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RISK STRATIFICATION USING APPENDICITIS INFLAMMATORY RESPONSE SCORE, A USEFUL TOOL TO REDUCE NEGATIVE APPENDICECTOMY RATE : OUR EXPERIENCE

General Surgery

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ABSTRACT

Background: Acute appendicitis is mostly considered a clinical diagnosis and many surgeons resort to clinical judgement for deciding its management. Such cases often pose a diagnostic dilemma and result in significant negative exploration rates. Appendicitis Inflammatory Response (AIR) score, designed in 2008, is a validated clinical scoring system which has outperformed the well-known Alvarado scoring system. This study evaluates the risk stratification of patients as per AIR scores, correlation with the post-op histopathological examination (HPE) diagnosis to calculate the negative appendicectomy rate and to evaluate the diagnostic performance of this scoring system.

Method: This is a prospective observational study carried out between Nov 2016 and May 2018, on 150 cases of acute appendicitis that underwent surgical management.

Result: This study data revealed a negative appendicectomy rate of 9.33 %. Statistical analysis showed that scores of 9 - 12 has great accuracy for diagnosis, with a specificity of 100 % and positive predictive value of 1.0 whereas low scores of 0-4 potentially identify cases who do not require surgery.

Conclusion: The AIR score is an accurate diagnostic tool when a score of 9 is taken as cut-off. Management algorithms based on AIR score have the potential of reducing negative appendicectomy rate by correct identification of those who don't require surgery.

KEYWORDS

Acute Appendicitis, AIR Score, Negative Appendicectomy

Introduction

Acute Appendicitis is the commonest cause of acute onset right lower quadrant (RLQ) pain requiring emergency surgical management and overall the second commonest cause of acute onset abdominal pain, only after non-specific pain abdomen (1). Traditionally, it is considered a clinical diagnosis and clinical judgement is often used for the management of these cases (2). The decision making has a lot of potential for improvement, as is reflected by the high negative exploration rates of up to 37 % (3). A large North American study showed a prevalent negative appendectomy rate of 13 % whereas a Dutch study showed a negative appendectomy rate of 15 % (4,5). Due to this preventable burden of negative explorations on health care system and the patients, there is perpetual need of devising a reliable scoring system that will help in quick and accurate diagnosis and eliminating negative explorations. A new scoring system called the Appendicitis Inflammatory Response (AIR) Scoring system (Table - 1) was proposed in 2008 to overcome these drawbacks and improve diagnostic accuracy (6). This system has shown to outperform the Alvarado scoring system and has been validated by multiple randomized studies (7,8).

Table – 1 : Appendicitis Inflammatory Response (AIR) Scoring system(6)

Parameters		Score
Vomiting		1
Pain in right iliac fossa		1
Rebound tenderness or muscular defense	Light	1
	Medium	2
	Strong	3
Body temperature ≥ 38.5 °C		1
Proportion of polymorphonuclear leukocytes	≥70–84%	1
	≥ 85%	2
WBC count	≥10.0 –14.9x10^9 Per Litre	1
	≥15.0x10^9 Per Litre	2
CRP concentration	10-49 mg/L	1
	≥ 50 mg/L	2
Sum (Maximum Score)		12

With the evolving principles of management of acute appendicitis, the old notion of *" when in doubt, take it out"* no longer holds valid mainly in view of the complications of appendicectomy. The current school of thought emphasises on the correct diagnosis and surgical management only when warranted. AIR score based algorithms for management of acute appendicitis cases have been validated for their diagnostic performance and have shown to optimize the utilization of health care resources without compromising patient safety(8).

This study was conducted at our tertiary care teaching hospital where most of the cases with presentation of acute appendicitis are attended by junior surgeons. An algorithmic approach based on a validated scoring system is aimed at removing the subjective variations in clinical examination and adding objectivity to the management. The decision to operate was not solely based on the AIR scores and the patients also underwent relevant imaging for confirmation of diagnosis. This helped minimising diagnostic errors and at the same time provided a good comparative platform to evaluate the diagnostic performance of the scoring system.

Materials and methods

This study is a prospective observational study conducted between November 2016 and May 2018. 150 consecutive patients who presented during this duration, with clinical features suggestive of acute appendicitis and underwent appendicectomy, were included in the study.

Inclusion Criteria:

1. All patients with acute onset non-traumatic abdominal pain in the right lower quadrant and based on clinical findings were suspected to be cases of acute appendicitis.
2. All those patients satisfying the above mentioned criteria, who were admitted and underwent open or laparoscopic appendicectomy, either emergency or interval, were included in the study.

Exclusion Criteria:

1. Patients with age <5 years
2. Patients with known urological diseases
3. Female patients with known gynaecological conditions
4. Patients unwilling for surgery
5. Patients who were lost to follow up prior to interval appendicectomy
6. Patients who had recent history of abdominal injury (major or minor) or the pain started as a result of the injury

For all these cases, AIR score was calculated and endorsed in the case sheets. The clinical findings, other investigations carried out for establishing diagnosis and the operative findings were recorded. Based on the AIR scoring system, each case was categorized into one of the following three categories(6) :-

1. Score 9–12 = High probability of acute appendicitis
2. Score 5–8 = Indeterminate group
3. Score 0–4 = Low probability of acute appendicitis

The appendix specimen obtained from each of the 150 cases

underwent histopathological examination for final confirmation of appendicitis and the pathological report was used as gold standard reference for the study. The parameters analysed in the study were the risk stratification of cases as per AIR score, correlation of post-op pathological diagnosis with surgical findings and AIR score, the negative appendectomy rate of the study and the diagnostic efficacy indices viz. sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and accuracy calculated taking ≥05 and ≥09 score as cut-offs with HPE diagnosis as gold standard.

The statistical analysis of the study data was done using Statistical Package for Social Sciences (SPSS version 21.0, IBM Corporation, USA). In the study, the p-values less than 0.05 was considered to be statistically significant. All the hypotheses were formulated using two tailed alternatives against each null hypothesis. The mathematical tools used in the analysis were the Chi-Square test and independent sample t testing.

Results

All the cases were classified as per their AIR score into the three categories of risk for appendicitis, as shown below. Majority of the cases (66 %) belonged to the intermediate risk category.

Table – 2 : Categorisation of cases as per risk stratification

AIR Score	Category	No. of cases	% of cases
0 – 4	Low Probability	18	12.0
5 – 8	Intermediate Probability	99	66.0
9 – 12	High Probability	33	22.0
Total		150	100.0

Calculation of negative appendectomy rate by comparison with post-op HPE diagnosis:

Table – 3 : Correlation with HPE diagnosis

Total sample size	Acute appendicitis confirmed on HPE	No findings of appendicitis on HPE
150	136	14

Negative Appendectomy Rate = Negative for appendicitis on HPE / Total number of appendectomy performed = 14 / 150 = 9.33 %

Out of the 14 cases where HPE diagnosis ruled out acute appendicitis, 10 belonged to intermediate risk group and 4 belonged to low risk group. All cases in the high risk group were proven to be acute appendicitis on HPE.

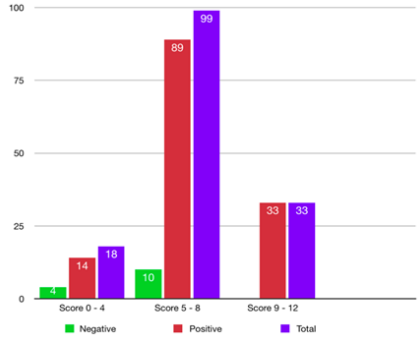

Fig 1: Distribution of HPE diagnosis among the three categories as per AIR score

For calculation of diagnostic efficacy parameters indices, statistical values were calculated in two scenarios, first when ≥05 is taken as cut-off i.e. AIR score up-to 4 (low risk category) is considered as negative and AIR score of 5 or higher is taken as positive and secondly when ≥09 is taken as cut-off i.e. AIR score up-to 8 (low and intermediate risk category) is considered as negative and AIR score of 9 or higher is taken as positive. The results are as follows:

Table - 4: The diagnostic efficacy indices calculated taking ≥05 and ≥09 as cut-offs

	Histopathological findings		Total	Sensitivity (%)	Specificity (%)	PPV	NPV
	Positive	Negative					
≥05	122	10	132	89.7	28.6	0.92	0.22
<5	14	4	18				
Total	136	14	150				
≥09	33	0	33	24.3	100	1.0	0.12
<9	103	14	117				
Total	136	14	150				

These results suggest that a score of ≥09 serves as a good tool for accurate diagnosis of acute appendicitis (Specificity - 100 %, PPV - 1.0). On the other hand, a low score (0-4) although has a good PPV of 0.92, its sensitivity in picking acute appendicitis is reduced to 89.7 % with a poor specificity rate of 28.6 % making it a poor diagnostic test. Rather, a low score merely signifies that more observation and investigations should be done to arrive at a concrete diagnosis.

Table 5: The diagnostic efficacy indices for different categories of AIR score

AIR Score Category	Sensitivity	Specificity	PPV	NPV	Cohen Kappa	P-value
0 – 4	10.3	71.4	77.8	7.6	- 0.038	0.045
5 – 8	65.4	28.6	89.9	7.8	- 0.027	0.652
9 – 12	24.3	100.0	100.0	11.9	0.056	0.037

The sensitivity, specificity, PPV and NPV of AIR score 0 – 4 i.e. the low risk category for accurately diagnosing acute appendicitis (HPE positive) are 10.3, 71.4, 77.8 and 7.6 respectively. Negative Cohen-Kappa with significant P-value (P-value<0.05) indicates that AIR Score shows statistically significant dis-agreement for the detection of abnormal HPE findings. The sensitivity, specificity, PPV and NPV of AIR scores 5 – 8 i.e. the intermediate risk category are 65.4, 28.6, 89.9 and 7.8 respectively. Negative Cohen-Kappa with non-significant P-value (P-value>0.05) indicates that AIR score show statistically non-significant dis-agreement for the detection of abnormal HPE findings. The sensitivity, specificity, PPV and NPV of AIR scores 9 – 12 i.e. the high risk category are 24.3, 100.0, 100.0 and 11.9 respectively. Positive Cohen-Kappa with significant P-value (P-value<0.05) indicates that Score shows statistically significant agreement for the detection of abnormal HPE findings.

Discussion

Acute appendicitis can often prove to be a diagnostic enigma, more so in female patients. This is attributed to the myriad of presentations these patients can have and the numerous other conditions that masquerade as acute appendicitis. Overall, 66 % of the cases belonged to the intermediate risk category, which suggests that most are in the grey zone of symptoms which is why diagnosing acute appendicitis clinically is challenging and requires additional modalities . Out of the study sample size of 150, 136 were confirmed to be appendicitis on HPE whereas 14 did not show histopathological features of appendicitis. This revealed a negative appendectomy rate of 9.33 %. This rate is slightly better as compared to other Indian studies and is on the lesser side of the wide range of appendectomy rates quoted in literature. On studying the distribution of HPE findings as per the AIR score, the relationship was found to be statistically significant with a P-value of 0.030. This implies that significantly higher proportion of cases with positivity for appendicitis on HPE had higher AIR score. In simpler words, cases with high AIR score, especially if >8, had significant likelihood of actually turning out to be appendicitis with histopathological confirmation.

The values of indices brought out in earlier studies are as shown in Table 6.

Table 6 : Diagnostic indices values of AIR score as per other studies

Study	Cut-off	Sensitivity (%)	Specificity (%)	PPV	NPV
Castro et al (11)	>4	93	85	0.79	0.95
	>8	10	100	1.0	0.66
Malyar et al (12)	>4	97	77	0.88	0.93
	>8	12	100	1.0	0.47
Kollar et al (13)	>4	94	62	0.59	0.95
	>8	33	97	0.88	0.71
A Scott et al (7)	≥05	90	63	0.49	0.94
	≥09	23	97	0.77	0.76

It can be seen that the trend of the indices in the present study are similar to those in other published studies. With a high cut-off, all the studies show a very high specificity almost reaching 100 % but a poor sensitivity whereas a low cut-off gives a good sensitivity of around 90 % but a reduced specificity ranging from 62 to 85 % in various studies mentioned above. The negative predictive value and specificity in the

present study is very low (28.6 %) because of very low negative appendectomy rate. The positive predictive value however, has a similar trend in both high and low cut-off categories. Thus it can be concluded that the diagnostic performance results brought out in this study are congruent with other studies.

Conclusion

The results prove that if a patient has a high AIR score of ≥09, the probability of being acute appendicitis is very high and such a patient should be operated without wasting valuable time on further evaluation. Those with low scores of up to 04 should be observed and managed conservatively as their probability of turning out to be appendicitis is low. Maximum number of cases would fit in the intermediate grey zone where further imaging is required for establishing the diagnosis. This managed algorithm can contribute in reducing the negative appendectomy rate and will also help in more optimum utilization of the health care resources . With several studies validating the AIR score and studies showing that it has better diagnostic accuracy compared to all the remaining scoring systems, the AIR score can be adopted into clinical practice to improve outcomes.

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