EVALUATION AND COMPARISON OF THE ACCURACY AND EFFICACY OF ALVARADO AND APPENDICITIS INFLAMMATORY RESPONSE SCORING IN ACUTE APPENDICITIS

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ABSTRACT

INTRODUCTION

Acute appendicitis (AA) is one of the most common causes of acute abdominal pain. Early surgery for acute appendicitis may lead to inadequate evaluation of differential diagnoses of acute abdominal pain and increases the chances of negative appendectomy, whereas delaying it leads to potential complications. Appendicitis inflammatory response (AIR) score, has been created to overcome shortcomings of the Alvarado score. In this, a mathematical model focused on detecting perforated appendicitis has been used. Unlike previously reported scores, this included C-reactive protein (CRP), which had been previously reported to have high accuracy in discriminating between simple and advanced acute appendicitis.

MATERIAL AND METHODS

Observational Cross sectional study was done in all patients admitted to UCMS hospital diagnosed to have acute appendicitis from October 2019 to March 2021. The primary objective was to determine if use of Appendicitis Inflammatory Response Score is better suited for planning management of patients with acute appendicitis. Comparison between groups was done with one-way Analysis of Variance (ANOVA). Receiver Operating Curve (ROC) was used to identify whether Appendicitis inflammatory response (AIR) score or Alvarado score was good predictor of acute appendicitis. Sensitivity, Specificity and Area under Curve (AUC) was used as indicators to predict the acute appendicitis.

RESULTS

In our study, the sensitivity of Appendicitis inflammatory response (AIR) score is high (85.4%) as compared to 82.3% of Alvarado score.

CONCLUSION

We concluded that Appendicitis inflammatory response (AIR) score is more reliable scoring system for the diagnosis of acute appendicitis and its use can be justified over the pre-existing Alvarado scoring.

KEYWORDS

Acute appendicitis, Appendicitis inflammatory response score, Alvarado score

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INTRODUCTION

Acute appendicitis is one of the most common causes of acute abdominal pain requiring operative management, and the lifetime probability of having this condition is approximately 7%. Early surgery may lead to inadequate evaluation of differential diagnoses of acute abdominal pain and increases the chances of negative appendectomy, whereas delaying it leads to potential complications.[1] Negative appendectomy although worrisome, is observed in 15–30% of cases, even to this date, where a decision for surgery is made based on the clinical symptoms and findings only. Delaying diagnosis may prove disastrous as various complications, including perforation, peri-appendicular abscess, wound infection, intraabdominal adhesion, sepsis etc. ensue.[1,2]

Multiple other conditions have the clinical presentation similar to that of acute appendicitis, like acute gastroenteritis, mesenteric lymphadenitis, torsion of intraabdominal organs, Meckel's diverticulitis, Crohn's disease, etc. Typical clinical appearance of acute appendicitis is present only in 30–40% of patients.[3]

Imaging techniques such as ultrasound (US) and computerized tomography (CT) and diagnostic laparoscopy have been used with better odds of yielding a rapid and accurate diagnosis. The main problems with routine use of diagnostic imaging are potentially harmful ionizing radiation (CT), examiner-dependent efficacy (US), and technique-associated morbidity (diagnostic laparoscopy). Diagnostic imaging performs sub optimally in groups of patients with low or high prevalence of disease in spite of high sensitivity and specificity of individual technique.[2]

Therefore, the initial management of patients with suspected appendicitis still is best when based on the disease history, physical examination findings, and laboratory investigations reflecting the inflammatory response an appendicitis produces.

The aim of the study was to determine if use of Appendicitis Inflammatory Response Score is better suited for planning management of patients with Acute Appendicitis and the objective is to compare sensitivity and specificity of two of scoring systems and to compare positive predictive value and negative predictive value of these scoring systems. (Table 1)

Table 1. Scoring systems in Acute Appendicitis[2,4]

Alvarado Score		Appendictis inflammatory response score	
Findings	Points	Findings	Points
Migratory RIF pain	1	Vomiting	1
Anorexia	1	Pain in the right iliac fossa	1
Nausea or vomiting	1	Rebound tenderness or muscular defense	1
Tender right iliac fossa	2	Light	2
Rebound tenderness RIF	1	Medium	3
Fever >36.3oC	1	Strong	1
Leukocytosis >10x109 cells/L	2	Body temperature >38.5oC	
Shift to the left (of neutrophils)	1	Polymorphonuclear leukocytes	1
		70%–84%	2
		≥85%	
		White blood cell count	1
		10.0–14.9x109 cells/L	2
		15.0x109 cells/L	
		C-reactive protein concentration	1
		10–49 g/L	2
		≥50 g/L	
Score: ≤3: Low likelihood of appendicitis; 4–6: Consider further imaging; ≥7: High likelihood of appendicitis		Score: 0–4: Low probability. Outpatient follow-up 5–8: Indeterminate group. Active observation or diagnostic laparoscopy; 9–12: High probability. Surgical exploration.	

This is a cross- sectional observational study carried out in UCMS-TH, Bhairahawa from October 2019 to March 2021. Ethical clearance was taken from Institutional Review Committee of UCMS-TH (UCMS/IRC/202/19). All the cases who had undergone surgery for acute appendicitis during this period was included. Patients with malignancy, tuberculosis, diabetes mellitus, and pregnancy and on anticoagulant therapy were excluded from the study.

Detail history of the patient was taken to find out the reasonable risk factor and complaints was recorded in chronological order. Clinical examination was done to find out the various modes of presentation. After taking the informed consent, patients were analyzed as per the Alvarado Scoring and Appendicitis Inflammatory Response Scoring. Grading of severity of rebound tenderness was done by visual analog score (VAS), (score 0: no pain, 1-3: mild, 4-6: moderate and 7-10: severe).

The mean difference in biochemical parameters in different types of appendicitis was calculated by Analysis of Variance (ANOVA). Receiver Operating Curve (ROC) was used to identify whether Appendicitis Inflammatory Response Score or Alvarado score was good predictor of acute appendicitis. Sensitivity, Specificity and Area under Curve(AUC) was used as indicators to predict the acute appendicitis. P-value less than 0.05 was considered as statistically significant. All computations were done in SPSS Version 22.0 (IBM).

RESULTS

The total number of patients included in the study was 104 in which 59 (56.7%) patients were male and 45 (43.3%) were female. The mean age was 29.41±17.67 years. Out of those 50% had phlegmonous appendicitis, 42.3% had complicated appendicitis and 7.7% had normal appendix.

The table 2 showed the mean difference in biochemical parameters in different types of appendicitis. The mean difference was calculated by Independent Sample t-test. The result showed that the mean difference in TLC in three types of appendicitis was statistically significant (p=0.02). The

result showed that TLC was significantly high in complicated appendicitis.

Similarly, the mean difference in Neutrophils was statistically insignificant (p=0.262). The results showed that there was highly significantly mean difference in CRP between types of appendicitis (p<0.001). The results showed that CRP was found significantly high in complicated appendicitis.

Table 2. Mean difference in biochemical parameters in different types of appendicitis

Biochemical Parameter	Type of Appendictis	Mean	Std. Deviation	*P* value
TLC	Normal appendix	7525.00	2805.99	
	Complicated appendicitis	12927.27	5409.57	0.02
	Phlegmonous appendicitis	11965.38	4725.56	
Neutrophils	Normal appendix	73.13	5.28	
	Complicated appendicitis	77.95	9.38	0.262
CRP	Phlegmonous appendicitis	75.71	8.93	
	Normal appendix	11.14	4.47	
	Complicated appendicitis	88.41	56.70	<0.001
	Phlegmonous appendicitis	20.22	15.56	

Alvarado score 8-10 was found in 45.2% patients, 5-7 score was found in 40.4% and 0-4 score was found in 14.4%. AIR score 0-4 was found in 20.2% patients, 5-8 score was found in 53.8% and 9-12 score was found in 26%.

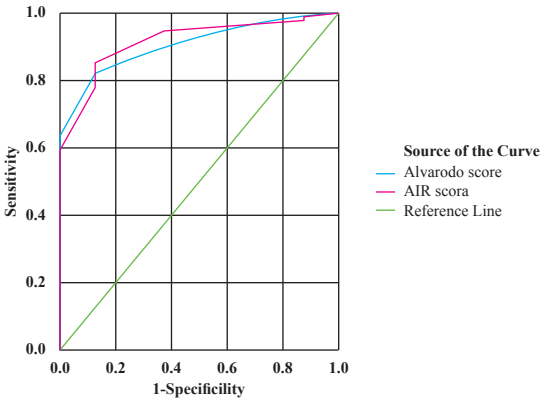

Figure 1. ROC curve to predict Acute Appendicitis

Table 3. ROC curve outcomes

Test Result Variable (s)	Area	*P* value	Asymptotic 95% CI Lower Bound	Upper Bound	Sensitivity	Specificity
Alvarado score	0.906	<0.001	0.833	0.978	0.823	0.875
AIR Score	0.917	<0.001	0.841	0.993	0.854	0.875

The ROC curve showed that AIR score is the good predictor of acute appendicitis with sensitivity 85.4%, specificity of 87.5% with AUC (0.917) (Table 3) with cutoff value of 4.50. (Figure 1)

Table 4. Comparative data for Alvarado 1 and ATR 1 group

	AIR ≥8	Alvarado≥ 8
Sensitivity(%)	89.4	88.9
Specificity(%)	73.3	70.1
AUC	0.885	0.862
PPV(%)	100	100
NPV(%)	10.4	14
Accuracy(%)	33.60	87.50

The table 4 showed that AIR>8 score is good predictor than Alvarado ≥8 score in predicting acute appendicitis with sensitivity (89.4%), specificity (73.3%) and AUC (0.885). (Figure 2, Figure 2 a)

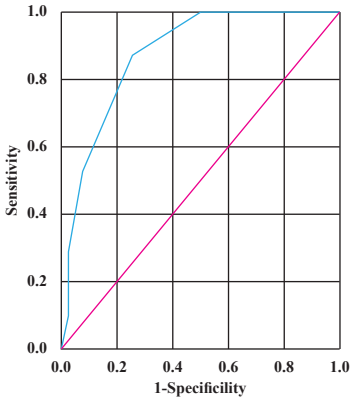

Figure 2. ROC curve for AIR ≥8

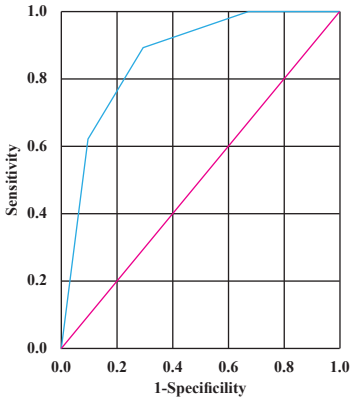

Figure 2a. ROC Curve for Alvarado≥ 8

Table 5. Comparative data for Alvarado 2 and AIR 2 groups

	AIR >4	Alvarado>4
Sensitivity(%)	83.1	71.1
Specificity(%)	86.7	90.5
AUC	0.915	0.884
PPV(%)	98.8	96.6
NPV(%)	33.3	33.3
Accuracy(%)	85.50	88.40

The table 5 showed that AIR>4 score is good predictor than Alvarado >4 score in predicting acute appendicitis with sensitivity (83.1%), specificity (86.7%) and AUC (0.915) (Figure 3 & 4)

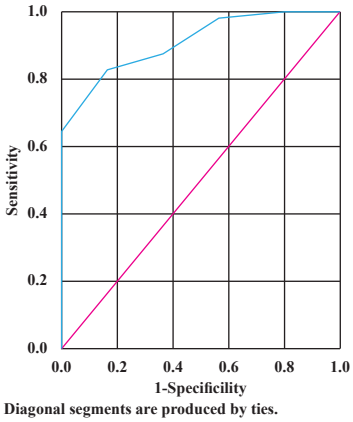

Figure 3. **ROC curve of AIR>4**

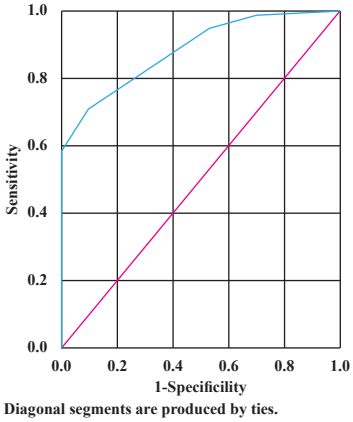

Figure 4. **ROC curve of Alvarado >4**

DISCUSSION

Most patients with suspicion of acute appendicitis till date present a common diagnostic challenge. Clinical diagnosis alone has been associated with a high rate of misdiagnosis. The use of imaging esp. USG and CT is generally regarded as the standard of care.[5,6] However, non-selective imaging does not perform well in subgroups with a high or low prevalence of appendicitis.[7] Indiscriminate use of imaging may also increase the detection and treatment of mild, non-perforated appendicitis that would otherwise resolve spontaneously.[8]

Although more accurate than USG, CT exposes the patient to ionizing radiation, raising concerns about cancer risk.[5,7,9] A prime issue that strikes us is in this modernized practice of medicine is that even when we are aided by a battery of radiological investigations, there is still a need of a clinical is scoring system to predict a common surgical issue like acute appendicitis. The answer lies in the matter that even if the investigations have improved their availability, sensitivity, specificity and overall performance, clinical scoring is still relevant at financially inadequate regions like ours where approximately 75% population still lives in villages, and remote areas who have no or little access to basic medical and surgical facilities.[10]

Only 50% of cases have a typical clinical presentation. Management of patients with equivocal diagnosis is more divisive. Delaying treatment increases complications and overtreatment increases morbidity. Diagnosis of acute appendicitis is predominantly clinical, being supplemented with laboratory findings and imaging modalities. Different scoring systems have been designed to aid in the clinical assessment of patients and decision making.[11]

In our study low probability group sensitivity as per AIR score was 83.1% vs. 71.1% of the Alvarado score with a specificity of 86.7% of AIR score and 90.5% of the Alvarado score. In the high probability group, AIR score had a sensitivity of 89.4% vs. 88.9% of the Alvarado group. The specificity was 73.3% for AIR score and 70.1% for the Alvarado score. Area under ROC was 91.5% for the AIR score vs. 88.4% of the Alvarado Score in the low probability group. In the high probability group, Area under ROC was 88.5% in AIR score vs. 86.2% of the Alvarado score.

In contrast to our study, study done by Anderson M. et. Al.[2] in 2008 in the construction of Appendicitis Inflammatory Response (AIR) scoring, the sensitivity of this system was found to be 96% in low probability group (AIR score ≤4) as compared to 97% of Alvarado score yet, the specificity was 73% vs. 61% of Alvarado scoring. For the high probability group (AIR score ≥8) sensitivity was 33% vs. 20% in the Alvarado score and both their specificity were 99%. The area under ROC curve was 93% for AIR vs. 88% for the Alvarado score (p=0.0007).

It our study the specificity was 73.3% in AIR score and 70.1% in Alvarado score, however both scoring systems were found to have a positive predictive value of 100%. A contrasting finding was that although de Castro's finding showed significantly different area under the ROC curve our finding was that the area under the curve was somewhat similar (91.7% for AIR score and 90.6% for Alvarado score) with slight favor towards AIR score.

Similar to our study, de Castro et. Al. in 2012 found the result that area under the ROC curve of the AIR score was 0.96 and significantly better than the area under the curve of 0.82 of the Alvarado score($p<0.05$) They also found that score greater than 8 points had a lower sensitivity for appendicitis for the AIR score compared with the Alvarado score (0.10 vs. 0.29). And this was associated with a higher specificity (1.00 vs. 0.95, respectively). It meant that positive predictive value of 0.77 and 1.00 for the AIR and the Alvarado scores.[12]

In our study, sensitivity and specificity of both scoring system was better (89.4% and 73.3% in AIR group and 88.9% and 70.1% in Alvarado score) with slightly better performance of AIR score even in high risk group.

In the study done by Vaziri M. et. al.[13] in 2020 compared AIR scoring with Alvarado scoring where they found among the patients with a low score for appendicitis, the AIR scoring system had a sensitivity and specificity of 95% and 74%, respectively, which was more promising in comparison to that of the Alvarado system (90% and 70%, respectively). The respective findings in AIR score were 83.1% and 86.7%. AIR scoring has better probability of determining that appendicitis was actually not the diagnosis. In the high-risk group,

the sensitivity and specificity of both the systems were found to be less than 50% (43% and 32% in Alvarado score and 48% and 25% in AIR score).

Limitations of the study includes: this was a single centre study and the subjective assessment of grading of severity of rebound tenderness might make the assessment of AIR score biased.

CONCLUSION

Based on the finding of this study, we concluded that AIR score is more reliable scoring system for the diagnosis of acute appendicitis and its use can be justified over the preexisting Alvarado scoring.

CONFLICT OF INTEREST

None

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