Original Article

Appendicitis Inflammatory Response Score in Acute Appendicitis: A Study at a Tertiary Care Center in North India

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Abstract

Introduction: Appendicitis is a common cause of acute abdominal pain. The diagnosis is eminently clinical and the cause is surgically correctable. However, a decision of surgery based on the clinical presentation only has a 15%–30% chance of the removal of a normal appendix. Thus, the diagnosis involves a corroboration of clinical, laboratory, and radiological findings. Appendicitis scoring systems can be considered to expedite the diagnostic and decision-making process. **Aim:** The present study was conducted to study the efficacy of Appendicitis Inflammatory Response (AIR) score in the diagnosis of acute appendicitis and its correlation with the histopathological findings. **Materials and Methods:** A cross-sectional study was conducted at a tertiary care center in North India comprising patients who presented to the surgery department with a provisional diagnosis of acute appendicitis and required appendectomy. **Results:** Appendicitis was histopathologically proven in 54 patients. Patients with an AIR score ≥5 were 2.18 times more likely to have appendicitis. The probability of having appendicitis with AIR score ≥5 was 92.16% (positive predictive value). The diagnostic accuracy of AIR score was 82.81%. **Conclusion:** AIR score has a high sensitivity and positive predictive value in the diagnosis of acute appendicitis. It is a quick and convenient system for clinical evaluation of patients in primary care or peripheral hospitals where advanced facilities such as USG scan or CT scan are not available all the time. The application of this scoring system definitely improves diagnostic accuracy and reduces negative appendectomy rate.

Keywords: *Appendectomy, appendicitis, histopathological, inflammatory, response, score*

Introduction

Acute abdomen is a very common emergency room presentation. Appendicitis being one of the major causes requires an urgent and specific diagnosis. The condition is serious and can spontaneously progress to perforation posing a lifetime risk of 7%–8%.[1-3] Thus, the surgeons may sometimes be biased to operate even when the diagnosis is probable.[4] Physical examination is a useful method to diagnose appendicitis, but it could be a challenge if the symptoms are vague. A surgical procedure based merely on suspicion may lead to negative appendectomy along with unnecessary cost of treatment and morbidity to the patient.[5,6] Imaging procedures are helpful in the case of uncertainty but tend to be overused in many cases further increasing the financial burden on the patient.[7-10] The diagnostic workup could be improved using clinical scoring systems which not only provide an early and accurate diagnosis but also help in risk evaluation.[11] The Appendicitis Inflammatory Response (AIR) score is one such scoring system that facilitates the importance of clinical and laboratory variables and makes the clinical diagnosis more objective. It implies the use of seven variables that are individually scored. Based on the score values, the patients are categorized into low-, intermediate-, and high-risk groups. The present study was conducted to study the efficacy of AIR score in the diagnosis of acute appendicitis in North Indian patient profile and its correlation with the histopathological findings.

Materials and Methods

A cross-sectional study was conducted at a tertiary care center in North India. All patients presenting with right iliac fossa pain and provisional clinical diagnosis of acute appendicitis were enrolled in this study. Patients presenting with nonright iliac fossa pain, those who had been admitted

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by other specialties for other complaints but subsequently developed right iliac fossa pain, and patients who did not give consent for the study were excluded from the study. Written informed consent was taken from the patients. The study protocol was approved by the institutional ethics committee, and it conformed to the ethical guidelines of the 1964 Declaration of Helsinki.

Based on the formula: $n = (Z^2 \text{ a} \times P \times (1 - P)/d^2$, we calculated the sample size, assuming the power of 80%, confidence level at 95%, and precision (d) at ± 6.0%.[12] We included 64 patients in our study. A detailed clinical history was taken for every consenting patient followed by a thorough physical and systemic examination. The laboratory investigations included complete hemogram, routine urine examination, and C-reactive protein. A pro forma was filled out for every patient which included all the patient details. The AIR score system consists of two symptoms, two signs, and three laboratory values. For every patient, the score of each of the variables was noted and the final sum of all the scores was calculated. According to the final value recorded, the patients were categorized into different risk groups. Patients having an AIR score from 0 to 4 were grouped into low-risk group, 5–8 were grouped into intermediate-risk group, and from 9 to 12 were grouped into high-risk group [Table 1].[4,11,13,14]

A diagnosis of acute appendicitis was confirmed by histopathological assessment of the appendectomy specimen. For this, all the surgical specimens were sent in formalin-filled container to the pathology department. The specimens were sectioned at the tip, body, and base, and the slides were stained with hematoxylin and eosin stain. Microscopically, positive appendicectomy was confirmed on the presence of acute inflammation with predominance of neutrophils in the mucosa or all the layers of appendiceal wall, mucosal erosions, crypt abscesses, collections of neutrophils in the lumen, and mural necrosis. Negative appendicectomy was defined as a totally normal appendix on histopathology. Hence, the reliability of AIR score system was assessed by the correlation between the score values and histopathological findings.

Appropriate statistical tests were applied to analyze the data. The range, mean ± standard deviation, frequencies (number of cases), and relative frequencies (percentages) were used as required. Quantitative variables were compared using Mann–Whitney *U*-test for nonparametric data. Chi-square test was used to identify associations among categorical data. True positives, true negatives, false positives, false negatives, sensitivity, specificity, and positive and negative predictive values were calculated. A probability value (*P* value) <0.05 was considered statistically significant. All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS 21 version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows.

Results

A total of 64 patients were included and majority were males (76.56%) as compared to females (24.43%). The mean age of presentation in males and females was 36.95 years and 34.66 years, respectively. The overall mean age for occurrence of appendicitis was 36.42 years. Based on the compiled seven-variable score of AIR, the patients were distributed into various risk groups. Table 2 depicts that maximum number of patients (51.56%) were of the intermediate-risk group. Histopathology confirmed a diagnosis of acute appendicitis in 54 patients, out of which 49 cases (90.74%) showed acute appendicitis, 3 (5.55%) cases were of acute suppurative appendicitis, and one case each of (1.8%) acute gangrenous appendicitis and perforated appendicitis. Table 3 depicts the correlation of AIR score with the histopathological diagnosis.

The optimum cutoff point for AIR score was ≥5, which had a sensitivity of 87.04%, specificity of 60%, and a positive likelihood ratio of 2.18. Hence, the patients with an AIR score ≥5 were 2.18 times more likely to have appendicitis. The probability of having appendicitis with AIR score ≥5 was 92.16% (positive predictive value) with a diagnostic accuracy of 82.81%. Table 4 depicts the entire statistical analysis of the AIR score.

Table 1: Appendicitis Inflammatory Response score

AIR score variables	Score
Vomiting	1
Pain in the right lower quadrant	1
Rebound tenderness (or muscle guarding)	
Light	1
Medium	2
Strong	3
Body temperature (>38.5°C)	1
Polymorphonuclear leukocytes (%)	
70-84	1
≥85	2
White blood cell count (cells/cumm)	
10,000-14,999	1
≥15,000	2
C-reactive protein estimation (mg/L)	
10-14	1
≥50	2

AIR: Appendicitis Inflammatory Response

Table 2: Distribution of total study population into various risk groups based on Appendicitis Inflammatory Response score

AIR score-based risk group	Number of patients (*n*=64), *n* (%)
Low (1-4)	13 (20.31)
Intermediate (5-8)	44 (68.75)
High (9-12)	7 (10.94)

AIR: Appendicitis Inflammatory Response

Table 3: Correlation of Appendicitis Inflammatory Response score with histopathology

AIR score	Histopathological diagnosis		Total
	Positive appendectomy (*n*=54)	Negative appendectomy (*n*=10)	
1-4 (low risk)*			
Acute appendicitis	7	6	13
Acute suppurative appendicitis	0		
Acute gangrenous appendicitis	0		
Perforated appendicitis	0		
5-8 (intermediate risk)*			
Acute appendicitis	40	4	44
Acute suppurative appendicitis	0		
Acute gangrenous appendicitis	0		
Perforated appendicitis	0		
9-12 (high risk)*			
Acute appendicitis	2	0	7
Acute suppurative appendicitis	3		
Acute gangrenous appendicitis	1		
Perforated appendicitis	1		
Total	54	10	64

*Chi square value: 11.912, P: 0.003. AIR: Appendicitis Inflammatory Response

Table 4: Sensitivity and specificity of Appendicitis Inflammatory Response score with histopathology

Statistic	Value (%)	95% CI
Sensitivity	87.04	75.10-94.63
Specificity	60.00	26.24-87.84
Positive likelihood ratio	2.18	1.01-4.68
Negative likelihood ratio	0.22	0.09-0.51
Disease prevalence	84.38	73.14-92.24
Positive predictive value	92.16	84.52-96.19
Negative predictive value	46.15	26.68-66.87
Accuracy	82.81	71.32-91.10

CI: Confidence interval

Discussion

Appendicitis is a common abdominal surgical emergency. On an average, 8.6% of males and 6.7% of females are at a risk of developing acute appendicitis and the probability of undergoing a surgery remains 12% and 23%, respectively.[15,16] Despite all the new advances, the decision to operate based on clinical evaluation or waiting for confirmatory diagnostic workup is a clinician's dilemma. A delayed decision might trigger the danger of complications such as appendicular perforation and infection, thus enhancing patient morbidity and mortality.[17] However, a decreased demonstrative accuracy expands the negative appendectomy rate, while injudicious use of diagnostic modalities such as computed tomography scan may raise the cost of health care considerably.[18,19]

The clinical diagnosis of acute appendicitis is challenging, wherein the appendicitis scoring systems might help by providing a definitive clue about the probability of appendicitis in a patient. The simple design of AIR score involving the use of physical examination findings, laboratory and inflammatory markers, makes it easy to apply. Risk stratification of patients with suspected acute appendicitis could guide in decision-making to reduce admissions, optimize the utility of diagnostic imaging, and prevent negative surgical explorations. For low-risk patients who are kept under observation, the score can be regularly repeated for monitoring their condition. An array of clinical scoring systems has been proposed over the past few years, out of which the AIR scoring system has been well known among the validation studies during the past decade.[11,20] Our study was conducted at a major tertiary care hospital to evaluate the efficacy of AIR score in North Indian population profile. The literature search revealed that the data regarding the use of AIR score for acute appendicitis in this demographic region are very limited.

The male: female ratio for appendicitis in our study was 3.2:1 which was consistent with the studies done by Sulu *et al.*[21] Saha *et al.*,[4] and Madasi.[22] Overall, the mean age for occurrence of appendicitis was 36.42 years, with a mean age of 36.95 years in males and 34.66 years in females. The youngest patient reported in our study was a 7-year-old female and the eldest patient was a 74-year-old male. Patil *et al.*[13] reported that the overall mean age for occurrence of appendicitis is 28.9 years. The mean age in females was 27.2 years and in males 29.8 years, with a range in both sexes being 9–72 years. Saha *et al.*[4] reported that maximum cases of appendicitis are found to occur in ≤30 years of age (78.6%). Scott *et al.*[23] in their study found that the mean age of appendicitis was 27 years.

Pain in the right lower quadrant along with vomiting was our most common symptom, which was found in 74.07% of the patients which was similar to the studies done by Saha *et al.*[4] and Patil *et al.*[13] who reported vomiting in 77.5% and 74% of patients, respectively. Leukocytosis in our study was found to be in 92.59% of patients which is higher than the percentage reported by Saha *et al.*[4] (63%), Patil *et al.*[13] (61%), and Kim *et al.*[24] (72%).

On the basis of AIR score, maximum number of patients in our study (68.75%) were categorized into the intermediate-risk group, while 20.31% in the low-risk group and 10.93% in the high-risk group. This was quite similar to the findings of Saha *et al.*[4] who recorded 73% of patients to be in the intermediate-risk group, 16% in the low-risk group, and 11% in the high-risk group. On histopathological correlation, we observed that the rate of negative appendectomy was higher (46.15%)

in the low-risk group, as compared to 9.09% in the intermediate-risk group and 0% in the high-risk group. The positive appendectomy specimens from the low- and intermediate-risk groups were all confirmed to be acute appendicitis on histopathology, while the appendectomies from the high-risk group featured complications such as acute suppurative appendicitis (5.55%), gangrenous appendicitis (1.8%), and perforation (1.8%). This further strengthens the fact that the higher the AIR score, lesser are the chance of negative appendectomies and more is the probability of encountering complications.

We evaluated the efficacy of AIR score on the basis of sensitivity, positive predictive value, and accuracy. The AIR score had an optimum cutoff point score value >5 with a sensitivity of 87.04%, specificity of 60.0%, positive likelihood ratio of 2.18, negative likelihood ratio of 0.22, positive predictive value of 92.16%, negative predictive value of 46.15%, and diagnostic accuracy of 82.81%. These findings are similar to a study conducted by Saha *et al*.[4] who reported (at score >4) a sensitivity of AIR score of 89.9% and specificity of 63.6%. The positive predictive value is 95.23%, and the negative predictive value is 43.75%. The sensitivity of AIR score was comparatively lower than Andersson and Andersson[20] who classified 63% of the patients into the low- or high-probability group with an accuracy of 97.2%, leaving 37% for further investigation. In their study, 73% of the nonappendicitis patients, 67% of advanced appendicitis, and 37% of all appendicitis patients were correctly classified into the low-, high-, and intermediate-probability zones, respectively. In the study done by Scott *et al*.,[23] an AIR score of 5 or more demonstrated high sensitivities for intermediate- and high-risk patients with appendicitis (90%) and for patients with advanced appendicitis (98%). Kollár *et al*.[25] in their study gave a final diagnosis of appendicitis in 67 of 182 patients (37%). In their study, AIR score was assigned in a smaller proportion of patients to the high-probability zone with a specificity of 97% and positive predictive value of 88%. In a study, Madasi[22] reported that the sensitivity of the AIR score was 95.7% and specificity of 90.5%. The positive and negative predictive values were 99.2% and 61.3% for AIR score, respectively. The overall diagnostic accuracy of AIR score was 95%.

Conclusion

This study aimed at validation of the AIR score in diagnosing acute appendicitis in North Indian patient profile, as not much study data have been published regarding the same. We found that the AIR score is a sufficiently sensitive and reliable tool for screening and stratification of patients with acute appendicitis, thereby decreasing the need for imaging modalities and preventing negative surgical explorations. However, this study was not without limitations. Being conducted at a single tertiary care center in North India, we had a limited number of patients. Thus, larger, multicentric, and comparative cohort studies are required to establish the present findings.

Ethical statement

The study was approved by the Research and Ethics Committee of Dayanand Medical College and Hospital, Ludhiana, Vide Reference No: 4/46-2017.

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Conflicts of interest

There are no conflicts of interest.

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