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Original Research Article

Comparison of acute inflammatory score and Alvarado score in diagnosis of acute appendicitis at a tertiary care hospital

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ABSTRACT

Background: Acute appendicitis remains as one of the most common surgical entity requiring early intervention. Hence there is always a need to develop a well-designed protocol for diagnosis and to reduce negative appendectomy. The most common and widely applied was Alvarado score and best performed in validating studies, but was observed with few drawbacks. A recently introduced appendicitis inflammatory response score (AIR) was designed to overcome the drawbacks associated with the implementation of Alvarado scoring system. The objective the present study was to evaluate the AIR score on cases of suspicious appendicitis and to compare it with Alvarado scorings system.
Methods: A prospective study for a period of two years from March 2015 to February 2017 was conducted on consecutive patients who presented to emergency department and scoring was performed based on the necessary variables.
Results: The present study was conducted on 300 cases suspicious of appendicitis. The results analysed showed the area under the ROC curve of the AIR score was 0.94 and better than the area under the curve of Alvarado score of 0.82. The AIR score also did well in difficult cases of women, children when compared to Alvarado score in diagnosis of appendicitis. In our study, 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.
Conclusions: To conclude, 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.

Keywords: Acute appendicitis, Alvarado scoring system, Appendicitis inflammatory score, Specificity

INTRODUCTION

Appendicitis defined as inflammation of appendix was first coined by "Reginald fitz" from Boston and identified as the common cause of right lower quadrant pain. Appendectomy was first performed by Robert Lawson in England.[1] Even now appendicitis still remains as one of the most common emergency and poses a difficulty in accurate diagnosis as the symptoms are ambiguous. It commonly occurs in adolescence and with a mal: woman ratio of 3:2.[2] The diagnosis of acute appendicitis is controversial at times and the management of patients with equivocal diagnosis is also controversial. Management of cases is dependent upon clinician's perspective, some advocating early intervention in preventing perforation, complications and morbidity while some others propose active observation of patients with equivocal diagnosis which avoids unnecessary

appendectomy without increasing the number of perforations.[3] Negative appendectomy rates have still remained above 6% in various studies conducted universally despite adoption of imaging studies like sonography and tomography widely. However, the main problem with routine use of imaging studies are potential harmful ionizing radiation, examiner dependent efficacy, and technique associated morbidity. Diagnostic imaging performs less well in groups of patients with low or high prevalence of disease even with high sensitivity and specificity. In most of the countries, surgeons still consider acute appendicitis a clinical diagnosis and don't perform imaging studies.[4]

Hence the diagnostic accuracy of the condition can be enhanced by integration of objective clinical predictors, laboratory markers into a clinical scoring system. Laboratory inflammatory markers either on its own or as a part of other scoring systems have been used to improve the predictability of appendicitis. The most common and widely applied was Alvarado score and best performed in validating studies, but was observed with few drawbacks. The scoring doesn't include CRP, a widely accepted laboratory marker in assessment of cases of acute appendicitis.[5] A recently introduced appendicitis inflammatory response score (AIR) was designed to overcome the drawbacks associated with the implementation of Alvarado scoring system. This scoring system incorporates CRP as one of the variable in scoring the cases of suspicious appendicitis. The objective the present study was to evaluate the AIR score on cases of suspicious appendicitis and to compare it with Alvarado scorings system.

METHODS

A cross sectional prospective study was conducted at ACSR government medical college, a teaching and tertiary care hospital for a study period of two years from March 2015 to February 2017. The study was started after approval of the institutional research committee and followed their protocol. Informed and written consent was obtained from all the enrolled cases and consent was obtained from the parents or guardians in case of children <14 years of age. 300 consecutive patients who attended the emergency department of the hospital and suspicious of acute appendicitis were enrolled in the study. All patients who complained of sudden onset, non-traumatic pain in the right lower quadrant were selected in the study.

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 and type of appendicitis based on microscopic findings. Diagnosis was confirmed when there is invasion of muscularis propria by neutrophil granulocytes in the specimen by microscopy. Based on Histopathological diagnosis, patients were classified into two groups, a) Phlegmonous appendicitis and b) Advanced appendicitis.

All the variables required for evaluating the scoring were noted and both Alvarado score and AIR score was calculated. The two scores were based on different variables and different points were assigned to each variable. An overview of each scoring system is given in Table 1.WBC and neutrophil counts were measured using automated analyzer and CRP levels were measured using Latex agglutination method.

Table 1: Characteristics of appendicitis inflammatory response (air) score and Alvarado score.

Diagnosis	Alvarado score	AIR score
Migratory RLQ pain	1	
Anorexia	1	
Nausea and vomiting	1	1
Tenderness	2	
Rebound tenderness	1	
Light		1
Medium		2
Strong		3
Raised temperature	1	1
Leukocytosis shift (%)	1	
70-80		1
>85		2
WBC count		
>10.0 $x10^9$/l	2	
>10.0- 14.9 $x10^9$/l		1
≥15$x10^9$/l		2
C-Reactive protein conc.		
10-49 g/l		1
>50 g/l		2

Alvarado score: 0-4= not likely appendicitis,5-6: Equivocal, 7: Probably appendicitis,9-10: Highly likely appendicitis. AIR score: 0-4: Low probability, 5-8: indeterminate group, 9-12: High probability.

Statistical analysis

All the variables were noted in a Microsoft excel spread sheet and checked for corrections. Analysis was performed using Graph pad prism version 5.0. A p value of <0.005 was considered significant. Pearson's chi-square test was used to test if the differences between the two groups were significant.

RESULTS

The present study included 300 patients with suspicion of appendicitis. There were 164 (54.67%) males and 136

(45.33%) of females with male preponderance in the study. The mean age of the male was 34 years with a range of 7-84 years and female was 31 years with a range of 12-74 years. The most common age group in the study was 16-25 years (34%) followed by 26-35 years (28%) (Table 2).

Table 2: Age and sex distribution of cases in the study.

Age (in years)	No	Percentage
<15	24	8
16-25	102	34
26-35	84	28
36-45	56	18.7
46-55	24	8
>55	10	3.3
Sex		
Male	164	54.67
Female	136	45.33

In present study, Anorexia was the common symptom seen in 94% of cases followed in order by vomiting (78%), pain in RLQ (72%), rebound tenderness (71%), guarding (70%) and Leukocytosis (70%) (Figure 1).

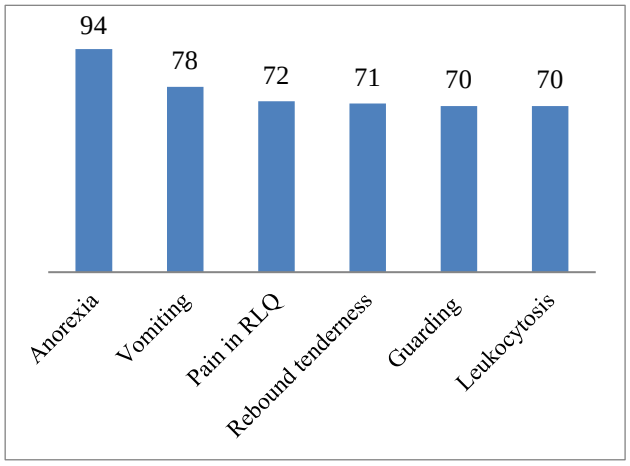

Figure 1: Distribution of signs and symptoms.

Table 3: Alternate diagnosis of patients on follow-up.

Diagnosis	After follow-up	At surgery
Pelvic inflammatory disease	17	13
Gastro enteritis	16	
Ulcerative colitis	8	
Diverticulitis	9	
Mesenteric adenitis	9	
Cholecystitis	6	
Urinary tract infection	17	
Genitourinary calculi	13	
Others	8	

In the study, 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 which are listed in Table 3. All these patients underwent routine follow-up. Nonspecific abdominal pain was found in 72 cases.

The area under the ROC curve of the AIR score was 0.94 and better than the area under the curve of Alvarado score of 0.82. The AIR score also did well in difficult cases of women, children when compared to Alvarado score in diagnosis of appendicitis. In our study, 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).

These findings correspond to Negative predictive value of 0.94 for AIR score compared to 0.90 for Alvarado score. In our study, 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 (Table 4).

Table 4: Diagnostic characteristics of AIR score and Alvarado score according to cut-off points.

Diagnostic value	AIR score		Alvarado score	
	>4 points	>8 points	>4 points	>8 points
All appendicitis				
Sensitivity	0.94	0.12	0.9	0.26
Specificity	0.87	1.00	0.54	0.95
PPV	0.74	1.00	0.54	0.77
NPV	0.94	0.67	0.90	0.70
Advanced appendicitis				
Sensitivity	0.94	0.21	0.92	0.34
Specificity	0.87	1.00	0.54	0.95
PPV	0.66	1.00	0.31	0.55
NPV	0.95	0.84	0.97	0.90

PPV: Positive predictive value; NPV: Negative predictive value.

One hundred forty-six patients 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 Table 5.

Table 5: Distribution according to the diagnostic test zone and diagnosis for the AIR score and the Alvarado score.

Diagnostic test zone	AIR score	Alvarado score
Score >8	50	86
Advanced appendicitis	16	18
Phlegmonous appendicitis	34	41
Negative appendectomy	0	17
Non-operated	0	10
Score 5-8	104	112
Advanced appendicitis	10	4
Phlegmonous appendicitis	38	26
Negative appendectomy	36	30
Non-operated	20	52
Score <5	146	102
Advanced appendicitis	2	6
Phlegmonous appendicitis	16	21
Negative appendectomy	90	20
Non-operated	38	55

DISCUSSION

Acute appendicitis is a common surgical emergency with an incidence of 1.17/1000 population and a lifetime risk of 8.6% in men and 6.7% in women, with highest incidence in adolescent age.[6] Most of the conditions which mimic appendicitis may create confusion in accurate diagnosis and management. Hence most of the surgeons rely on imaging studies which provides valuable information regarding the diagnosis. But as mentioned in many studies, tomographic studies are associated with increased radiation hazard and increased cost in low income countries. Hence false diagnosis and delay in diagnosis may result in unnecessary appendectomies and increased complications and morbidity.[7]

Most of the cases of diagnosis in acute appendicitis relies upon surgeon's knowledge and experience with similar cases. Hence the drawbacks could be overcome by using a clinical scoring system which can help in diagnosis as well as prognosis of the current patient from those presenting with similar clinical scenario. In developing countries and low-income countries, a simple and effective scoring system without tomographic or imaging studies could help in preventing misdiagnosis and decrease the rate of negative appendectomies.

The widely applied scoring system was Alvarado scoring system which was validated in many studies globally with few limitations and drawbacks.[8] Several modifications of Alvarado scoring system were developed. Hence to overcome the limitations of Alvarado scoring system, Appendicitis inflammatory response score (AIR) was developed in Sweden in 2008 based on prospectively collected data of variables with independent prognostic value. This scoring system because of its simple design and application could estimate the probability of appendicitis and acts a supportive aid in decision making process of acute appendicitis.[9]

The present study was conducted to compare the AIR score with Alvarado scoring system in cases suspected with acute appendicitis. Another advantage in AIR scoring is not only in accurate diagnosis but also in discriminating objectively the necessity to operate or not to operate with a follow up. 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 Sudhir et al and Kim BS et al in their studies.[10,11]

Few of the studies which used Alvarado scoring system did not include C reactive protein in the study group and found no difference in the rates of perforated appendix, negative appendectomies and complications between the groups. They also found a delayed appendectomy rate (2 vs 8%) and a lower delayed discharge rate (11 vs 22%) in the group.[12] In the present study, Sensitivity of AIR scoring system was 94% (At score of >4 points) when compared to Alvarado scoring system in both Phlegmonous and advanced appendicitis cases and 12% for AIR scoring and 26% for Alvarado scoring when compared at score of >8 points in the study. Findings of our study were similar with findings of Castro et al.[13]

Present study clearly validates that AIR scoring system performs well than Alvarado scores in children and almost equal to Alvarado scoring system in adolescent age group at high score values. This would clearly help in selecting patients who require surgical intervention and follow up in cases of low score individuals. This also helps the cases to avoid hospitalization and to prevent costly investigations in which the diagnosis is unlikely. Hence a prospective randomized control trial should be done on large scale population to evaluate the effect of AIR scoring system and to compare the results.[14]

CONCLUSION

To conclude, 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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REFERENCES

1. Seal A. Appendicitis: a historical review. Can J Surg. 1981;24:427-33.
2. Borges PSG, Nogueira LMC, Neto GHF. Validation of the Alvarado score in the diagnosis of acute appendicitis in children and adolescents at the Instituto Materno Infantil de Pernambuco-IMIP. Infant. 2003;3(4):439-45.
3. Andersson RE, Hugander A, Thulin AJ. Diagnostic accuracy and perforation rate in appendicitis: Association with age and sex of the patient and with appendicectomy rate. Eur J Surg. 1992;158:37-41.
4. Florence M, Flum DR, Jurkovich GJ, Lin P, Steele SR, Symons RG, et al. Negative appendectomy and imaging accuracy in the Washington state surgical care and outcomes assessment program. Annals of surgery. 2008;248(4):557-63.
5. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med. 1986;15:557-64.
6. Patil S, Harwal R, Harwal S, Kamthane S. Appendicitis inflammatory response score: a novel scoring system for acute appendicitis. Int Surg J. 2017;4:1065-70.
7. Flum DR, Koepsell T. The clinical and economic correlates of misdiagnosed appendicitis: nationwide analysis. Arch Surg. 2002;137(7):799-804.
8. Andersson RE. Meta-analysis of the clinical and laboratory diagnosis of appendicitis. Br J Surg. 2004;91:28-37.
9. 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.
10. 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.
11. Kim BS, Ryu DH, Kim TH, Jeong U, Song JH, Cho SI, et al. Diagnosis of acute appendicitis using scoring system: compared with the Alvarado score. J Korean Surg Soc. 2010;79:207-14.
12. Ohmann C, Franke C, Yang Q, Margulies M, Chan M, Van Elk PJ, et al. Diagnostic score for acute appendicitis. Der Chirurg; Zeitschrift fur alle Gebiete der operativen Medizen. 1995;66(2):135-41.
13. De Castro SMM, Ünlü C, Steller EPH, Wagensveld BA, Vrouenraets BC. Evaluation of the appendicitis inflammatory response score for patients with acute appendicitis. World J Surg. 2012;36(7):1540-5.
14. Andersson RE. Meta-analysis of the clinical and laboratory diagnosis of appendicitis. Br J Surg. 2004;91:28-37.

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