**ORIGINAL ARTICLE**

# To Assess the Diagnostic Accuracy of Alvarado Scoring System by Placing Variables in Time Scale for the Diagnosis of Acute Appendicitis

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## ABSTRACT

Acute appendicitis is one of the commonest surgical emergencies received in the surgical ERs. The incidence is 1.5 to 1.9 per 1000 population. The diagnosis of acute appendicitis is mainly clinical judgment of the attending clinician. However the efficacy of the diagnosis can be improved and the chances of negative appendectomies can be decreased by following different diagnostic criteria. We worked on Alvarado scoring system and found out that the outcome of right diagnosis can be improved by adjusting different variables of the scoring system into time frame. For example the patient presenting in 2-3 hours of acute attack may not have elevated leucocyte counts or even anorexia, similarly the clinical judgment will mainly depend on experience of the clinician. We propose few changes in the alvarodo scoring syetem to make it more diagnosis friendly.

The study was conducted in the emergency department by one of the three units at Sir Ganga Ram Hospital, Lahore. A total number of 190 cases were evaluated during a period of six months. Mean age of the patients included in the study was 30.34±9.47 years. Mean time of presentation to the ER 16.60 ±6.91 hours. 75.8% were suspected of suffering from acute appendicitis by applying Alvarado

**Keywords:** Alvarado scoring system, time scale, acute appendicitis

## INTRODUCTION

Acute appendicitis is common cause of acute abdomen in surgical patients. Its incidence is 1.5-1.9/1000 in male and female population respectively[1]. The diagnosis of Acute Appendicitis is based mainly on a clinical diagnosis. A study done by Salahuddin et al. observed that the incidence was 48% of acute appendicitis i.e.36 out of 75 cases[8].

In order to aid the clinical judgment the Alvarado Scoring System has been found to be convenient and inexpensive decision making tool; however, points have been raised about the application of Alvarado scoring system in the diagnosis of acute appendicitis and needs to be improved. This study was conducted in order to improve the Alvarado scoring system by placing different variables in time frame i.e. the total duration of time started from the onset of that particular symptom at the time of presentation in ER

Clinical prediction rules have the potential to reduce the diagnostic error[3]. But the utility of clinical scores (namely Alvarado score) in the diagnosis of acute appendicitis remains controversial[4]. Moreover, differences in accuracy have been observed if the scores were applied to different populations and clinical settings[5].

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According to one study in Karachi, Pakistan, in 2013 the sensitivity and the specificity of Alvarado scoring system is 93.5% and 80.6% respectively[6]. Another study was conducted in 2014, according to which clinical judgment had better specificity and sensitivity than the Alvarado scoring system, in which number of negative appendectomies was 12 when diagnosed by applying Alvarado scoring system and 5 when diagnosed clinically[7]. So it can be studied further to improve the sensitivity and specificity of Alvarado scoring system for better diagnosis of acute appendicitis.

Alvarado Scoring System

| | | | **Scores** |
|---|---|---|---|
| Symptoms | M | Migratory right iliac fossa pain | 1 |
| | A | Anorexia | 1 |
| | N | Nausea | 1 |
| Signs | T | Tenderness | 2 |
| | R | Rebound tenderness | 1 |
| | E | Elevated temperature | 1 |
| Laboratory Investigation | L | Leukocytosis | 2 |
| | S | Shift to left | 1 |
| Total | | | 10 |

Alvarado is one of the most commonly applied scoring system helping in difficult or borderline cases. However, one of the dilemmas faced by surgeons in emergency is the possible changes in various variables of Alvarado score depending upon time of

presentation from onset of symptoms. A patient presenting within 1 or 2 hours of onset of symptoms may still have no migration of pain or rebound tenderness in right lower quadrant. Shifting of pain may not be seen in about 30% of patients with acute appendicitis[16]. Similarly white cell count may not be elevated or shift to left may not be apparent in early hours of presentation. This leads to missing the diagnosis in some patients with acute appendicitis.

This cross sectional study is planned to assess the diagnostic accuracy of Alvarado score over different time intervals from onset of symptoms. It will help the surgeon to make the diagnosis of acute appendicitis more confidently by keeping in mind these cut points for patients presenting at different time intervals.

## MATERIALS AND METHODS

This cross sectional study was conducted at department of surgery, Sir Ganga Ram Hospital, Lahore during a period of months from 28/08/2015 to 27/02/2016. Sample size of 190 patients was calculated with 95% confidence level and 5% margin of error for sensitivity 93.5% and 8% margin of error for specificity 80.6% of Alvarado score in the diagnosis of acute appendicitis taking expected percentage of acute appendicitis to be 48%. Sampling technique was non-probability, consecutive sampling.

**Inclusion criteria**

1. All patients who presented with right iliac fossa pain, tenderness, and rebound tenderness (i.e., clinically suspected acute appendicitis) in surgical emergency of Sir Ganga Ram hospital Lahore.
2. Patients of both genders male and female.
3. All patients above 14 years to 60 years of age who gave written and informed consent.

**Exclusion criteria**

1. Patients with other urological and gynecological problems e.g. pelvic inflammatory disease/urinary tract infection (as assessed by history taking and examination like per vaginal discharge, burning micturition, frequency, urgency).
2. Patients with significant co morbidities falling under American society of anesthesia grade III & IV

## RESULTS

The age of the patients ranged from 17 years to 56 years with a mean of 30.34±9.47 years. Majority 115(60.5%) of the patients were aged between 17-29 years followed by 30-42 years 49(25.8%) and 43-56 years 26(13.7%). There were 129(67.9%) male and 61(32.1%) female patients in the study group. The time of presentation ranged from 5 hours to 28 hours with a mean of 16.60±6.91 hours. Most of the patients 86(45.3%) presented during 12-24 hours followed by <12 hours 66(34.7%) and 24-48 hours 38(20%) as shown in Table 1.

144(75.8%) patients were suspected of acute appendicitis on Alvarado score while upon surgery acute appendicitis was confirmed in 148(77.9%) patients as shown in Table 2. When cross-tabulated, there were 140 true positive cases, 4 false positive cases, 8 false negative cases and 38 true negative cases. It yielded 94.59% sensitivity, 90.48% specificity, 97.22% positive predictive value, 82.61% negative predictive value and 93.68% accuracy for Alvarado score in predicting acute appendicitis taking surgical findings as gold standard. When stratified, sensitivity of Alvarado score was higher in young; 17-29 vs. 30-42 vs. 43-56 years (97.75% vs. 90.48% vs. 88.24%), males; male vs. female (94.95% vs. 93.88%) and those who presented with in first 12 hours; >12 vs. 12-24 vs. 24-48 hours (98.00% vs. 94.52% vs. 88.00%).

Table 1 Baseline Characteristics of the Patients

| **Characteristics** | **Participants (n=190)** |
|---|---|
| Age (years) | 30.34±9.47 (17 - 56) |
| Age Groups | |
| • 17-29 years | 115 (60.5%) |
| • 30-42 years | 49 (25.8%) |
| • 43-56 years | 26 (13.7%) |
| **Gender** | |
| • Male | 129 (67.9%) |
| • Female | 61 (32.1%) |
| Time of presentation (hrs) | 16.60±6.91 (5-28) |
| Time of presentation groups | |
| • <12 hours | 66 (34.7%) |
| • 12-24 hours | 86 (45.3%) |
| • 24-48 hours | 38 (20.0%) |

Table 2 Frequency table for Alvarado Score and surgical diagnosis of acute appendicitis (n=190)

| | **Acute Appendicitis** | **n** |
|---|---|---|
| Alvarado Score | 144 (75.8%) | 46(24.2%) |
| Surgical Findings | 148 (77.9%) | 42(22.1%) |

Table 3: Contingency Table for Senility and Specificity Analysis with Stratification

| | Diagnosis on Alvarado Score | Diagnosis on Surgical Findings | | P value | Sensitivity and Specificity |
|---|---|---|---|---|---|
| | | | No | | |
| Over all | Acute Appendicitis | 140 | 4 | 0.000* | SN= 94.59% SP = 90.48% |
| | No | 8 | 38 | | |
| **Age groups** | | | | | |
| 17-29 years | Acute Appendicitis | 87 | 2 | 0.000* | SN = 97.75% SP = 92.31% |
| | No | 2 | 24 | | |
| 30-42 years | Acute Appendicitis | 38 | 1 | 0.000* | SN = 90.48% SP = 85.71% |
| | No | 4 | 6 | | |
| 43-56 years | Acute Appendicitis | 15 | 1 | 0.001* | SN = 88.24% SP = 88.89% |
| | No | 2 | 8 | | |
| **Gender** | | | | | |
| Male | Acute Appendicitis | 94 | 2 | 0.000* | SN = 94.95% SP = 93.33% |
| | No | 5 | 28 | | |
| Female | Acute Appendicitis | 46 | 2 | 0.000* | SN = 93.88% SP = 83.33% |
| | No | 3 | 10 | | |
| **Time of presentation** | | | | | |
| <12 hours | Acute Appendicitis | 49 | 1 | 0.000* | SN = 98.00% SP = 93.75% |
| | No | 1 | 15 | | |
| 12-24 hours | Acute Appendicitis | 69 | 1 | 0.000* | SN = 94.52% SP = 92.31% |
| | No | 4 | 12 | | |
| 24-48 hours | Acute Appendicitis | 22 | 2 | 0.000* | SN = 88.00% SP = 84.62% |
| | No | 3 | 11 | | |

*Cross-tabulation with Chi-square test, * Statistically significant p<0.05, SN Sensitivity, SP Specificity*

## DISCUSSION

Acute appendicitis is a common cause of acute abdomen in surgical patients with an incidence of 1.5-1.9/1000 in male and female population. Although investigations help to reduce unnecessary operations to remove the normal appendix but appendicitis remains mainly a clinical diagnosis[1]. The Alvarado scoring system is a convenient and inexpensive decision making tool which helps the surgeons to clinically diagnose a case of suspected acute appendicitis[2]. However it depends upon the surgeon's ability to properly perform and interpret the score as evident from variation in the existing evidence on its sensitivity and specificity. Thus there was need to perform this study in local setup to determine the sensitivity and specificity of Alvarado score in predicting acute appendicitis.

The objective of this study was to determine the diagnostic accuracy of Alvarado scoring system in predicting acute appendicitis by taking surgical findings as gold standard. It was a cross-sectional study conducted at Department of Surgery, Sir Ganga Ram Hospital Lahore 6 months from 28/08/2015 to 27/02/2016. This study involved 190 patients of both genders, aged between 14-70 years presenting with right iliac fossa pain, tenderness, rebound tenderness (i.e. clinically suspected acute appendicitis) in surgical emergency of Sir Ganga Ram Hospital, Lahore. A written informed consent was obtained from every the age of the patients ranged from 17 years to 56 years with a mean of 30.34±9.47 years. Kanumba et al. in 2011 observed a similar mean age of 29.64±12.97 years among acute appendicitis patients in Africa[5]. A relatively lower mean age of 24.80±9 years was observed by Memon et al. in 2009 in patients presenting at Pakistan Institute of Medical Sciences Islamabad with right iliac fossa pain[6]. Jalil et al. in 2011 (22.27±7.67 years)[9] and Soomro et al. in 2008 (20.47 years)[14] however observed much lower mean age in local population.

Majority (n=115, 60.5%) of the patients were aged between 17-29 years followed by 30-42 years (n=49, 25.8%) and 43-56 years 26(13.7%). A similarly higher proportion of young patients was also observed by Talukder et al. in 2009 who observed that 71% of the patients were aged between 10-30 years followed by 31-40 years (17%) and 41-60 years (12%)[11.]

There were 129 (67.9%) male and 61(32.1%) female patients in the study group. A similar male predominance has also been observed by Soomro et al. in 2008 (66.07% vs. 33.92%)[10], Memon et al. in 2009 (65% vs. 35%)[12], Memon et al. in 2013 (71.8% vs. 28.2%)[6], Jalil et al. in 2011 (58% vs. 42%)[9] in local population, Talukder et al. (58% vs. 42%)[11] in Bangladeshi population and Pogorelić et al. in 2015 (55.3% vs. 44.7%)[13] in European population. Kanumba et al. however observed female predominance in African such patients (29.1% vs. 70.9%)[5].

144(75.8%) patients were suspected of acute appendicitis on Alvarado score while upon surgery acute appendicitis was confirmed in 148(77.9%) patients. A similar frequency of confirmed cases among suspected cases of acute appendicitis has been reported by Memon et al. in 2013 (71.3%)[6], Kanumba et al. in 2009 (66.9%)[5], Talukder et al. in 2009 (84%)[11], and Pogorelić et al. in 2015 (85.2%)[13]. Soomro et al. in 2008 (96.22%)[10] observed much higher frequency of confirmed acute appendicitis while much lower frequency has been reported by Salahuddin et al. in 2012 (48%)[8]. The negative appendectomy rate in the present study was thus comparable with the existing literature.

When cross-tabulated, there were 140 true positive cases, 4 false positive cases, 8 false negative cases and 38 true negative cases. It yielded 94.59% sensitivity, 90.48% specificity, 97.22% positive predictive value, 82.61% negative predictive value and 93.68% accuracy for Alvarado score in predicting acute appendicitis taking surgical findings as gold standard. Our results match with those of Kanumba et al. in 2011 who observed the sensitivity, specificity, positive predictive, negative predictive values and accuracy of Alvarado score to be 94.1%, 90.4%, 95.2%, 88.4% and 92.9% respectively[5]. The results of the present study are also comparable with a number of other studies reviewed in Table 9.1 apart from Jalil et al. in 2011 (SN=66%, SP=81%)[9] and Memon et al. in 2009 (SN=58.2%, SP=88.9%) who observed quite lower sensitivity and specificity of Alvarado Score. This variation can be due to difference in surgeon's ability to properly perform and interpret the Alvarado score.

When stratified, sensitivity of Alvarado score was higher in young patients; 17-29 vs. 30-42 vs. 43-56 years (97.75% vs. 90.48% vs. 88.24%). Our observation is in line with that of Wani et al. in 2006 who also observed gradual decline in sensitivity of Alvarado score with increasing age in both male and female patients[15].

When stratified, sensitivity of Alvarado score was higher in males; male vs. female (94.95% vs. 93.88%) our observation is in line with that of Jalil et al. in 2011 ((97% vs. 92%)[9], Talukder et al. in 2009 (93% vs. 84%)[11] and Kanumba et al. in 2011 (95.8% vs. 88.3%)[5] who also observed similar difference in the sensitivity of Alvarado score between male and female patients.

When stratified, sensitivity of Alvarado score was higher in patients who presented with in first 12 hours; >12 vs. 12-24 vs. 24-48 hours (98.00% vs. 94.52% vs. 88.00%). A similar temporal association has also been reported by Wani et al. in 2006; <24 vs. 24-48 hours vs. >48 hours (71.1% vs. 58.8% vs. 33.33%)[15].

Thus Alvarado score was 94.59% sensitive, 90.48% specific and 93.68% accurate with a positive predictive value of 97.22% and negative predictive value of 82.61% in predicting acute appendicitis taking surgical findings as gold standard.

The results of the present study are comparable with a number of existing local and international studies and thus advocate the use of Alvarado score in predicting acute appendicitis in patients presenting with right lower quadrant pain in future practice.

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