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Original Research Article

Comparison between AIR score and Alvarado score in cases of non-perforated and perforated acute appendicitis

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ABSTRACT

Background: Acute abdominal pain is a common complaint in the emergency department. Diagnostics of one of the most common pathologies behind acute abdominal pain, acute appendicitis, has radically changed over the last decades. There are several different diagnostic scores for suspected acute appendicitis. The Alvarado score being most widely known. Appendicitis Inflammatory Response (AIR) score was designed to overcome drawbacks of previous scores. This score incorporated the C-reactive protein value in its design and was developed and validated on a prospective cohort of patients with suspicion of acute appendicitis.
Methods: Patients with pain in RIF were admitted. Scores were assessed, patients whose score was significant by either of the system were subjected for appendicectomy. The specimens of appendix were sent for histo-pathological examination (HPE). Post-operative histopathology report was correlated with the scores. Sensitivity, specificity, positive predictive value and negative predictive for AIR and Alvarado score were calculated.
Results: For scores >4, AIR score has higher sensitivity and specificity. The negative predictive value (NPV) of AIR score was higher and the positive predictive value (PPV) of AIR score was also high. For scores >8, Alvarado score has higher sensitivity as compared to AIR score whereas AIR score has higher specificity as compared to Alvarado score. NPV of Alvarado score was higher while PPV of AIR score was higher.
Conclusions: In this study AIR score had Alvarado score displaying higher sensitivity and specificity.

Keywords: Appendicitis inflammatory response, C-reactive protein, Computed tomography, Erythrocyte sedimentation rate, Magnetic resonance imaging, Right lower quadrant, Receiver operating characteristics

INTRODUCTION

Acute abdominal pain is a common complaint in the emergency department, diagnostics of one of the most common pathologies behind acute abdominal pain, acute appendicitis, has radically changed over the last decades. Traditionally, the diagnosis of appendicitis was made solely based on clinical symptoms and signs, and later diagnosis included results of inflammatory laboratory variables such as leukocytes, neutrophils, and C-reactive Protein (CRP).[1-3]

The vermiform appendix is considered by most to be a vestigial organ; its importance in surgery is only due to its tendency for inflammation resulting in the syndrome called acute appendicitis. Acute appendicitis is the most common cause of an "acute abdomen" in young adults. Appendectomy is the most frequently performed emergency abdominal operation.

The rate of appendectomy is 12% for men and 25% for females.[4] Obstruction of the appendix lumen is important, some form of luminal obstruction by either a faecolith or stricture is found in the majority of cases. Obstruction of orifice by tumor (carcinoma of the caecum) is a cause of acute appendicitis, in middle age and elderly.[5]

Continuous secretion of mucinous fluid in an obstructed viscous lead to increase in intraluminal pressure sufficient to cause collapse of draining veins this leads to ischemic injury to the appendix. Ischemia favours bacterial proliferation with additional inflammatory edema and exudation, further hampering the blood supply. It is observed that a significant minority of inflamed appendices does not have any luminal obstruction and the pathogenesis of inflammation remains unknown.

Perforation of gangrenous appendix carries significant risk of morbidity and mortality. Overall rate of perforated appendicitis is 25.8% of the total cases.[2] Faecoliths are found nearly in 90% of the patients with acute gangrenous appendicitis with rupture.[6]

The development of imaging modalities, especially that of computed tomography (CT), has enabled more accurate diagnostics with a significant decrease in false positive diagnoses, which has led to lower rates of negative appendectomies.[7,8]

Ultrasound (US) is often used as a primary imaging method to avoid radiation induced by CT. Though US is often inconclusive.[9-11] Scoring has often been simply investigated in the surgical literature as an alternative to imaging.[12] The aim is to achieve accurate diagnosis with minimal risks, delays, and costs in a standardized manner independent of the experience level of the clinician.[13,14]

There are several different diagnostic scores for suspected acute appendicitis. The Alvarado score is the most widely known of these scores. The Alvarado score was originally developed for both paediatric and adult patients, and includes eight clinical and laboratory variables.[15]

The Appendicitis Inflammatory Response Score (AIR) was published in 2008 and is similar to the Alvarado score in many aspects but emphasizes the inflammatory response laboratory results and seems to perform better compared to the Alvarado score.[16,17]

The recently introduced AIR score was designed to overcome these drawbacks. This score incorporated the CRP value in its design and was developed and validated on a prospective cohort of patients with suspicion of acute appendicitis.[18]

Scoring systems have been designed to aid in the clinical assessment of patients with acute appendicitis. The Alvarado score is the most well known and best performing in validation studies, but it has some drawbacks. Its construction was based on a review of patients who had been operated with suspicion of appendicitis, whereas the score is supposed to be used on all patients with suspicion of appendicitis. Also, the score does not incorporate CPR as a variable, although many studies have shown the importance of CRP in the assessment of patients with appendicitis.[19]

The recently introduced AIR score was designed to overcome these drawbacks.[16] This score incorporated the CRP value in its design and was developed and validated on a prospective cohort of patients with suspicion of acute appendicitis.

Characteristics of the Alvarado score

Interpretation of cumulative Alvarado score:

- 0-4 = not likely appendicitis,
- 5-6 = equivocal,
- 7-8 = probably appendicitis,
- 9-10 = highly likely appendicitis.

Table 1: Characteristics of the Alvarado score.

Symptoms	Migration of abdominal pain to the RLQ	1
	Anorexia	1
	Nausea/vomiting	1
Signs	Tenderness in the RLQ	2
	Rebound pain	1
	Increase of temperature (≥37.3 °C)	1
Laboratory	Leukocytosis (>10,000)	2
	Shift to the left (in a differentiated WBC count) (e.g., neutrophilia >75%)	1

Characteristics of the appendicitis inflammatory response (AIR) score

Interpretation of cumulative AIR score:

- 0-4 = low probability,
- 5-8 = indeterminate group,
- 9-12 = high probability.

Hence, the present study was done at our tertiary care centre to compare the efficacy of AIR score with the Alvarado score in the diagnosis of perforated and non perforated acute appendicitis.

Table 2: Characteristics of the appendicitis inflammatory response (AIR) score.

Clinical parameters	Score
Vomiting	1
Pain in RIF	1
Muscular defence	
Low	1
Mild	2
Severe	3
Temperature >38.5°C	1
Segmented neutrophils	
70-84%	1
>85%	2
Leukocytes	
$>10.0\text{-}14.9\times10^3$	1
$>15.0\times10^3$	2
CRP	
10-49 gm/l	1
>50 gm/l	2
Total	12

METHODS

A hospital based observational study was conducted with 100 patients to compare the efficacy of Appendicitis Inflammatory Response (AIR) score with the Alvarado score in the diagnosis of perforated and non-perforated acute appendicitis. This study was conducted at Dr. D. Y. Patil Medical College and Hospital and Research Centre, Pimpri, Pune, Maharashtra, India. This was a prospective and comparative study. This study was conducted from July 2016 to September 2018. Total 100 cases involved in this study.

Inclusion criteria

All patients who present with pain in right Iliac fossa suggestive of acute appendicitis at Dr. D. Y. Patil Hospital, Pimpri, Pune, Maharashtra, India.

Exclusion criteria

- Patients presenting with any form of non right Iliac Fossa pain such a and those who had undergone other emergency laparotomy where appendicectomy was also performed as a part of the procedure.
- Elective appendicectomy.
- Lump in right Iliac fossa.
- Any other pathology found intraoperatively.
- Immuno compromised.
- All pregnant patients.

Methodology

Informed and written consent of all the patients were taken before including them in study, Detailed examination and investigations of all the patients were carried out as per proforma.

All patients with pain in RIF presenting in the casualty and surgical OPD of Dr. D. Y. Patil hospital, Pimpri, Pune were admitted. History and physical examination were done as per proforma. All routine haematological investigations were done. Scores were assessed.

All the cases were examined clinically thoroughly by a senior faculty and posted for surgical intervention. Laboratory investigations were performed and imaging studies (CT or Ultra sonography) were performed at the discretion of the surgeon in selected cases. Demographic data, clinical examination (signs and symptoms) were noted in separate case record form. Laparotomy or diagnostic laparoscopy was performed and followed by appendectomy. The excised appendix was sent to the histopathological evaluation for confirmation of diagnosis. Based on Histopathological diagnosis, patients were classified into two groups, a) Phlegmonous appendicitis and b) Advanced appendicitis.

Post-operative histopathology reports were correlated with the scores. A score of 5 is the optimal cut off threshold for AIR score and 7 for Alvarado scoring system. Sensitivity, specificity, positive predictive value (PPV) and negative predictive (NPV) for AIR and Alvarado score were calculated.

RESULTS

A hospital based observational study was conducted with 100 patients to compare the efficacy of Appendicitis Inflammatory Response (AIR) score with the Alvarado score in the diagnosis of perforated and non-perforated acute appendicitis.

Distribution of patients according to histopathology findings

Histopathology findings showed that out of 100 patients who were taken into consideration in the study, 90 (90%) patients had acute appendicitis while 10 (10%) patients had chronic appendicitis (Table 3).

Table 3: Distribution of patients according to histopathology findings.

Histopathology Findings	N	%
Acute appendicitis	90	90%
Chronic appendicitis	10	10%
Total	100	100%

Distribution of patients according to AIR and Alvarado score

Majority of patients were present in the score range of 5-8, with 57 (57%) patients being grouped by Alvarado

score and 75 (75%) patients grouped by AIR score. Followed by ≥4 with 15 (15%) by AIR score and 23 (23%) by Alvarado score and least was in >8 10 (10%) by Air score and 20 (20%) by Alvarado score (Table 4).

Table 4: Distribution of patients according to AIR and Alvarado score.

Score	AIR		Alvarado	
	N	%	N	%
≤4	15	15%	23	23%
5-8	75	75%	57	57%
>8	10	10%	20	20%
Total	100	100%	100	100%

Correlation of AIR Score with histopathological findings

AIR diagnosed 85 patients as acute appendicitis (at score >4) of which 5 were false positive cases. AIR score ruled out acute appendicitis (at score <4) in 15 individuals of which 10 were false negative ones (Table 5).

Table 5: Correlation of AIR score with histopathological findings.

Score	AA		CA		Total	
	N	%	N	%	N	%
≤4	10	10%	5	5%	15	15%
>4	80	80%	5	5%	85	85%
Total	90	90%	10	10%	100	100%

AIR diagnosed 10 cases of acute appendicitis (at score >8) with no false positive cases. It was positive side of the score. AIR diagnosed 90 cases of acute appendicitis with score ≤8 out of which 10 were false positive (Table 6).

Table 6: Correlation of AIR score with histopathological findings.

Score	AA		CA		Total	
	N	%	N	%	N	%
≤8	80	80%	10	10%	90	90%
>8	10	10%	0	-	10	10%
Total	90	90%	10	10%	100	100%

Correlation of Alvarado score with histopathological findings

Alvarado score diagnosed 77 patients as acute appendicitis (at score >4) of which 7 were false positive cases. Alvarado score ruled out acute appendicitis (at score <4) in 23 individuals of which 20 were false negative ones (Table 7).

Alvarado score diagnosed 20 cases of acute appendicitis (at score >8) with no false positive cases and 80 cases with score ≤ 8 with 10 false positive cases (Table 8).

Table 7: Correlation of Alvarado score with histopathological findings.

Score	AA		CA		Total	
	N	%	N	%	N	%
≤4	20	20%	3	3%	23	23%
>4	70	70%	7	7%	77	77%
Total	90	90%	10	10%	100	100%

Table 8: Correlation of Alvarado score with histopathological findings.

Score	AA		CA		Total	
	N	%	N	%	N	%
≤8	70	70%	10	10%	80	80%
>8	20	20%	0	-	20	20%
Total	90	90%	10	10%	100	100%

Diagnostic characteristics of AIR score and Alvarado score according to cut-off points

It is observed that for scores >4, sensitivity for AIR score and Alvarado score are 98.33% and 81.33% respectively, specificity 91.20% and 12.33% respectively, PPV 89.22% and 54.92% respectively, NPV 81.66% and 78.26%. While for scores >8 sensitivity for AIR score and Alvarado score are 36.66% and 42.33% respectively, Specificity 97.94% and 96.94% respectively, PPV 70.82% and 66.67% respectively, NPV 84.66% and 94.33% (Table 9).

Table 9: Diagnostic characteristics of AIR score and Alvarado score according to cut-off points.

Value	AIR score		Alvarado score	
	>4 points	>8 points	>4 points	>8 points
Sensitivity (%)	98.33%	36.66%	81.33%	42.33%
Specificity (%)	91.20%	97.94%	12.33%	96.94%
PPV (%)	89.22%	70.82%	54.92%	66.67%
NPV (%)	81.66%	84.66%	78.26%	94.33%

DISCUSSION

A hospital based observational study was conducted with 100 patients to compare the efficacy of Appendicitis Inflammatory Response (AIR) score with the Alvarado score in the diagnosis of perforated and non-perforated acute appendicitis.

Based on many variables which were found in 305 patients with acute appendicitis, The Alvarado was first reported in 1986. Other variations exist but do not differ much.[20,21] A scoring system should be of simple design in order to aid in decision making process for treatment. The goal of scoring system should be to discriminate when there is uncertainty rather than making a diagnosis.

The intent of the scoring system is to discriminate objectively about the uncertainity in diagnosing appendicitis. The added advantage of using such a scoring system is to better describe the patients which are included in the clinical studies, facilitating the comparison of results.

In the present study, histopathology findings showed 90 (90%) patients had acute appendicitis while 10 (10%) patients had chronic appendicitis. Patil S et al, found histopathology which was the gold reported 89 cases as acute appendicitis and 11 cases as chronic appendicitis.[22]

Gopalam PR et al, cross sectional prospective study reported 116 cases of 300 (38.7%) were diagnosed pathologically as appendicitis, with 88 cases as phlegmonous appendicitis and 28 as cases of advanced appendicitis. In the remaining 184 cases which were negative pathologically for appendicitis, other alternate causes of diagnosis were found in 116 cases. All these patients underwent routine follow-up. Nonspecific abdominal pain was found in 72 cases.[23]

Sudhir S et al, study reported overall 109 patients out of 200 had pathologically proven appendicitis. Fifty-three (26.5%) patients had phlegmonous appendicitis, 49 (24.5%) had advanced appendicitis. Seven patients had chronic appendicitis (3.5%). Ninety-one patients out of 200 had no pathologically proven appendicitis.[24]

Majority of patients in our study were present in the score range of 5-8, with 57 (57%) patients being grouped by Alvarado score and 75 (75%) patients grouped by AIR score.

Patil S et al, study reported maximum number of patients were present in score range of 5-8, with 56 patients being grouped by Alvarado score and 73 patients grouped by AIR score.[22]

It was observed in the present study that AIR diagnosed 85 patients as acute appendicitis (at score >4) of which 5 were false positive cases. AIR score ruled out acute appendicitis (at score <4) in 15 individuals of which 10 were false negative ones. AIR diagnosed 10 cases of acute appendicitis (at score >8) with no false positive cases.

Patil S et al, reported AIR diagnosed 84 patients as acute appendicitis (at score >4) of which 4 were false positive cases. It ruled out acute appendicitis (at score <4) in 16 individuals of which 9 were false negative ones. AIR could diagnose 11 cases of acute appendicitis (at score >8) with no false positive cases.[22]

In our study, Alvarado score diagnosed 77 patients as acute appendicitis (at score >4) of which 7 were false positive cases. Alvarado score ruled out acute appendicitis (at score <4) in 23 individuals of which 20 were false negative ones. Alvarado score diagnosed 20 cases of acute appendicitis (at score >8) with no false positive cases.

Patil S et al, reported Alvarado diagnosed 75 patients as acute appendicitis (at score>4) of which 5 cases were false positive ones. Alvarado ruled out acute appendicitis (at score<4) in 25 individuals of which 19 were false negative ones. Alvarado score (at score >8) correctly diagnosed in 19 individuals with zero false positive cases.[22]

Gopalam PR et al, cross sectional prospective study reported 146 out of 300 cases were placed under low risk category by scoring less than 5 points, with 16 cases of Phlegmonous appendicitis and 2 cases of advanced appendicitis. In the cases scored by Alvarado scoring, 102 cases were of lower risk category with 21 phlegmonous and 6 cases of advanced appendicitis. Of the 184 cases of non-appendicitis group, AIR scoring correctly identified 128 cases as low risk group as compared to Alvarado scoring which classified 75 cases as low risk category. AIR scoring classified 50 cases as high risk (>8 score), all were pathologically diagnosed as appendicitis. In comparison Alvarado scoring identified 86 cases as high risk with 27 cases not diagnosed pathologically. The AIR score identified 90 of total 126 negative appendectomies as low risk group, and none to the high-risk group. But in Alvarado scoring, 17 cases were in high risk and 20 cases in low risk group.[23]

It was observed in the present study that for scores >4, AIR score has higher sensitivity and specificity (98.33% and 91.20%) as compared to Alvarado score (81.33% and 12.33%). The negative predictive value (NPV) of AIR score and Alvarado score was 81.66% and 78.26% respectively while the positive predictive value (PPV) of AIR score and Alvarado score was 89.22% and 54.92% respectively. For scores >8, Alvarado score has higher sensitivity as compared to AIR score (42.33% vs. 36.66%) whereas AIR score has higher specificity as compared to Alvarado score (97.894% vs. 96.94%). The negative predictive value of AIR score and Alvarado score was 84.66% and 94.33% respectively.

Gopalam PR et al, cross sectional prospective study reported in cases with score >4 points, similar sensitivity was observed with AIR and Alvarado scoring (0.94 vs. 0.90) but gave more specificity (0.87 vs. 0.54). For AIR score, negative predictive value is 0.94 in comparison to the negative predictive value of 0.90 for Alvarado score. In cases with >8 points, a lower sensitivity was observed in AIR scoring than Alvarado scoring (0.26 vs. 0.12) but was associated with higher specificity (1.00 vs. 0.95). In these cases, PPV turned out to be 1.00 for AIR scoring and 0.77 for Alvarado scoring.[23]

Patil S et al, study reported sensitivity of AIR of 89.9% (at score >4), Both AIR and Alvarado (at score >8) demonstrated specificity of 12.3% and 21.3%

respectively and specificity of Alvarado (at score >4) at 54.5%.[22]

Sudhir S et al, study reported cases of phlegmonous appendicitis, for scores >4, Alvarado score has high sensitivity (97.06) compared to AIR score (78.43). Whereas AIR score has high specificity (89.8 vs. 10.02) which translates to negative predictive value of 80% and 76.92% for AIR score and Alvarado score, respectively. For scores >8, Alvarado score has high sensitivity and specificity compared to AIR score, 33.33 versus 20.59 and 97.96 versus 96.94 respectively. This translates to negative predictive value of 58.54 and 53.98 for Alvarado score and AIR score, respectively.[24]

Even after the introduction of ultra sonography, computed tomography, and diagnostic laparoscopy. The management of patients with suspected acute appendicitis is still challenging, and the optimal management strategy is still unknown.

In this study with a high discriminating power AIR score externally validating that the AIR score has a high discriminating power and performs equally with the Alvarado score at high score values. This score could help in selecting patients who require surgery in time or those who require further investigations. Finally, the score could safely avoid hospitalization and non specific investigations in patients with an unlikely diagnosis, making such a scoring system important for future research and result comparison.

CONCLUSION

Although acute appendicitis is one of the commonest surgical emergencies, its management is still challenging. Appendicitis inflammatory response score was better than Alvarado score displaying higher sensitivity and specificity. AIR scoring performed well almost equally with Alvarado system with high specificity and high negative predictive value preventing unnecessary negative appendectomies. Follow up of these cases will help in deciding surgical intervention in unnecessary cases. This scoring system also prevents unnecessary and costly radiological investigations thereby reducing the financial burden to the patients.

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