nausea/vomiting   | 1            | No difficulty with micturition 2.0   | 2.0          |
| Tenderness in the right lower quadrant  | 2            | Steady pain 2.0  | 2.0          |
| Rebound pain 1  | 1            | Leukocytosis ( $\geq 10,000$ white blood cells per mm <sup>3</sup> [10 × 10 <sup>9</sup> per l]) 1.5   | 1.5          |
| Shift of wbc count to the left (> 75 percent neutrophils)                           | 1            | Age less than 50 years 1.5   | 1.5          |
| Elevated temperature ( $\geq 99.1^{\circ}$ f [37.3° c])                             | 1            | Migration of pain to the right lower quadrant 1.0  | 1.0          |
| Leukocytosis ( $\geq 10,000$ wbcs per mm <sup>3</sup> [10 × 10 <sup>9</sup> per l]) | 2            | Abdominal rigidity 1.0   | 1.0          |
| <b>Prediction if pt has acute appendicitis</b><br>1-4- 30% 5-6- 66% 7-10- 93%       | 10           | <b>Prediction if pt has acute appendicitis</b><br><b>Low-</b> < 4-0% 4.0 to 5.5-3%<br><b>Moderate-</b> 6.0 to 7.5- 10%- 8.0 to 9.5-15% 10.0 to 11.5- 24%<br><b>High-</b> 12.0 to 13.5-38% >13.5- 74% | 16           |

There are many scoring systems which are available for discriminating between acute appendicitis and non specific abdominal pains. Alvarado score and ohmann score has been used in this study since these are traditionally used in preoperative diagnosis of acute appendicitis. Though the validity of these scores in certain patients groups and at

different cut points is still debatable. () further none of the scoring systems are considered ideal since negative appendectomy rate is still high in the best of centers with all available radiological investigations.

This study is aimed to assess and calibrate the performance of alvarado scores and ohmann scores with the operative and histopathological reports. Such that a ideal judgmental score can be found which can be useful in the situations where radiological evaluation are limited and in present COVID pandemic like scenarios and in conditions where radiological investigations are difficult viz peripheral military hospitals and government hospital.

**2.Methods**

This study was carried out in multiple government service hospitals from 2009 to may 2020. Here we also considered the non availability of radiological evaluation in certain situation and in present COVID pandemic scenario, where your clinical examination and finding have to judge the requirement of surgery. Though there are many literatures which accepts surgical appendectomy even for normal appendix than waiting and ending with complications. (2)

But still it was felt ethically important to assess and conclude based on important and time tested scoring systems as suggested by surgical text books. Here we have chosen the alvarado score and Ohmann Score. Since they were commonly used and data was also available.

We assessed the accuracy of the score to a cut of point of Alvarado Score Ranged— up to 5-6 which predicted – 66% for acute appendicitis and Ohmann Score-upto 11- 12.5 which predicted of only -38% for acute appendicitis.

Calibration was compared with operative and pathological reporting.

**3.Results**

A total 198 patients (male >18= 128 male< 18= 12 female >18= 49 female <18= 9) where included after initial assessment with the Alvarado Score And Ohmann Score.

We divided the patients as group- 1 which included patients who presented within 24hrs of onset of pain ( 131patients) and had the Alvarado Score Ranged— up to 5-6 and Ohmann Score - 11- 12.5.and the group-2 who presented with history of more than 24 hrs of onset of pain. ( 67 patients)

Patients who were not included in the study were females who had missed menstrual cycles. And known case of ureteric calculi/ ureteric colic who resolved after analgesic and where further confirmed by ultrasonography. This study also did not include a normal or asymptomatic patient which was felt essential for specificity and predictions.

Table 1 depicting score for both the group of patients and their predominance

Group 1- 131/ 198 patients (66%)- presented within 24hrs of onset of symptoms. these patients mainly had the following scores which ranged Alvarado score ranged— up to 6 And ohmann score - up to 12.5 and prediction for acute appendicitis are 66% and 38% respectively.

But operative and hpe of this score were consistent with 120/131=91.6% sensitive towards acute appendicitis and around 8.4% suggestive of normal or other causes in females and childrens.

Group 2 who presented history > 24hrs- 67 patients (33%) these patients mainly had the following scores which ranged Alvarado score ranged— >= 7 And ohmann score > 13.5 with predictions for acute appendicitis>93% and>74% respectively. Score variable chart is as on table (1)

Of the above 187 patients underwent appendectomy, 1 patient underwent laparotomy and peritoneal lavage for gangrenous appendix and 7 patients where managed conservatively after confirmation of lump. In 3 three cases the surgery but was abandoned due to dense adherent lump intraoperatively. This is as indicted in table (2)

|  | Alvarado score<br>Score/<br>Ohmann score | < 24h | > 24h | <24h<br>Score<br>variable<br>% | >24h<br>Score<br>variable<br>% | %<br>overall<br>variable |
|--|--|-------|-------|--------------------------------|--------------------------------|--------------------------|
| Migration of pain to the right lower quadrant / common in both score                       | 1/1                                      | 131   | 52    | 66.16                          | 26.26                          | 92.42                    |
| Anorexia   | 1  | 5     | 67    | 2.5                            | 33.83                          | 36.33                    |
| Nausea/vomiting  | 1  | 3     | 65    | 1.5                            | 32.82                          | 34.32                    |
| Tenderness in the right lower quadrant / mc burneys point tenderness- common in both score | 2/4.5                                    | 131   | 67    | 66.16                          | 33.83                          | 99.99                    |
| Rebound pain tenderness/ common for both   | 1 / 2.5                                  | -     | 54    | 0                              | 27.27                          | 27.27                    |
| Shift of wbc count to the left (> 75 percent neutrophils)                                  | 1  | 100   | 67    | 50.50                          | 5.55                           | 71.66                    |
| Elevated temperature (≥ 99.1° f [37.3° c])   | 1  | -     | 60    | 0                              | 30.30                          | 30.30                    |
| Leukocytosis (≥ 10,000 wbcs per mm3 [10 × 10 <sup>9</sup> per l]) common in both score     | 2/1.5                                    | 131   | 60    | 66.16                          | 30.30                          | 96.46                    |
| No difficulty with micturition 2.0   | 2.0                                      | 131   | 67    | 66.16                          | 33.83                          | 99.99                    |
| Steady pain 2.0  | 2.0                                      | 131   | 67    | 66.16                          | 33.83                          | 99.99                    |
| Age less than 50 years   | 1.5                                      | 131   | 67    | 66.16                          | 33.83                          | 99.99                    |
| Abdominal rigidity 1.0   | 1.0                                      | -     | 63    | 0                              | 31.82                          | 31.82                    |
| Persistent tachycardia- constant finding apart from the score                              |  | 131   | 60    | 66.16                          | 30.30                          | 96.46                    |

**Table 2:** Histopathological Results /Intraoperative Findings/ Patient-Male /Female / Mean Age

| Histopathological Results /Intraoperative Findings/ Patient-Male /Female / Mean Age   | M>18 | M<18 | F>18 | F<18 |
|---|------|------|------|------|
| Acute appendicitis -120 -95/25 mean age- 21yrs  | 92   | 3    | 23   | 2    |
| Normal appendix-6- 4/2 mean age 9yrs  | 3    | 1    | 2    | 0    |
| Normal appendix with mesenteric adenitis with free fluid- 3- 1/2 mean age 7yrs  | 0    | 1    | 0    | 2    |
| Ovarian cyst ruptured-2-0/2 avg age- 24.5yrs  | 0    | 0    | 2    | 0    |
| Gangrenous but intact appendix with serous peritonitis -10 - 8/2- mean age 25yrs  | 5    | 3    | 2    | 0    |
| Serous peritonitis with inflamed appendix- 39 - 22/17 mean age 22yrs  | 20   | 2    | 13   | 4    |
| Perforated appendix with purulent peritoneal fluid -3 – 2/1 mean age 32yrs  | 2    | 0    | 1    | 0    |
| Early lump formation- periappendicular collection with thin adhesion -4 - 3/1 mean age- 27yrs                                       | 2    | 1    | 1    | 0    |
| Localised abscess formation requiring only drainage-1 -1/0-mean age- 30yrs  | 1    | 0    | 0    | 0    |
| Lump formation on clinical examination/usg- confirmed conservatively mgt-7- 2/5 mean age- 28yrs                                     | 1    | 1    | 4    | 1    |
| Case abandoned- due to dense adherent lump missed due to rigidity/ obesity /non availability of usg-3 patients 2/1 - mean age-37yrs | 1    | 0    | 2    | 0    |

Operative time was on an average 30 min vs 120 min and postoperative stay 1day vs more than 3 days for the two groups respectively.

Data analysis suggested- patients who presented before 24h– Alvarado score - up to 6 predicting up to 66% for acute appendicitis and Ohmann up to 12.5 predicting for acute appendicitis is 38% but in our study we found these score had a sensitivity of 91.6% for acute appendicitis though specificity cannot be calculated due to absence of negative statistics and the normal non symptomatic patients who had the probability of developing acute appendicitis.

Further on analysis of the score in between the two groups the following were more consistent for acute appendicitis when presented before 24hrs.

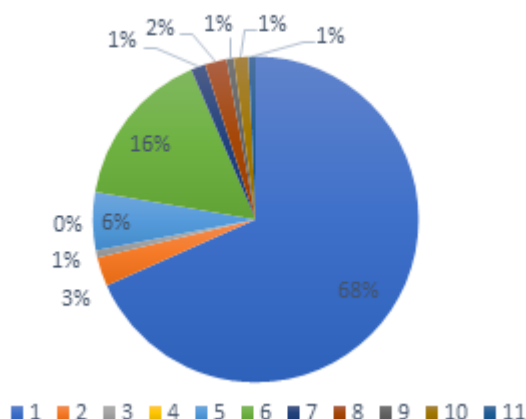
- 1)Steady pain abdomen with no difficulty in micturition and tenderness in the right lower quadrant- 100%
- 2)Leukocytosis ( $\geq 10,000$  white blood cells per mm<sup>3</sup> [10 × 10<sup>9</sup> per L]) and Persistent tachycardia- even after pain control and hydration -96.46%
- 3)Migration of pain to the right lower quadrant, -92.42%

While anorexia, nausea, vomiting, fever/ elevated temperature, rebound tenderness abdominal rigidity and shift of WBC count to the left (> 75 percent neutrophils) were more consistent with delayed presentation and associated complications of acute appendicitis.

**Table 3:** Statistical analysis

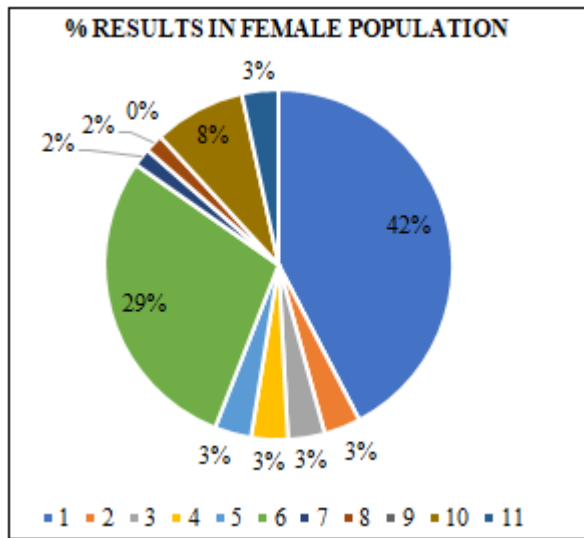
| Histopathological/ intraoperative findings/ patient-male/female / mean age  | M     |      | % of Patients | F    |      | Total | % of Patients |
|---|-------|------|---------------|------|------|-------|---------------|
|   | >18   | <18  |               | >18  | <18  |       |               |
| Acute appendicitis -120 -95/25 mean age- 21yrs  | 92    | 3    | 68%           | 23   | 2    | 120   | 61%           |
| Normal appendix-6- 4/2 mean age 9yrs  | 3     | 1    | 3%            | 2    | 0    | 6     | 3%            |
| Normal appendix with mesenteric adenitis with free fluid- 3- 1/2 mean age 7yrs  | 0     | 1    | 1%            | 0    | 2    | 3     | 2%            |
| Ovarian cyst ruptured-2-0/2 avg age- 24.5yrs  | 0     | 0    | 0%            | 2    | 0    | 2     | 1%            |
| Gangrenous but intact appendix with serous peritonitis -10 - 8/2- mean age 25yrs  | 5     | 3    | 6%            | 2    | 0    | 10    | 5%            |
| Serous peritonitis with inflamed appendix- 39 - 22/17 mean age 22yrs  | 20    | 2    | 16%           | 13   | 4    | 39    | 20%           |
| Perforated appendix with purulent peritoneal fluid -3 – 2/1 mean age 32yrs  | 2     | 0    | 1%            | 1    | 0    | 3     | 2%            |
| Early lump formation- periappendicular collection with thin adhesion -4 - 3/1 mean age- 27yrs                                       | 2     | 1    | 2%            | 1    | 0    | 4     | 2%            |
| Localised abscess formation requiring only drainage-1 -1/0-mean age- 30yrs  | 1     | 0    | 1%            | 0    | 0    | 1     | 1%            |
| Lump formation on clinical examination/usg- confirmed conservatively mgt-7- 2/5 mean age- 28yrs                                     | 1     | 1    | 1%            | 4    | 1    | 7     | 4%            |
| Case abandoned- due to dense adherent lump missed due to rigidity/ obesity /non availability of usg-3 patients 2/1 - mean age-37yrs | 1     | 0    | 1%            | 2    | 0    | 3     | 2%            |
| Mean Patients   | 11.55 | 1.09 |               | 4.55 | 0.82 |       |               |
| Standard Deviation of Data  | 26.01 | 1.08 |               | 6.77 | 1.27 |       | 33.83 17.1%   |

**% RESULTS IN MALES POPULATION**



**Table 4:** % Results in males

|    |   |
|----|---|
| 1  | Acute appendicitis -  |
| 2  | Normal appendix-  |
| 3  | Normal appendix with mesenteric adenitis with free fluid-   |
| 4  | Ovarian cyst ruptured-  |
| 5  | Gangrenous but intact appendix with serous peritonitis  |
| 6  | Serous peritonitis with inflamed appendix   |
| 7  | Perforated appendix with purulent peritoneal fluid  |
| 8  | Early lump formation- periappendicular collection with thin adhesion                                |
| 9  | Localised abscess formation requiring only drainage-  |
| 10 | Lump formation on clinical examination/usg- confirmed conservatively mgt                            |
| 11 | Case abandoned- due to dense adherent lump missed due to rigidity/ obesity /non availability of usg |



**Table 5:** % Results in females

|    |   |
|----|---|
| 1  | Acute appendicitis -  |
| 2  | Normal appendix-  |
| 3  | Normal appendix with mesenteric adenitis with free fluid-   |
| 4  | Ovarian cyst ruptured-  |
| 5  | Gangrenous but intact appendix with serous peritonitis  |
| 6  | Serous peritonitis with inflamed appendix   |
| 7  | Perforated appendix with purulent peritoneal fluid  |
| 8  | Early lump formation- periappendicular collection with thin adhesion                                |
| 9  | Localised abscess formation requiring only drainage-  |
| 10 | Lump formation on clinical examination/usg- confirmed conservatively mgt                            |
| 11 | Case abandoned- due to dense adherent lump missed due to rigidity/ obesity /non availability of usg |

Results in female also showed the second serous peritonitis with inflamed appendix as predominant possibility and development in the group 2 (>24 hrs)

**Table 6**

| t-Test: Paired Two Sample for Means |            |            |
|-------------------------------------|------------|------------|
|                                     | Variable 1 | Variable 2 |
| Mean                                | 75.43      | 60.00      |
| Variance                            | 4,436.11   | 218.62     |
| Observations                        | 14.00      | 14.00      |
| Pearson Correlation                 | (0.29)     |            |
| Hypothesized Mean Difference        | -          |            |
| df                                  | 13.00      |            |
| t Stat                              | 0.80       |            |
| P(T<=t) one-tail                    | 22.0%      |            |
| t Critical one-tail                 | 1.77       |            |
| P(T<=t) two-tail                    | 43.9%      |            |
| t Critical two-tail                 | 2.16       |            |

**Table 6:** t- Test - For both the set of data above the p-value in case of 1 tailed as well as 2 tailed is >5% (which proves that the null hypotheses is insignificant. Since we found these score had a sensitivity of 91.6% for acute appendicitis though specificity cannot be calculated due to absence of negative statistics and the normal non symptomatic patients who had the probability of developing acute appendicitis in future.)

Further it was also noted that persistent tachycardia had been a constant finding in both the groups. but this variable will

require further studies before including it in the scoring system.

#### 4. Discussion

Acute appendicitis has been a surgical dilemma since ages and till date (1). No conclusive test, evaluation or score is available which can accurately judge the requirement of surgery. Sometimes removal of normal appendix becomes a routine due to such judgments. There are literatures which support the removal of normal appendix rather than delaying surgery and further complicating the situation. (2). This only adds to negative appendectomies rate, which ranges up to 40%, which is much beyond the acceptable up to 20 % (6-8) though sonography which is sometimes easily available at most of the centres but still often unavailable at most of the peripheral government hospital. And further it is completely operator dependent hence the reliability is debatable. Computed tomography (CT) is more accurate but unfortunately it is not available at most of the peripheral hospitals (4, 5). And there are situations like the present COVID scenario where getting such investigation is really a herculian affair. In consideration of above several scoring systems have been developed and modified, to decrease the negative appendectomy and increase the sensitivity and specificity of diagnosing acute appendicitis. (3, 9, 10, 11, 12). Review of literature suggests the criteria for diagnostic quality based on 15% rate of negative appendectomies, 10% negative laparotomy, 35% rate of potential perforation, 15 % rate of overlooked perforation and a 5% rate of overlooked acute appendicitis. (4-5). Above all mis diagnosis and late surgical intervention leads to increased morbidity and mortality. Here in this study we have tried to calibrate the two time tested Alvarado score and Ohmann scores with the intraoperative and the pathological reports of the specimens Here we have compared the prediction of the score per se with the intra operative finding and the histopathological outcomes and confirmations.

To further understand the patho-physiology and progression of symptoms of acute appendicitis we have divided them into two groups. The following chronology of symptoms and evaluation was observed. Steady abdominal pain without difficulty in micturition and on examination tenderness in the rif was present in 100% of patients. History of migration to rif was present in 92.42%. Persistent tachycardia even after pain control and hydration was present in 66.16% with mild to moderate leucocytosis of patients in group 1 or in the initial 24 hrs from onset. While history of anorexia nausea, vomiting, fever, constipation and obstipation and examination findings abdominal rigidity and rebound tendernes and moderate to severe leucocytosis with left side shift presented most often after 24 hours from onset. And they usually had a complicated outcomes intra operatively. It was also learned that 66% patients usually present in the initial 24hrs due to pain abdomen. Hence timely intervention can improve the outcomes significantly.

#### 5. Conclusion

From this study we have come to a relative conclusion that we must understand the progression of acute appendicitis. And further the predictive values as suggest by these score



will require a mild to moderate calibration based on history, clinical examination and evaluations even in the absence of radiological assistance so that we can judge and intervene timely and avoid complications. Since increased caliber of the Alvarado score up to 6 and Ohmann score up to 12.5 is more consistent with acute appendicitis and further scores of each are usually complicated appendicitis. Timely intervention based on clinical diagnosis rather than further investigations is the key to avoid further complications.

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