Evaluation of the Appendicitis Inflammatory Response Score against Alvarado Score in Diagnosis of Acute Appendicitis

Karki OB, Hazra NK

Department of Surgery

Manipal College of Medical Sciences

Phulbari-11, Pokhara, Nepal.

Corresponding Author

Om Bahadur Karki

Department of Surgery,

Manipal College of Medical Sciences,

Phulbari-11, Pokhara, Nepal.

E-mail: karkiom225@yahoo.com

Citation

Karki OB, Hazra NK. Evaluation of the Appendicitis Inflammatory Response Score against Alvarado Score in Diagnosis of Acute Appendicitis. *Kathmandu Univ Med J.* **Online First.**

ABSTRACT

Background

Patients presenting with suspected appendicitis pose a diagnostic challenge. Various scoring systems have been designed to aid in the clinical assessment of these patients. Widely applied was Alvarado score and best performed in validating studies, but was observed with few drawbacks. Appendicitis inflammatory response (AIR) score was designed to overcome the drawbacks associated with the implementation of Alvarado scoring system.

Objective

The main objective of this study was to evaluate the Appendicitis inflammatory Response Score and compare its performance in predicting risk of appendicitis with the Alvarado score.

Method

Appendicitis inflammatory response score and Alvarado scores were calculated prospectively on patients suspected of acute appendicitis presenting to Manipal Teaching Hospital, Pokhara, Nepal between July 2017 and June 2019. Diagnostic performance of the two scores was compared. Statistical analysis was done using SPSS 21 and p value < 0.05 was considered significant.

Result

The study included 217 patients with 109 (50.2%) males and 108 (49.8%) females. The mean age of patients was 25.77±15.54. The results analyzed showed better sensitivity of Appendicitis Inflammatory Response score (96.91%) as compared to 94.30% of Alvarado score. The positive and negative predictive values of Alvarado score were 74.87% and 50%, as compared to 79.70% and 72.20% for AIR score. Furthermore, the area under receiver operating curve of the appendix inflammatory response score was better (0.701) than that of Alvarado score (0.580).

Conclusion

Appendicitis Inflammatory Response (AIR) scoring performed well and more accurate than Alvarado scoring system with high specificity and high negative predictive value preventing negative appendectomies.

KEY WORDS

Appendectomy, Appendicitis, Appendix

INTRODUCTION

Acute appendicitis is one of the commonest surgical emergencies and has a lifetime risk of 7-8%.[1] The clinical presentation is typical only in 50% of the cases. Particularly among the children, elderly and females of reproductive age, where other conditions can present with signs and symptoms similar to those of acute appendicitis, diagnosis is difficult to establish.[1,2] Management of patients with equivocal diagnosis is also controversial.[2,3] Delay in treatment increases the incidence of complications.[4,5] Diagnosis of acute appendicitis is eminently clinical, being supplemented with laboratory findings and imaging modalities. Negative appendectomy rates have still remained above 6% in various studies.[5] Different scoring systems have been designed to aid in the clinical assessment of patients but only a few have stood the test of time.

In 1986, Alvarado presented a clinical scoring system to improve the accuracy of diagnosing acute appendicitis, based on eight predictive clinical factors.[6,7] This scoring doesn't include C-reactive protein (CRP), a widely accepted laboratory marker in assessment of acute appendicitis Appendicitis inflammatory response (AIR) score uses seven scored variables including CRP with maximum score of 12 points to stratify patients into low, intermediate and high-risk cohorts (Table 1).[8,9] AIR score relies less on subjective symptoms such as anorexia or nausea, includes C-reactive protein and employs graded parameters, compared with the dichotomized variables in the Alvarado score.[2,4,8] (Table 1)

The aim of the study is to evaluate Appendicitis Inflammatory Response score and compare its performance in predicting the risk of appendicitis with the Alvarado score.

METHODS

The study was conducted in Department of Surgery, Manipal Teaching Hospital, a tertiary level teaching hospital in Gandaki province of Nepal, from July 2017 to June 2019. The current study was a prospective analytical study.

Inclusion criteria

All consecutive patients admitted under general surgery with suspected acute appendicitis during the study period were included for observation.

Exclusion criteria

- Pregnant females
- Patients with known abdominal malignancies
- Patients who refused to undergo surgical intervention or were managed conservatively
- Incidental and valentino appendectomy
- Patients with appendicular lump

Patients were examined clinically. Laboratory investigations including complete blood count (CBC), C-reactive protein, bleeding and clotting time, renal function test (RFT), random blood glucose (RBS) were performed along with ultrasound (USG) of the abdomen and pelvis. Though diagnosis and the decision for operation were based on clinical examination still then USG of the abdomen and pelvis was done in all patients to rule out other differential diagnosis. Patients suspected of having acute appendicitis were then taken up for surgery under spinal or general anesthesia. Either open or laparoscopic appendectomy was performed. Intra-operative findings were noted and routine post operative care given to all patients. Specimen of the appendix was then sent to the pathology department for histo-pathologic examination (HPE). Appendicitis was confirmed, when there was neutrophilic granulocytes infiltration into the muscularis propria.[2,10]

Variables recorded to evaluate the scoring systems included: nausea, vomiting, anorexia, migration of pain to the right lower quadrant (RLQ), pain in the right iliac fossa, tenderness and rebound tenderness, body temperature, white blood cell (WBC) count, proportion of polymorphonuclear leukocytes, level of C-reactive protein. All of the variables required for evaluating the scoring were noted and both Alvarado score and AIR score was calculated. Patients having AIR score below five were grouped into low, scores between five to eight as intermediate and scores between nine to twelve as high-risk group. Over view of Alvarado and AIR score is given in Table 1.

The study was approved by institutional ethics committee. Informed and written consent was obtained from all the enrolled cases and consent was obtained from the parents or guardians in case of children less than 16 years.

Statistical analysis was performed with SPSS version 21 statistical software (SPSS Inc, Chicago, IL). P value < 0.05 was considered as statistically significant. Pearson's chi-square test was used to test if differences between dichotomous groups were significant. The area under the receiver operating characteristic (ROC) curves used to examine the performance characteristics of the two scoring systems.

RESULTS

The present study included 217 patients for final analysis. There were 109 (50.2%) males and 108 (49.8%) females. The mean age of patients was 25.77 ± 15.54. Majority of the patients were either or below 20 years of age. (Table 2)

There was a statistically significant association between AIR score categories with the diagnosis of acute appendicitis than between Alvarado score and the histopathologic (HPE) diagnosis. (Table 3)

The study showed better sensitivity of AIR score (96.91%) as compared to 94.30% of Alvarado score. The positive and negative predictive values of Alvarado score were 74.87%

Table 1. Characteristics of the Alvarado and the appendicitis inflammatory response (AIR) score

Diagnosis	Alvarado score	AIR score
Vomiting		1
Nausea or vomiting	1	
Anorexia	1	
Pain in RLQ	2	1
Migration of pain to RLQ	1	
Rebound tenderness	1	
Light		1
Medium		2
Strong		3
Body temperature >37.5°C	1	
Body temperature >38.5°C		1
Leukocytosis shift	1	
Polymorphonuclearleukocytes		
70-84%		1
≥85%		2
WBC count		
>10.×10^9/l	2	
10.0-14.9.×10^9/l		1
≥15.0.×10^9/l		2
CRP concentration		
10-49 g/l		1
≥50 g/l		2
Total score	10	12

Alvarado score: sum 0-4 = not likely appendicitis, sum 5-6 = equivocal, sum 7-8 = probably appendicitis, sum 9-10 = highly likely appendicitis.
Acute appendicitis response score
(AIR): sum 0-4 = low probability, sum 5-8 = indeterminate group, sum 9-12 = high probability
RLQ right lower quad

Table 2. Age-group and test results in study population (N=217).

Age-group	≤20 yrs	101(46.5%)
	20-40yrs	82(37.8%)
	40-60yrs	26(12%)
	>60yrs	8(3.7)
Operation	Open appendectomy	119 (54.8%)
	Laparoscopic appendectomy	91 (41.9%)
	Peritoneal lavage and drainage	7 (3.2%)
Histopathology	Acute appendicitis	199 (91.7%)
	Normal appendix	18 (8.3%)
Appendix type	Noncomplicated	144 (66.4%)
	Complicated	55 (25.3)
	Normal	18 (8.3%)

and 50%, as compared to 79.70% and 72.20% for AIR score. (Table 4)

The predictive validity of AIR score as assessed by area under the ROC curve was 0.760, as compared to 0.623 for Alvardo score for score > 4. Similarly, the area under the ROC curve for AIR score was 0.701 which was greater than

Table 3. Association between the risk scores and histopathology findings in study population

Parameter	Histopathology		Chi-Square Value	P value
	Acute appendicitis (N=199)	Normal appendix (N=18)		
Alvarado Score				
≤4	50	9	5.159	0.023
>4	149	9		
AIRS				
≤4	40	13	23.93	0.000
>4	157	5		
Alvarado				
≤8	156	17		
>8	43	1	2.631	0.105
AIRS				
≤8	97	16	10.66	0.001
>8	102	2		

Table 4. Comparison of validity, predictive values and reliability of the two risk scores

Diagnostic value	AIR score (%)		Alvarado score (%)	
	> 4 points	> 8 points	> 4 points	> 8 points
Sensitivity	96.91	98.08	94.30	97.73
Specificity	24.53	14.06	15.25	9.83
Positive predictive value	79.70	51.26	74.87	21.61
Negative predictive value	72.22	88.89	50.00	94.44
Accuracy	79.07	54.38	72.81	27.65

0.580, the area under the ROC curve for Alvarado score for score > 8. (fig. 1 and fig. 2)

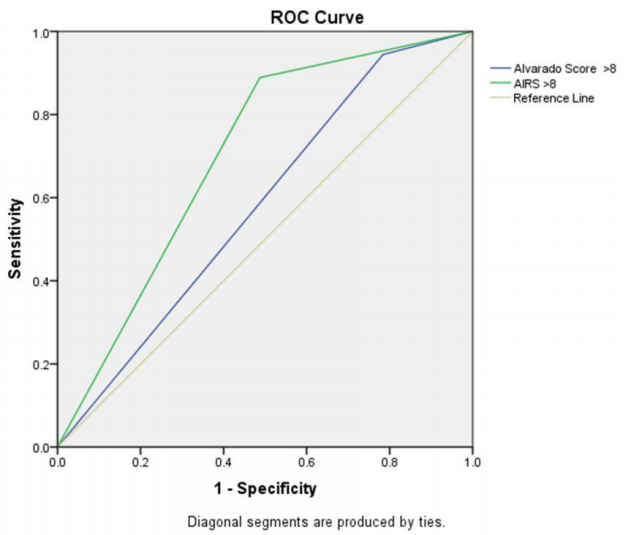

Figure 1. Combined Receiver operating characteristic curves of study population for two scores.

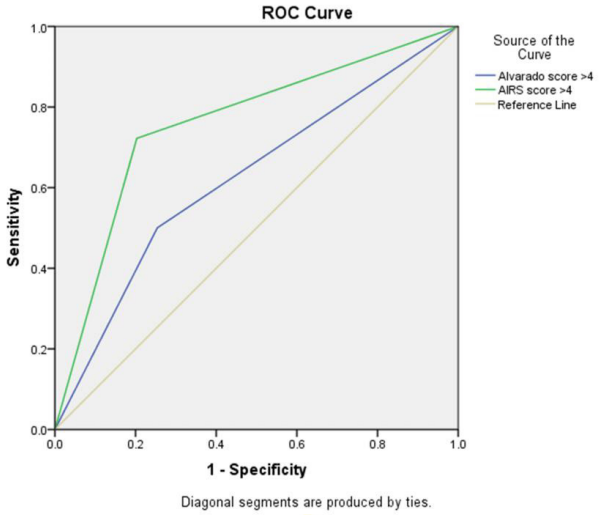

Figure 2. ROC curve of the two scores in study population at score 4.

DISCUSSION

The present study shows that the AIR score has a good statistical discrimination for patients with acute appendicitis compared to Alvarado score. The discriminatory property of the AIR score remains high in the more difficult to diagnose patients (women, children and elderly). De Castro et al. reported that the AIRS had greater discriminative power than the Alvarado score in diagnosing acute appendicitis as a result of the addition of the CRP component.[4] Meta-analysis showed that when leucocytosis and elevated C-reactive protein level are present, there is a five-fold increase in the positive likelihood ratio for acute appendicitis. Nowadays, the use of computed tomography (CT scan) in patients suspected of having appendicitis is common, but in developing countries like Nepal diagnostic accuracy of the scoring systems enhanced by integration of objective clinical predictors, laboratory markers can be helpful and easy thus minimizing the routine use of CT scan.[9] Unselective use of CT may lead to needless appendectomies involving patients whose appendicitis might have been improved naturally through the use of antibiotics.[10] Further, the score can be repeated during active observation period and this will influence the decision making. Moreover, an objectively validated scoring system could legally strengthen decisions made in the emergency room and could avoid malpractice liability.[4]

The Alvarado score was first reported in 1986 after a study in 305 patients with acute appendicitis based on the weight of several significant variables.[6,9] The AIR score developed recently was first reported in 2008. It was based on data collected prospectively from four hospitals of 545 patients admitted for suspected appendicitis. The AIR score was developed on 316 randomly selected patients and evaluated on the remaining 229 patients. It was based on values similar to the Alvarado score, but also included CRP as a new variable.[8,9] AIR score is considered to be better validation score than the Alvarado score in the pediatric age group because the variables scored are easy to apply to children, as the Alvarado score requires children to identify nausea, anorexia, and migration of pain that may be difficult.

Sensitivity of the AIR score was 96.915 as compared to 94.30% of Alvarado score. The positive and negative predictive values of Alvarado score were 74.87% and 50%, as compared to 79.70% and 72.20% for AIR score. The overall diagnostic accuracy of AIR score was 79.07% while Alvarado score had accuracy of 72.81%. Our results are similar to the results of Gopalam et al.[2]

In a study by Karami et al. at the optimal cutoff point of > 7 for the Alvarado scoring system, the sensitivity and the specificity were 78.41% and 100%, respectively, while at optimal cutoff point of > 4 for the AIR scoring system, the sensitivity and the specificity were 78.41% and 91.67%, respectively.[11]

In our study appendicitis is more common in males (50.2%) compared to females (49.8%), this is consistent with the study conducted by Karami et al. in which appendicitis was more common in males (66%) compared to females.[11] But in study by de Castro et al. females (56%) presented with features of acute appendicitis against 44% males.[4]

Most cases of appendicitis is found to occur in ≤ 20 years of age (46.5%) with mean age of 25.77 years. This is consistent with the study conducted by Scott et al. in which the mean age of appendicitis was found to be 27 years.[12] The negative appendectomy rate in our study was 8.3% which is very much comparable with other studies.[3,9,11]

High rate of negative appendectomy in females is probably attributed for the low pain threshold in females and so presenting early and due to other gyenecological causes of lower abdominal pain like pelvic inflammatory diseases, ruptured ectopic pregnency, torsion of ovarian cyst.[13]

In this study, the predictive validity of Alvardo score as assessed by area under the ROC curve was 0.580, as compared to 0.701 for AIR score. de Castro et al. have reported an area under curve of 0.96 for AIR score and 0.82 for Alvarado score.[4] Similarly, the area under the ROC curve of Alvardo score was 0.74 and AIR score was 0.95 in a study done in India by Madashi.[14] In our study there was a good statistical correlation of AIR score in cases of acute appendicitis when compared to Alvarado scoring system. The same was validated in many studies prior by Gopalam et al. and Sudhir et al. in their studies.[2,9]

The use of ultrasound abdomen and pelvis in every patient may have added to the confounding bias in the study as the surgeon might be influenced by the USG findings though the diagnosis of acute appendicitis is clinical. Small sample size and single centre study were other limitations of the study.

CONCLUSION

Acute appendicitis still largely remains a clinical diagnosis. Appendicitis inflammatory response score, recent reproducible scoring system in acute appendicitis outperforms Alvarado score in making precise decision in suspected cases of acute appendicitis. It has high specificity when analyzing patients who fell under low-risk group (score < 8). The score has high negative predictive value there by reducing negative appendectomies. Application of AIR score can decrease unnecessary radiological and surgical interventions.

REFERENCES

1. Chen CY, Chen YC, Pu HN, Tsai CH, Chen WT, Lin CH. Bacteriology of acute appendicitis and its implication for the use of prophylactic antibiotics. *Surg Infect*. 2012;13(6):383-90.
2. Gopalam PR, Konidala MVSS. Comparison of acute inflammatory score and Alvarado score in diagnosis of acute appendicitis at a tertiary care hospital. *Int Surg J.* 2017;4:4034-8.
3. Singh A, Kuka AS, Singh S, Kuka PS. To study the pattern of RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis) score in acute appendicitis. *Int J Contemp Med Res.* 2017; 4 (1):236-40.
4. de Castro SM, Ünlü C, Steller EP, van Wagensveld BA, Vrouenraets BC. Evaluation of the Appendicitis Inflammatory Response score for patients with acute appendicitis. *World J Surg*. 2012; 36: 1540-5.
5. Von-Mühlen B, Franzon O, Beduschi MG, Kruel N, Lupselo D. AIR score assessment for acute appendicitis. *Arq Bras Cir Dig*. 2015;28(3):171-3.
6. Vaghela K, Shah B. Diagnosis of Acute Appendicitis Using Clinical Alvarado Scoring System and Computed Tomography (CT) Criteria in Patients Attending Gujarat Adani Institute of Medical Science - A Retrospective Study. *Pol J Radiol*. 2017;82:726-30.
7. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med*. 1986; 15: 557-64.
8. Andersson M, Andersson RE. The appendicitis inflammatory response score: A tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. *World J Surg.* 2008;32:1843-9.
9. Sudhir S, Sekhar AP. Evaluation of Appendicitis Inflammatory Response Score as a Novel Diagnostic Tool for Diagnosis of Acute Appendicitis and its Comparison with Alvarado Score. *IJSS Journal of Surgery.* 2017;3(1):21-6.
10. Livingston EH, Woodward WA, Sarosi GA, Haley RW. Disconnect between incidence of nonperforated and perforated appendicitis: implications for pathophysiology and management. *Ann Surg*. 2007;245:886-92.
11. Karami MY, Niakan H, Zadebagheri N, Mardani P, Shayan Z, Deilami I. Which One is Better? Comparison of the Acute Inflammatory Response, Raja Isteri Pengiran Anak Saleha Appendicitis and Alvarado ScoringSystems. *Ann Coloproctol*. 2017;33:227-31.
12. Scott AJ, Mason SE, Arunakirinathan M, Reissis Y, Kinross JM, Smith JJ. Risk stratification by the appendicitis inflammatory response score to guide decision-making in patients with suspected appendicitis. *Br J Surg.* 2015;102:563-72.
13. Hesham Sayed Ahmed Ahmed, H. Comparative Study between Alvardo Score and Appendicitis Inflammatory Response Score in Diagnosis of Acute Appendicitis. *The Egyptian Journal of Hospital Medicine*. 2018;72(2): 3904-8.doi: 10.21608/ejhm.2018.9067.
14. Madasi V. Comparison of Predictive Validity of Alvarado Score and Appendicitis Inflammatory Response (AIR) Score, A Hospital Based Observational Study. *Int J surg Orthopedics*. 2016;2(3):29-34.