

## Comparison of appendicitis inflammatory response (AIR) score with Alvarado score in the diagnosis of acute appendicitis

Mumtaz Hussain, Dileep Kumar, Raheel Ahmed, Paras, Erum Kazim, Muhammad Zubair

### Received:

17th December, 2018

### Accepted:

13th July, 2019

### Abstract:

**Objective:** The objective of this study was to compare Appendicitis Inflammatory Response (AIR) score to Alvarado score to determine which one is more accurate as a diagnostic tool for acute appendicitis.

**Study design:** Cross Sectional study.

**Place and duration of study:** Department of Surgery, Dr. fRuth K.M Pfau Civil Hospital Karachi from October 2017 to April 2018.

**Material and Methods:** This study included 102 patients who visited Emergency Department and were suspected clinically with acute appendicitis. Both AIR and Alvarado scores were calculated and decision for surgical intervention was made on strong clinical judgment. After surgery specimen of every patient was sent for histopathology to confirm the clinical diagnosis. Results of histopathology were compared with AIR and Alvarado score individually. All data was recorded in the predesigned proforma.

**Results:** The average age of the patients was  $30.09 \pm 1.92$  years. There were 59 (57.84%) male and 43 (42.16%) female. Sensitivity, specificity, positive predictive value (PPV), Negative Predictive Value (NPV) and accuracy of Alvarado score 70.3%, 81.8%, 97%, 25% and 71.6% and for AIR score was 86.8%, 81.8%, 97.5%, 42.9% and 86.2% respectively. Area under Curve (AUC) of AIR was higher as compared to Alvarado score (AUC: 0.82 vs 0.88 ;  $p < 0.05$ )

**Conclusion:** It was concluded that AIR scoring system provides better accuracy than Alvarado score for diagnosis of acute appendicitis consistent with final surgical pathology.

**Keywords:** Appendicitis, Appendicitis inflammatory response AIR, Alvarado score

### Introduction:

The vermiform appendix, a true diverticulum of the Cecum appears in sixth week of human embryonic development life as an elevation from postero-medial wall about 2 cm below ileocecal valve.<sup>1</sup> Inflammation of the appendix has remained common surgical disease with an estimated life time prevalence of 8.6% for the males and 6.7% for the females and higher incidence in second and third decades of life.<sup>2</sup> The exact cause of appendicitis is often unknown but most theories agree with luminal obstruction as primary pathology.<sup>3</sup> Clinical diagnosis of patients with acute appendicitis is still challenging for the physicians especially in young children and women of child bearing age due to different

over-lapping symptoms of female pelvis organs.

Early and correct diagnosis is mostly achieved through clinical assessment and sometimes diagnostic imaging, particularly CT scan may be required to avoid negative appendectomy on final confirmatory diagnosis on histopathology.<sup>4,5</sup> However diagnosis is predominantly clinical one and this selective use of CT scan may not be always possible particularly in developing countries there-by surgeons utilize clinical scoring systems which provide consistently reliable and standardized pathway for the clinical diagnosis.<sup>6</sup>

Different scoring system are utilized to diagnose the appendicitis on clinical grounds and

### DUHS/ Civil Hospital, Karachi

M Hussain

E Kazim

Paras

R Ahmed

D Kumar

M Zubair

### Correspondence:

Dr. Raheel Ahmed

Department of Surgery

Unit-IV, DUHS/ Civil

Hospital, Karachi.

Cell:

Email: draheelahmed@

gmail.com

Table-1: Association between complications and success rate

Clinical feature	AIR Score	Alvarado Score
Vomiting	0	1
<b>Pain in RIF</b>	1	0
Migratory RIF pain	0	1
Anorexia	0	1
<b>Tenderness</b>		
Present	0	2
Low (Tenderness with no physical response)	1	0
<b>Mild (Tenderness with grimace, wince or flinch)</b>	2	0
Severe (Positive jump sign or patient refusal to palpated due to pain)	3	0
Rebound Tenderness	0	1
Body temperature > 37.5°C	0	1
Body temperature > 38.5°C	1	0
<b>WBC Count</b>		
> 10 x 10 <sup>9</sup> /l	0	2
10.0 x 14.9 x 10 <sup>9</sup> /l	1	0
≥ 15.0 x 10 <sup>9</sup> /l	2	0
<b>Poly-morpho-nuclear leukocytes</b>		
70–84%	1	0
≥ 85%	2	0
Leukocytosis shift	0	1
<b>CRP Concentration</b>		
10–49 g/l	1	0
≥ 50 g/l	2	0
<b>Maximum Score</b>	<b>12</b>	<b>10</b>

prompt its management. These scoring systems are formed by combination of clinical assessment and laboratory results. An example is the Alvarado scoring system which was devised two decades ago but still commonly used scoring system helping clinicians to triage patient into different management groups according to scores and stratify patient in low, intermediate and high risk. Although Alvarado scoring is mostly used by the clinicians but alone it cannot diagnose or exclude reliably acute appendicitis.<sup>7,8</sup>

Appendicitis inflammatory response is recently designed scoring system which included C-reactive protein value and is more helpful, better and more accurate than Alvarado score in high risk patients and excluding the condition in low risk patients.<sup>9,10</sup>

The aim of this study was to compare recently introduced AIR clinical scoring system which helps in recognizing patients in need of urgent surgery without delay and avoiding the unnecessary risks and costs of surgical intervention in patients without true appendicitis.

#### Material and Methods:

This was a cross-sectional study conducted over a period of 06 months from October 2017 to April 2018 which included consecutive patients (102), admitted in department of Surgery, Dr. Ruth K. M. pfau Civil Hospital Karachi, with a preliminary diagnosis of acute appendicitis. Patients of both sexes with the age of 16 to 60 years, presented with pain in the right lower abdomen or paraumbilical pain shifting to the right iliac fossa and those who were clinically diagnosed as cases of acute appendicitis on clinical examination were included while patients with mass in right iliac fossa on clinical examination or already planned for interval appendectomy and patients who did not consent were excluded from the study. Appendicitis Inflammatory Response (AIR) and Alvarado score was calculated in all patients (table 1).

All investigations included CRP were carried out and data was recorded in the predesigned proforma. Consultant surgeons had decided the need for surgery based on clinical assessment and kept blind about the scores. A patient in whom AIR score more than 5 and Alvarado score more than 7 was deemed as true positive if consistent with histopathology which is gold standard to diagnose the condition. The data was analyzed in SPSS version 19. The true negative appendectomy rate was calculated for both scoring system and score considered as the reliability of scoring system. Two sub-groups were made and sensitivity, specificity, positive and negative predictive values and accuracy was derived individually for the both subgroups. Receiver Operating characteristic (ROC) ROC curve was plotted to compare AUC of AIR and Alvarado score according to histopathology finding in diagnosis of acute appendicitis. P < 0.05 was considered as significant.

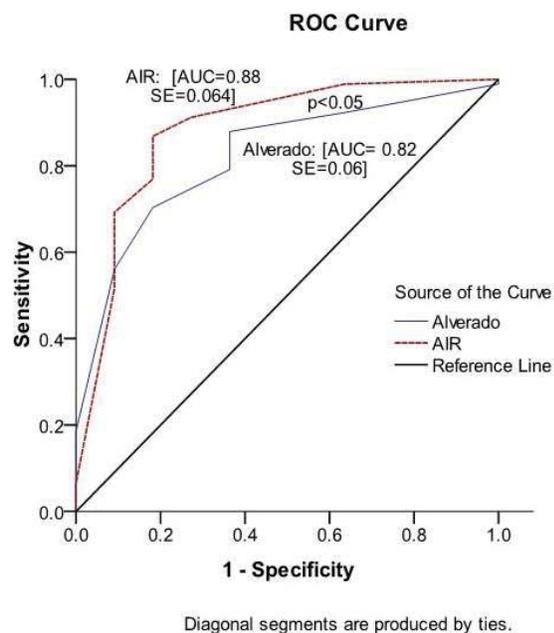


Fig. 1: Comparison of area under the curve of appendicitis inflammatory response scoring and Alvarado Scoring in diagnosis of acute appendicitis with histopathology

### Results:

102 patients with clinical diagnosis of acute appendicitis were included in the study. More than 60% patients were below 30 years of age with gender distribution of 59 (57.84%) male and 43 (42.16%) female. Overall diagnostic accuracy derived from confirmation of appendicitis based on histo-pathology report was 89.22% (91/102). Accuracy for Alvarado score and AIR score in diagnosis of acute appendicitis were computed as 71.6% and 86.2% respectively. Sensitivity, specificity, PPV and NPV of Alvarado score 70.3%, 81.8%, 97% and 25% and for AIR score was 86.8%, 81.8%, 97.5% and 42.9% respectively. Diagnostic accuracy of Alvarado score below the age of 30 years was 63.6% and accuracy of AIR score for this age group was 81.8%. Similarly with respect to gender, accuracy of Alvarado score and AIR for male patients was 57.6% and 88.1% respectively and for female cases the value was 67.4% and 83.7% respectively. Comparison of AUC (Area under the curve) for AIR score and Alvarado score in diagnosis of acute appendicitis were plotted which show that AUC of AIR was significantly high as compared to Alvarado score (AUC: 0.82 vs 0.88;  $p < 0.05$ ).

figure 1.

### Discussion:

Acute appendicitis is one of the most frequent cause of patients with abdominal pain in emergency department.<sup>2,10</sup> Because of its similarity with many other conditions, making an exact diagnosis still remains a challenge even for the most experienced clinicians despite advances in imaging and laboratory sciences.<sup>11</sup> Timely diagnosis and surgical intervention is crucial to avoid appendicular perforation which can lead to increased morbidity and medico legal issues. Moreover the dilemma for the clinicians is also a negative appendectomy rate varying from 4-45% which can cause unnecessary removal of appendix, exposure to general anesthesia and peri-operative surgical care costs.<sup>12</sup> Although sensitivity and specificity have been much improved with the advent of CT scan and minimal invasive laparoscopy to diagnose with great certainty but this has led to surgical removal of appendix which could have been treated with non-operative antibiotics and conservative management similar to patients with diverticulitis.<sup>13</sup> Therefore making diagnosis of appendicitis needs an alternate approach including laboratory diagnostic tools and biomarkers which can predict severity of disease.

The most popular diagnostic scoring system was devised by Alvarado in 1986. However this scoring system had not achieved parallel results when subsequently applied for Asian population with consequence of moderately low sensitivity and specificity.<sup>14,15</sup> The AIR scoring system is another scoring system which incorporated the utility of CRP component which enhanced its discriminative power and outperformed Alvarado scoring system.<sup>16</sup> Therefore we decided to apply AIR score system in our tertiary care hospital and compared diagnostic accuracy, sensitivity, specificity and other variables with Alvarado scoring system. A study by Afsar et al noted patients operated for acute appendicitis had normal pathology report whose CRP component was normal as compared to increased value which was consistent with inflamed appendix on final histopathology report. He reported sensitivity and specificity of CRP component as

93.6% and 86.6% respectively.<sup>17</sup> Another study revealed that raised CRP levels with leucocytosis increased positive likelihood ratio from 4.24 to 23.32.<sup>21</sup> A study conducted by Karami et al supported our results and reported diagnosis sensitivity and specificity of AIR score as 78.4% and 91.6% respectively.<sup>14</sup> Similarly Yeşiltaş et al and other studies also concluded that adding CRP value can decrease unnecessary radiological imaging and surgical intervention and in addition predict severity of the disease including perforated and gangrenous appendix.<sup>18-20</sup> Our results were similar to study by Castro<sup>16</sup> who reported area under curve AOC for AIR score better than Alvarado and concluded that AIR score outperformed Alvarado score in more difficult to diagnose patients e.g. children, females and elderly patients.

#### Conclusion:

Despite of this common surgical condition correctly diagnosis of atypical appendicitis remains challenge for the clinicians. It is crucial to diagnose the condition early which can be expedited by utilizing one of the multiple clinical scoring systems. AIR Scoring system is latest scoring system which include biological markers and can suffice to reach the diagnosis in majority of the cases more accurately than old traditional Alvarado scoring system.

**Conflict of interest:** None

**Funding source:** None

#### Role and contribution of authors:

Dr Mumtaz Hussin, collected the data and did the initial write up

Dr Erum Kazim, collected the references and did help in writing the introduction

Dr Paras, helped in collecting the data and references and also helped in material and methods writing

Dr Raheel Ahmed, helped in collecting the references and helped in discussion writing.

Dr Dileep Kumar, went through the article and advised for useful changes.

Prof Muhammad Zubair, critically review the article and made for final changes

#### References:

1. Standing S, Ellis H, Healy JC, Johnson D, Williams A, Collins P. *Alimentary System*. 39th edition. New York, NY, USA: Churchill Livingstone; 2005. Gray's anatomy; pp. 1189-90
2. Liang MK, Andersson RE, Jaffe BM, Berger DH. The appendix. In: Brunnicardi FC, Andersen DK, Billar TR, Dunn DL, Hunter JG, Matthews JB, et al, eds. *Schwartzs principles of surgery*. 10th ed. New York: McGraw Hill education; 2014. p. 1241-62
3. Farmer DL. Clinical practice guidelines for pediatric complicated appendicitis: the value in discipline. *JAMA Surg*. 2016 May 18;151(5):e160193
4. Yu YR, Shah SR. Can the Diagnosis of Appendicitis Be Made Without a Computed Tomography Scan? *Adv Surg*. 2017 Sep;51(1):11-28.
5. Zoarets I, Poluksht N, Halevy A. Does Selective Use of Computed Tomography Scan? Reduce the Rate of White (Negative) Appendectomy. *Isr Med Assoc J*. 2014;16:335-337.
6. Kalliakmanis, V., et al. Acute Appendicitis: The Reliability of Diagnosis by Clinical Assessment Alone. *Scandinavian Journal of Surgery*. 2005 Sep;94(3):201-6.
7. Ohle R, O'Reilly F, O'Brien KK, Fahey T, Dimitrov BD. The Alvarado score for predicting acute appendicitis: a systematic review. *BMC Med*. 2011;9:139.
8. Petroianu A. Diagnosis of acute appendicitis. *International Journal of Surgery*. 2012 Jan 1;10(3):115-9.
9. Kollár D, McCartan DP, Bourke M, Cross KS, Dowdall J. Predicting acute appendicitis? A comparison of the Alvarado score, the Appendicitis Inflammatory Response Score and clinical assessment. *World J Surg*. 2015;39(1):104-109.
10. Howell JM, Eddy OL, Lukens TW, Thiessen MEW, Weingart SD, Decker WW, et al. Clinical policy: critical issues in the evaluation and management of emergency department patients with suspected appendicitis. *Ann Emerg Med*. 2010;55(1):71-116.
11. Debnath J, Sharma V, Ravikumar R, et al. Clinical mimics of acute appendicitis: Is there any role of imaging?. *Med J Armed Forces India*. 2015;72(3):285-92.
12. Joshi MK, Joshi R, Alam SE, Agarwal S, Kumar S. Negative Appendectomy: an Audit of Resident-Performed Surgery. How Can Its Incidence Be Minimized?. *Indian J Surg*. 2014;77(Suppl 3):913-7.
13. 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(6):886-92
14. 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 Scoring Systems. *Ann Coloproctol*. 2017;33(6):227-31.
15. Von-Mühlen B, Franzon O, Beduschi MG, Kruehl N, Lupselo D. AIR score assessment for acute appendicitis. *Arq Bras Cir Dig*. 2015;28(3):171-173.
16. de Castro SM, Ünlü C, Steller EP, van Wagenveld BA, Vrouenaerts BC. Evaluation of the appendicitis inflammatory response score for patients with acute appendicitis [published correction appears in *World J Surg*. 2012 Sep;36(9):2271]. *World J Surg*. 2012;36(7):1540-5.
17. Asfar S, Safar H, Khoursheed M, Dashti H, Al-bader A: Would measurement of C-reactive protein reduce the rate of negative exploration for acute appendicitis? *J R Coll Surg Edinb* 2000, 45:21-24

18. Yeşiltaş M, Karakas DO, Gökçek B, Hot S, Egin S, Alvarado and Appendicitis Inflammatory Response Scores Can Evaluate Severity of Acute Appendicitis? *Ulus Travma Acil Cerrahi Derg* 2018;24(6):557-62.
19. Shelton JA, Brown JJ, Young JA. Preoperative C-reactive protein predicts the severity and likelihood of complications following appendicectomy. *Ann R Coll Surg Engl*. 2014;96(5):369-372.
20. Van den Worm L, Georgiou E, De Klerk M. C-reactive protein as a predictor of severity of appendicitis. *S Afr J Surg*. 2017;55(2):14-17
21. Andersson RE. Meta-analysis of the clinical and laboratory diagnosis of appendicitis. *Br J Surg* 2004;91:28-37.