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(RESEARCH ARTICLE)

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A comparative study of Appendicitis inflammatory response (AIR) score with Alvarado score in diagnosis of acute appendicitis at KCMC Hospital

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Abstract

Background: Acute appendicitis is an acute inflammation of the appendix, most resulted from obstruction of the lumen of the appendix. It is one of the most common causes of acute abdomen. Although a very common and long-known phenomenon, appendicitis remains a diagnostic challenge for most surgeons.

Objective: To compare the validity of Appendicitis Inflammatory Response Score with Alvarado score in diagnosis of acute appendicitis at KCMC Hospital.

Methods: A prospective hospital based cross sectional study done over a period of six months (September 2016 to March 2017). Patients were admitted to general surgical ward after the diagnosis of acute appendicitis reached and all parameters included in the AIR score and Alvarado score were prospectively recorded on patients presenting symptoms of acute appendicitis. All removed appendix specimens were sent for histopathological examination. Data was entered and analyzed using statistical package of social sciences version 20.

Results: A total of 35 patients enrolled in this study, 57% male, male to female ratio 1.3:1, mean age of 27(14-49) years. 31 patients confirmed histologicaly to have features of acute appendicitis, among these inflamed appendicitis were 51.6%. And advanced appendicitis 48.4% and negative appendicectomy rate was 11.4%. The sensitivity and specificity of both AIR and Alvarado score were 54.4%, 77.4% and 75%, 75%. PPV and NPV were 94.4%, 96% and 17.6%, 30% respectively.

Conclusion: From our study we have seen Alvarado score is a better assessment tool that is accurate helping in diagnosis of acute appendicitis. Its high sensitivity and ROC is greater than that of the AIR score. We conclude that AS has outperform AIR score in accuracy in diagnosis of AA.

Keywords: Acute appendicitis; Alvarado score; AIR score; Sensitivity and specificity

1. Introduction

Acute appendicitis is the most common indication for emergency surgery worldwide, with incidence of 1.17 per 1000 and lifetime risk of 8.6% in men and 6.7% in women. Clinical diagnosis alone leads to a negative appendectomy rate of 15 to 30%. The diagnosis is specially challenging for women of fertile age. Delay in diagnosis will lead to complication,

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which increases morbidity whereas overzealous diagnosis may lead to negative Appendectomy rate (Sammalkorpi et al, 2014). Although a very common and long-known phenomenon, appendicitis remains a diagnostic challenge for surgeons and emergency physicians.

More than 250,000 appendectomies are performed each year in the US (*Addiss* et al.,1990).

In 2015 about 11.6 million cases of appendicitis occurred which resulted in about 50,100 deaths (Feigin et al, 2016). Overall, an estimated 36 incidental procedures are performed to prevent one case of appendicitis. (*Addiss* et al., 1990).

Symptoms of appendicitis overlap with a number of other conditions making diagnosis a challenge, particularly at an early stage of presentation (Bundy et al, 2007). Scoring systems have been designed to aid in the clinical assessment of patients with acute appendicitis (de Castro et al, 2012). The most widely used score so far is the Alvarado score. A systematic review and pooled diagnostic accuracy study showed that the score has good sensitivity (especially in men) but low specificity, limiting its clinical impact and meaning that few surgeons rely on it to guide management above and beyond their own clinical opinion. The recently, the appendicitis inflammatory response score has been developed, and seems to outperform the Alvarado score in terms of accuracy (Bhangu et al, 2015).

An ideal scoring system would work as a tool that's speeds up and increases the accuracy of decision-making and at the same time reduces the need of potentially harmful and expensive imaging (Sammalkorpi et al, 2014). The main aim of this study was to compare the validity of Appendicitis Inflammatory Response Score with Alvarado score in diagnosis of acute appendicitis.

2. Methods

The study was conducted in KCMC consultant hospital, KCMC is one of the four consultant referral hospitals in Tanzania. A cross sectional study on 35 patients who admitted or transferred to general surgery ward from September 2016 to March 2017 with clinical suspicion of acute appendicitis based on history and clinical examination were included in the study. After the diagnosis of acute appendicitis reached, all parameters included in the AIR score and Alvarado score were prospectively recorded on patients presenting symptoms of acute appendicitis using a questionnaire. All removed appendix specimens were sent for histopathological examination.

The diagnosis of acute appendicitis reached by responsible doctors/ residents was based on clinical judgment only and these score was not influencing in any decision making.

After appendicectomy all specimens were collected into a container with preservative formalin solution and then sent for histopathology. The histopathological results were the confirmatory for acute appendicitis. The identified inflamed appendix was classified as advanced when accompanied with gangrene, perforation or inflamed where the inflammation will be simple i.e.catarrhal and phlegmonous stage. After data collection, analysis was done using SPSS statistical software version 20. Diagnostic performances of sensitivity, specificity, positive and negative predictive values were calculated by comparing simple diagnostic tests (Alvarado score and Appendicitis Inflammatory Response with reference test (histopathology). The area under the receiver operating characteristic (ROC) curves was used to examine the performance characteristics of Alvarado score and AIR score. A p value of 0.05 was used as cut off points of significant test.

2.1. Ethical clearances

Ethical clearance with certificate number 965 was sought from KCMC Research and Ethical committee. Permission to collect data and specimen was sought from the department of general surgery. Confidentiality and privacy of the information obtained were maintained.

3. Results

A total of 35 patients were enrolled in the study, male 57.1 %, male to female ratio of 1.3:1, the age group 15-30 years are more affected with peritonitis by 34.0% than rest of the age group, most of the patients were resided rural areas.

Table 1 Social demographic characteristic

Variable	**N**	**%**
Sex		
Male	20	57.1
Female	15	42.9
Location		
Urban	17	48.6
Rural	18	51.4
Duration of illness Median (IQR))	4[3,8]	
Age		
< 15 yrs	9	25.7
15-30 yrs	12	34.3
31-45 yrs	3	8.6
>46	11	31.4
Median (IQR))	27 [14,49]	

3.1. Patients treated before scoring

Among the patients 22 participants were on antibiotics treatment before we scored them. These were either self-medicated or given on peripheral hospitals. Majority 22 (62.86%) had been on antibiotics and 13(37.14%) were not antibiotics before.

3.2. Scoring parameters

Every patient was scored by both AS and AIR score and parameters filed in the score chart. The major clinical parameter was tenderness on the right iliac fossa which was present in every patient (100%), followed by nausea / vomiting. The least presentation was elevated temperature which was much lower in both score, from these results we see most patients don't presents with fever. On laboratory parameters CRP was leading followed by neutrophilia then leukocytosis. The full scoring parameters are outlined in below tables.

Table 2 Symptoms and signs among patients in AIR score

Vomiting	**AIR**	
No	3	8.6
Yes	32	91.4
Pain in right fossa	35	100
Rebound tenderness		
Absent	5	14.3
Light	2	5.7
Medium	8	22.9
Strong	20	57.1
Elevated temperature		
No	33	94.3
Yes	2	5.7

Leukocytosis		
No	14	40.0
10-14.9 wbc	13	37.1
>15 wbc	8	22.9
Neutrophilia		
No	12	34.3
70-84%	17	48.6
>85%	6	17.1
C reactive protein		
<10mg/l	7	20.0
10-49 mg/l	7	20.0
>50mg/l	7	60.0

Table 3 Symptoms and Signs among patients in Alvarado score

Alvarado		
Pain right iliac fossa		
Yes	35	100.0
Nausea / Vomiting		
No	3	8.6
Yes	32	91.4
Anorexia		
No	6	17.1
Yes	29	82.9
Rebound tenderness		
No	5	14.3
Yes	30	85.7
Pain migration		
No	20	57.1
Yes	15	42.9
Elevated temperature		
No	24	68.6
Yes	11	31.4
Leucoytosis		
No	14	40.0
Yes	21	60.0
Neutrophilia		
No	13	37.1
Yes	22	62.9

3.3. Comparison of Sensitivity and specificity:

The sensitivity and specificity of both AIR and Alvarado score is shown on tables below taking histopathological results as reference test (gold standard). The figures are 54.4%, 77.4% and 75%, 75% respectively. The cutoff point of 9 and above for AIR score and 7 and above for AS were used as to qualify the presence of acute appendicitis.

Positive and negative predictive values of AIR and Alvarado score displayed in table 10 below are 94.4%, 96% and 17.6%, 30% respectively.

Table 4 Association between AIR score and Histopathological Diagnosis

		Histopathology			
		Appendicitis	**Normal**	**Total**	**P value**
AIR	Appendicitis	17	1	18	0.338
	Normal	14	3	17	
	Total	31	4	35	

Table 5 Association between Alvarado score and Histopathological Diagnosis

		Histopathology			
		Appendicitis	**Normal**	**Total**	**P value**
Alvarado score	Appendicitis	24	1	25	0.061
	Normal	7	3	10	
	Total	31	4	35	

Table 6 Comparison of Sensitivity, specificity, PPV and NPV of AS vs AIR score

	AIR	**AS**
Sensitivity	54.8 %	77.4 %
Specificity	75 %	75 %
PPV	94.4 %	96 %
NPV	17.6 %	30 %

3.4. Negative appendicectomy rate

A negative appendicectomy is taken as a surgery performed due to preoperative diagnosis of appendicitis that results in a normal histopathology specimen. In our study a negative appendicectomy rate of 11.4% was obtained. The rate was higher in females (3) compared to male (1).

3.4.1. Association between inflammatory makers and histopathology

We saw the association between the inflammatory markers present in both scores and the histopathological results. High in the list was the CRP mostly in cut of points of >50mg\ l (61.5%) and least in 10 – 49mg\l (22.5%). The leukocytosis and neutrophilia in AIR score is stratified compared to AS which has one cut point only. From the table 12 below we can see the relationship between these markers and histopathology in diagnosis of AA. And all were statistical significance.

Table 7 Association between Inflammatory makers and histopathology

Histopathology			
	No	**Yes**	**P value**
AS Leukocytosis			0.009
<10 x 10* / l	4(100)	10 (32.26)	
>10 x 10* / l	0	21 (67.74)	
AS Left shift			0.006
<75%	4(100)	9 (37.14)	
>75%	0	22 (70.97)	
AIR Leukocytosis			0.034
<10 x 10* / l	4(100)	10(32.26)	
10-14.9 x 10 / l	0	13(41.94)	
>14.9 x 10* /l	0	8(25.81)	
AIR Neutrophils			0.013
<70%	4(100)	8(25.81)	
70-84%	0	17(54.84)	
>85%	0	6(19.35)	
CRP			0.013
<10mg/l	3(75)	4(12.90)	
10 -49mg/l	0(0)	7(22.58)	
>50mg/l	1(25)	20(61.52)	

3.4.2. Receiver operator characteristic (ROC) curve analysis

The overall ROC curve for AS and AIR score showed a predictive power of 0.89 and 0.77 respectively which was statistically significant (P= 0.003). Other discrimination comparing the AIR score and AS with social demographic data are outlined below.

Table 8 Discriminating capacity of the AIR score compared to the Alvarado score, according to patient demographic characteristics using receiver operator characteristic (ROC) curve analysis

Variable	**N (%)**	**Alvarado test**	**Appendicitis Inflammatory score**	**P value**
Overall	35	0.89	0.77	0.003
Sex				
Male	20(57.14)	0.92	0.84	0.036
Female	15(42.86)	0.83	0.67	0.041
Age				
≤25	12(34.29)	0.80	0.81	0.055
>25	23(65.71)	0.93	0.88	0.075
Place				
Urban	17(48.57)	0.82	0.64	0.004

Rural	18(51.43)	0.94	0.88	0.083
Duration of illness				
1-3 days	12(34.29)	0.85	0.87	0.061
Above 3 days	23(65.71)	0.94	0.91	0.317

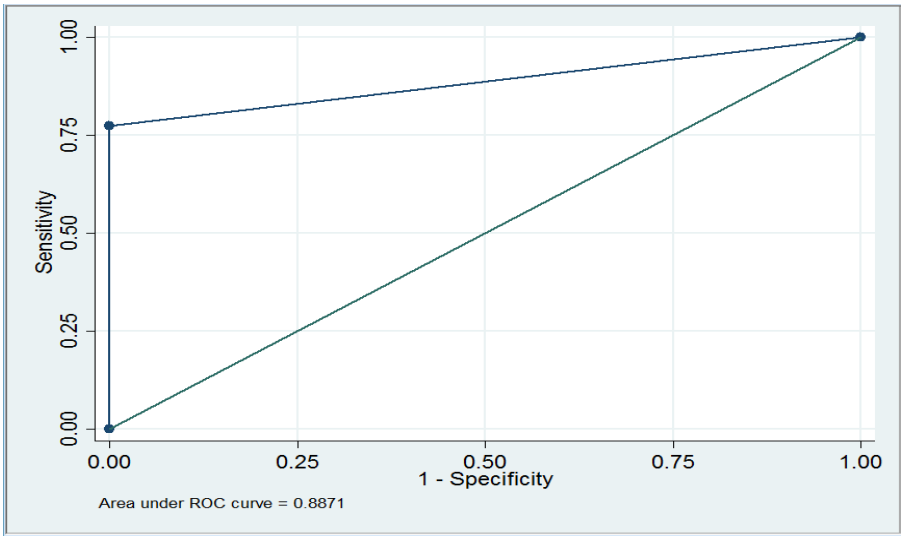

Figure 1 ROC curve of Histopathology vs Alvarado score

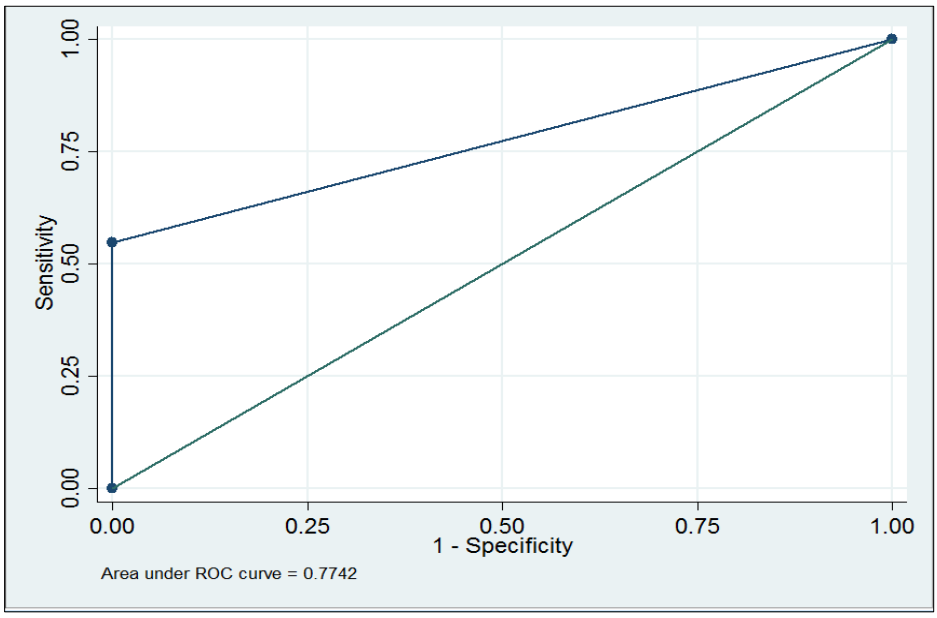

Figure 2 ROC curve of histopathology vs AIR score

4. Discussion

Acute appendicitis is among the most common cause of acute abdominal pain. The AS is popular and has been validated in many studies across the world while situation is opposite for AIR score. It's the first time its validation is done in Africa. The scoring systems is to be used as a decision support tool when evaluating patients with AA. If the prediction is so high one can proceed with intervention and avoid unnecessary waiting time or further investigations. In this study

the patients in age group of less than 30years were the majority 21(60%) other studies done by malyar et al.(2015), Jain et al, 2015 (74%). had almost similar findings. The reason is this is the typical age for appendicitis due to the fact that the appendix is full of lymphoid follicles and hyperplasia of these follicles lead to obstruction and hence the development of acute appendicitis. Among the participants male were predominant by 57% while female contributed to 42.9% bringing the ratio of m: f to be 1.3:1.Similar observations have been reported in South Africa, Kong et al, 2014 (54%), India, Jain et al, 2015 (70%) and in Kenya by chavda et al, 2005 (61%) .Contrasting higher AA rates in females have been reported in Tanzania, Kanumba et al 2011(70.9%) also in Kenya by Willmore et al, 2001, however no particular reason for the discrepancies has been established in our study.

According to the literature, the incidence of negative appendectomy ranges between 11 and 40 % (Yüksel et al, 2015) . However accepted range of negative appendicectomy is 10% to 20% in order to minimize the incidence of perforated appendicitis with its increased morbidity (Colson et al, 1997). A study done by Kanumba et al in Bugando reported the incidence of negative appendectomy was 33.1 %. A local study done in 2002 by Kondo et al at KCMC General Surgery department reported 55% of negative appendicectomy. A second study in 2015 at KCMC by Nkika et al reported a negative appendicectomy rate of 25%. Nasiri et al, 2012, Anderson et al, 2000 reported negative appendectomy rates about 10.7 % and 12% respectively which is consistent with our findings (11.4%). This study had the lowest negative appendicectomy rates 11.4% compared to much higher rates reported by Kondo at KCMC and kanumba at Bugando this could be attributed to the small sample size, besides neither AIR score nor AS were used at KCMC study which reported 55% negative appendicectomy rates. On top of that we attribute this to the high number of advanced appendicitis we had during our study.

In this study all enrolled 35 patients were operated. Histological examination confirmed 31(88.4%) specimens to have features of AA. In scoring 17 were categorized to have appendicitis based on AIR score and 24 based on AS out of the 31 patients respectively. Four patients had normal appendix indicating negative appendicectomy. The calculated overall sensitivity, specificity, PPV and NPV were 54.8%, 75%, 94.4%, 17.6% for AIR score and 77.4%, 75%, 96%, 30% for AS respectively. In this study AS has shown many similarities with the results of other studies done , Alvarado et al, 1986 had 51% of advanced appendicitis compared to 48% in our study, similarities was noted also by Jain et al, 2012 with sensitivity and specificity of 80% and 70%, PPV and NPV of 96% and 28%. These similarities of results could be attributed to similarities in the study population in terms of age of presentation, male predominance of the patients and both studies were conducted at a tertiary hospital. Difference in AS were noted in other studies Anderson et al, 2008, Malyar et al, 2015, Kollar et al, 2014. We attribute this to fact that these had more females in their sample size and, less advanced form of appendicitis. The high PPV recorded in our study could be attributed to many cases seen at our tertiary hospital with full blown symptoms; failure to responds to antibiotics therapy given in other peripheral hospital is the reason to explain the low NPV.

AIR score in our study was outperformed by AS in predicting the diagnosis of AA. Studies done by Anderson et al, 2008, Scott et al, 2015, Kollar et al, 2014, Malyar et al, 2015 all concluded that AIR score outperformed AS in diagnosis of AA, an observation completely different from our study. The AIR score study for predicting AA is the first ever to be done in an African setting and has shown low sensitivity in predicting AA compared to AS. This could be explained by high cut off points applied to its parameters like temperature of 38.5 degree of Celsius which was observed in only 2 patients. However AIR score could be very useful diagnosing advanced appendicitis which recorded an accuracy of 93.3%. The general poor performance of AIR score in our setup could be attributed to the cohort of patients presenting to a tertiary hospital having a long history of illness and perhaps having been exposed to antibiotic treatment and partially aborting the progression of disease as pointed out that 62% had already started on antibiotics. AIR scoring system showed a very good sensitivity and specificity when applied to western population kollar et al, (2012). Subsequently, when this scoring was applied to our populations, it showed relatively less specificity and sensitivity to diagnose acute appendicitis.

However the remarkable component of this score was CRP. This seems to be a very potent inflammatory marker in diagnosis of AA. It has the accuracy of 80% in suspicion of AA with a cut off measurement of above 10mg/l, this has been pointed out in another study done by Yokoyama et al, (2015) who concluded that the CRP level has been clearly demonstrated to contribute to the prediction of the severity of appendicitis. The importance of inflammatory markers in diagnosis of AA is of high importance as seen in table 8, CRP is leading followed by neutrophilia / left shift. These findings are similar to a study done by Xharra et al (2012) which shows the combination of the CRP, the WBC, and the neutrophil percentage has greater diagnostic accuracy in acute appendicitis. This author recommended CRP measurements a routine laboratory test in patients with suspected diagnosis of AA. As regards to sensitivity, specificity PPV and NPV the AS was far superior to AIR score for diagnosis of AA. But there was a notable association of CRP > 50mg/L with all cases of advanced appendicitis (48%) in form of gangrene or perforation. Therefore this single entity of CRP > 50mg/L could be a useful predicting tool to predict advanced appendicitis and therefore effect prompt surgery for such patients.

In comparison of the two score in our population the AS has performed better than the AIR score in the diagnosis of AA. Better sensitivity, higher PPV and NPV compared to AIR score. When the two score where analysed using Receiver operating characteristic (ROC) curves for the detection of AA, Alvarado score scored better with AUC 0.89 vs. 0.774 0f AIR score and this was statistical significant (p = 0.003).

5. Conclusion

From this study we have seen Alvarado score has higher sensitivity and ROC is greater than that of the AIR score, make it well supporting tool in identifying patients with AA in our setting. We conclude that AS has outperform AIR score in accuracy in diagnosis of AA. Also we have seen the importance of inflammatory marker especially the CRP to be incorporated in making the diagnosis of AA. Overall Negative appendicectomy rate was within the acceptable but could be better improved if we would rely on scoring these patients before intervention. We recommend Alvarado score should be used in making a diagnosis of every patient with features of acute appendicitis. Future prospective research can be undertaken to validate the AIR score, with a possible modification, in order to improve its relevance in our environment.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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