Alvarado Score Vs Appendicitis Inflammatory Response (Air) Score In Predicting Acute Appendicitis In A Tertiary Care Centre

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ABSTRACT:

Background: Acute appendicitis is a common cause of right iliac fossa pain, necessitating accurate diagnostic tools to prevent unnecessary appendectomies. We compared the diagnostic efficacy of Appendicitis Inflammatory Response (AIR) and Alvarado scores in predicting perforated appendicitis cases. Negative appendectomies, estimated up to 17.5% in India, pose challenges, leading to prolonged hospital stays and increased costs. The study aimed to provide insights into effective diagnostic methods in clinical settings.

Materials and Methods: Conducted in a tertiary care teaching hospital, the observational study included 120 surgically managed appendicitis patients. Inclusion criteria ensured a diverse patient cohort, while exclusion criteria streamlined participant selection. The study, spanning January to September 2023, incorporated specific cut-off scores for both scoring systems. Statistical analyses were performed using IBM SPSS Version 26.0.

Results: The cohort predominantly comprised males (76.7%) with varying surgical procedures. Alvarado Score (>6) exhibited 85.45% sensitivity and 56.92% specificity, while AIR Score (>6) showed 76.36% sensitivity and 53.85% specificity. Both scores correlated with intra-operative findings, emphasizing their predictive potential. The Area Under the Curve (AUC) for Alvarado and AIR scores were 0.778 and 0.722, respectively, indicating good discriminatory capabilities.

Conclusion:The Alvarado and AIR scores demonstrated differential diagnostic performances, emphasizing the trade-offs between sensitivity and specificity. AIR Score's superior AUC-ROC suggests enhanced differentiating capabilities.

Key Words: Appendicitis, Alvarado Score, Appendicitis Inflammatory Response (AIR) Score, Diagnostic Accuracy

INTRODUCTION:

Acute appendicitis, one of several differential diagnosis for acute right iliac fossa pain, has a lifetime incidence of 7% (8.6% in males and 6.7% in females).(McCartan et al., 2010; Snyder et al., 2018) Numerous people with various conditions visit surgical emergency rooms with right iliac fossa pain. In India, clinical suspicion might lead to a 17.5% negative appendicectomy rate (Sharma et al., 2007). The present study compared the diagnostic efficiency of Appendicitis Inflammatory Response score and Alvarado scoring system in predicting acute appendicitis perforation. Diagnostic issues arise when aberrant findings result in negative appendectomies. 8–35% of negative appendectomies are performed; in women who are fertile, this number might reach 45%.(Rao et al., 1998) Negative appendectomy increases hospital stays and expenditures despite being considered harmless.(Mock et al., 2016) Later-onset acute appendicitis increases morbidity and mortality. Surgeons avoid this difficulty by operating, early based on their experience and patient presentation.(Pittman-Waller et al., 2000) Acute appendicitis diagnosed quickly can reduce perforation complications with an early appendicectomy. Ultrasound and CT scans have good sensitivity and specificity and can help diagnose the patient, but they cost more

and may delay the emergency appendicectomy. Radiation in CT scan concerns health as well. In low-resource settings, clinical judgment is still relied on because imaging is not always available and high-quality.Thus, a fast and straightforward appendicitis diagnosis in clinical settings would help clinicians. Several grading systems have been developed to help diagnose acute appendicitis.Since 1986, the Alvarado scoring system has been the most used for acute appendicitis. The scoring technique is still popular due to its high sensitivity and specificity. (Alvarado, 1986; Owen et al., 1992) The Modified Alvarado Scoring System is most popular internationally. The 2008 Appendicitis Inflammatory Response (AIR) score is a newer rating system for suspected appendicitis.

MATERIAL AND METHODS:

This research was an observational study in a tertiary care teaching hospital in Chennai, Tamil Nadu. This study used specified inclusion and exclusion criteria to establish a well-defined and representative patient population. All appendix patients receiving surgery were included, emphasizing on individuals actively seeking treatment. Additionally, consenting patients were eligible for the trial. Exclusion criteria were used to refine the participant pool. The analysis eliminated patients without AIR scoring system indicators, those unwilling to have surgery, those not consenting to the trial, and those histopathological examinations (HPE) which did not establish appendicitis.The study took place between January and September 2023, as originally intended. This timeline allowed data collection within a set timeframe, adding to the research's temporal context. All eligible patients were included in the research. The study included 120 laparoscopic or open appendicectomy patients. This sample size was intended to provide a strong dataset, statistical significance, and scientific rigor. These parameters, combined with the study period and sample size, enable a full investigation of appendicitis surgical therapy and prediction score systems.All patients gave written, informed consent prior to the trial. The study was approved by the institutional ethics committee. Regarding continuous and categorical variables means and proportions were calculated. Chi-square test was used to determine whether the proportional differences were statistically significant. P values under 0.05 were significant. IBM SPSS Version 26.0, Armonk, NY, was used for the statistical study.

RESULTS: In Table 1, baseline characteristics of our 120-patient research sample. The distribution of crucial factors reveals our participants' demographic and clinical makeup. The population we represented was 76.7% male and 23.3% female. The participants' average age was 28.3 years, with a standard deviation of ±11.79 years, indicating age variety in our study population.Participants received laparoscopic surgery 69.2% of the time and open surgery 30.8%. The participants in our study scored 0.8%- 5, 36.7% -6, 35.0% -7, 17.5% - 8, and 10.0% - 9 on the Alvarado Scoring system, which predicts appendicitis. In parallel, the AIR Scoring system, scored 10.0%- 4, 12.5% - 5, 17.5% - 6, 12.5% - 7, 19.2% - 8, 19.2% - 9, 4.2% - 10, and 5.0% - 11.

Table 2 represents the intra-operative findings distribution of research subjects. Among the affected, inflamed appendices found in 0.8% of patients. Retrocaecal (45.8%) was the most common appendix position, followed by locations pre ileal, post-ileal and pelvis. The majority (54.2%) of patients did not have perforated appendices, although 45.8% did. Peri-appendiceal fluid was found in 67.5% of patients and pus in 32.5%. Surgery site infections occurred in 16.7% of patients, while 83.3% did not.

Table 3 shows the predicted accuracy of the Alvarado Score, AIR Score, and perforation. Perforation was more common in patients with an Alvarado Score cut-off value of >6 (85.5%) than in those without (43.1%). The statistical analysis showed a substantial difference (p < 0.001). The Alvarado Score effectively identified perforation patients with 85.45% sensitivity and 56.92% specificity. Positive likelihood ratio: 1.98; negative likelihood ratio: 0.26. Positive and negative predictive values were 12.99% and 98.11%, respectively. Overall Alvarado Score accuracy was 58.92%.A higher percentage of patients with perforation (76.4%) had a significantly higher AIR Score (>6) compared to those without perforation (46.2%, p < 0.001). AIR Score sensitivity was 76.36%, specificity 53.85%, positive likelihood ratio 1.65, and negative likelihood ratio 0.44. The accuracy was 55.42%, the positive predictive value 11.07%, and the negative predictive value 96.80%.

The Alvarado's AUC of 0.778 indicates good discrimination. This estimate is precise with a 95% confidence interval of 0.694 to 0.863. The AUC of the AIR Score is 0.722, showing a little decreased but still reasonable discriminative capacity. The true AUC is likely to fall within the 95% confidence interval, 0.631 to 0.813. (Figure 1)

Table I. Distribution of study patients based on baseline characteristics (n=120)

Parameter	Frequency	Percentage
Sex		
Male	92	76.7
Female	28	23.3
Age (in years)	28.3±11.79	
Type of Surgery		
Laparoscopic	83	69.2
Open	37	30.8
Alvarado Scoring – 6.99±0.99		
5	1	.8
6	44	36.7
7	42	35.0
8	21	17.5
9	12	10.0
AIR Scoring – 7.18±1.9		
4	12	10.0
5	15	12.5
6	21	17.5
7	15	12.5
8	23	19.2
9	23	19.2
10	5	4.2
11	6	5.0
Total	120	100.0

Table II. Distribution of study patients based on Intra-Operative findings (n=120)

Parameter	Frequency	Percentage
Inflamed appendix	1	0.8
Position		
Pre-Ileal	29	18.3
Retrocaecal	55	45.8
Post-Ileal	22	24.2
Pelvic	14	11.7
Perforation		
Not Perforated	65	54.2
Perforated	55	45.8
Type of Fluid		
Peri-Appendiceal	81	67.5
Pus	39	32.5
Post OP Surgical Site Infection (SSI)		
Absent	100	83.3
Present	20	16.7
Total	120	100.0

Table III.Predictive accuracy of Alvarado Score, AIR score and perforation (n=120)

Score	Perforation		Total	p value*
	Present	**Absent**		
Alvarado Score				
>6	47(85.5%)	28(43.1%)	75(62.5%)	<0.001
≤6	8(14.5%)	37(56.9%)	45(37.5%)	
Parameter	*Value*		*95% CI*	
Sensitivity	85.45%		73.34% to 93.50%	
Specificity	56.92%		44.04% to 69.15%	
Positive Likelihood Ratio	1.98		1.47 to 2.68	
Negative Likelihood Ratio	0.26		0.13 to 0.50	
Positive Predictive Value	12.99%		9.96% to 16.77%	
Negative Predictive Value	98.11%		96.36% to 99.03%	
Accuracy	58.92%		49.57% to 67.82%	
AIR Score				
>6	42(76.4)	30(46.2%)	72(60.0)	<0.001
≤6	13(23.6%)	35(53.8%)	48(40.0)	
Parameter	*Value*		*95% CI*	
Sensitivity	76.36%		62.98% to 86.77%	
Specificity	53.85%		41.03% to 66.30%	
Positive Likelihood Ratio	1.65		1.22 to 2.24	
Negative Likelihood Ratio	0.44		0.26 to 0.74	
Positive Predictive Value	11.07%		8.44% to 14.40%	
Negative Predictive Value	96.80%		94.71% to 98.08%	
Accuracy	55.42%		46.07% to 64.50%	

* Chi square test was applied to test statistical difference in proportions.

Fig 1. ROC Analysis of Alvarado Score and AIR Score.
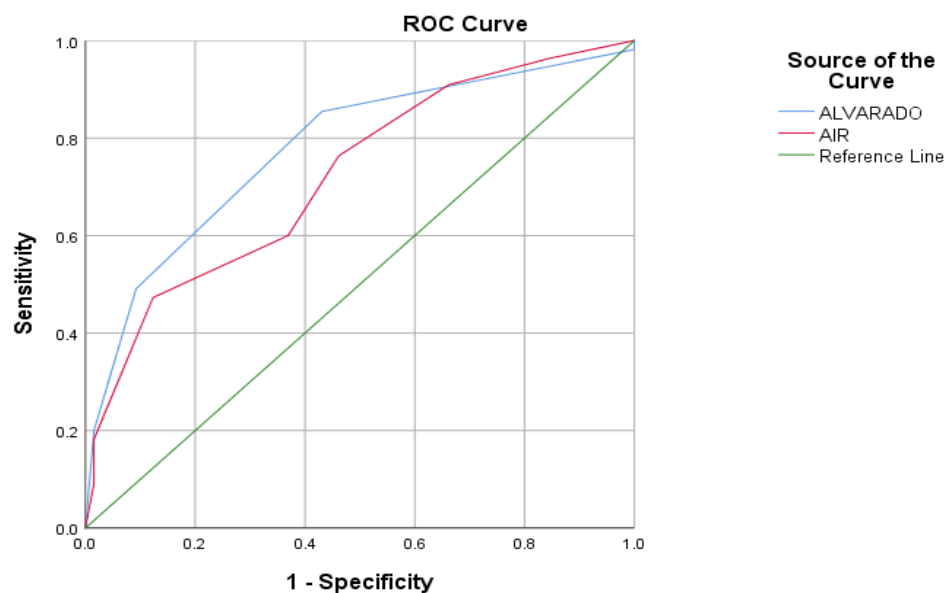
Diagonal segments are produced by ties.

Area Under the Curve			
		Asymptotic 95% Confidence Interval	
Score	**Area**	**Lower Bound**	**Upper Bound**
Alvarado	0.778	0.694	0.863
AIR	0.722	0.631	0.813

Discussion:

In our study, cohort of 120 appendicitis patients was 76.7% male. The average age was 28.3, showing a varied age range, while laparoscopic and open surgeries were performed, with 69.2% and 30.8%. In accordance with the Alvarado Score, 85.5% of patients with a score >6 had perforation, whereas the AIR Score indicated 76.4% perforation. AIR Score predicted perforation with 76.36% sensitivity and 55.42% accuracy, while Alvarado Score had 85.45% sensitivity and 58.92% accuracy. Similar patterns were found in the prediction accuracy of the Alvarado and AIR scores for appendicitis in our study and Madasi et al (Assistant professor, Department of general Surgery, Rajiv Gandhi Institute of medical Sciences (RIMS), Ongole, Andhra Pradesh, India & Madasi, 2016). The Alvarado score had an area under the ROC curve of 0.74 and the AIR score 0.95, according to Madasi et al.(Assistant professor, Department of general Surgery, Rajiv Gandhi Institute of medical Sciences (RIMS), Ongole, Andhra Pradesh, India & Madasi, 2016), but our study demonstrated 58.92% and 55.42% accuracy in predicting perforation.Our 85.45% Alvarado and 76.36% AIR sensitivity matches Madasi et al's 87.3% and 95.7%, respectively. Our AIR score specificity was 56.92%, while Madasi et al.'s was 90.5%. Our investigation found 52.4% specificity for Alvarado, matching Madasi et al. Our work and those of Madasi et al.,(Assistant professor, Department of general Surgery, Rajiv Gandhi Institute of medical Sciences (RIMS), Ongole, Andhra Pradesh, India & Madasi, 2016) Meena et al.,(Meena et al., 2023) Jose et al.,(Jose & Rajesh, 2021) and Gope et al.(Gope et al., 2019) reveal different patterns that illuminate appendicitis scoring system diagnostic accuracy across diverse patient demographics and study contexts. Our primarily male cohort's demographic mix and average age of 28.3 years align with observations in the literature, emphasizing the consistent demographic trends across these studies. In our investigation, the Alvarado score has 85.45% sensitivity and 56.92% specificity, corresponding to Madasi et al (Assistant professor, Department of general Surgery, Rajiv Gandhi Institute of medical Sciences (RIMS), Ongole, Andhra Pradesh, India & Madasi, 2016) and Jose et al.(Jose & Rajesh, 2021) The nuanced sensitivity and specificity of the Alvarado score underscore the complexity of utilizing this scoring system in different clinical contexts. In terms of AIR score, our sensitivity of 76.36% and specificity of 53.85% at a cut-off of >6 differ from Jose et al[11] (98%, 97%). Patient characteristics and variations in scoring system application can influence the AIR score's diagnostic performance. We did not explicitly assess C-reactive protein (CRP) and white blood cell (WBC) count, but in the study by Jose et al, emphasized these markers, suggesting the importance of understanding how individual parameters affect diagnostic accuracy. Notably, the overall diagnostic accuracy of the scoring systems in our study (58.92% for Alvarado and 55.42% for AIR) contrasts with the higher accuracy reported by Madasi et al (Assistant professor, Department of general Surgery, Rajiv Gandhi Institute of medical Sciences (RIMS), Ongole, Andhra Pradesh, India & Madasi, 2016) (95% for AIR) and Jose et al (Jose & Rajesh, 2021) (91% for AIR). Score system performance is difficult to generalize across patient demographics and therapeutic contexts due to these variances. The varied cut-off values used in different studies, such as >6 in our study and >5 in Jose et al.,(Jose & Rajesh, 2021) emphasize the need for a nuanced approach to threshold selection to optimize sensitivity and specificity based on specific study contexts. The constant patterns in positive and negative predictive values across studies show that appendicitis diagnosis trades sensitivity and specificity. Indian researchers reported a comparable outcome.(Gopalam & Konidala, 2017; Gupta et al., 2022; Patil et al., 2017) Karki et al (Karki & Hazra, 2020) study

determined that the AIR score had 96.91% sensitivity, compared to 94.30% for the Alvarado score. This supports the AIR score's ability to detect appendicitis more accurately.Positive predictive value was 74.87% and negative predictive value 50% for the Alvarado score. AIR had higher positive and negative predictive values at 79.70% and 72.20%, respectively.The AIR score exhibited a more favourable AUC-ROC of 0.701, surpassing the Alvarado score, which had an AUC-ROC of 0.580.

Conclusion:

Alvarado Score demonstrated 85.45% sensitivity and 56.92% specificity, underscoring the trade-offs involved in striking a balance between sensitivity and specificity when diagnosing appendicitis. Parallel to the Alvarado Score, AIR Score shows diagnostic distinctions with sensitivity of 76.36% and specificity of 53.85%. The AIR Score's more effective AUC-ROC supports its appendicitis classification. Ultimately, our research advances our knowledge of diagnostic terrain surrounding appendicitis and encourages further research and validation across patient types and medical settings.

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