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Correlation of Alvarado Score and Intra-operative Findings in patients presenting to a tertiary Center in Northwestern Nigeria

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ABSTRACT
BACKGROUND*: Acute appendicitis is the most common abdominal emergency in both the developed and developing countries. This common surgical disease continues to remain a diagnostic problem. This study aims to evaluate the accuracy of the Alvarado score (AS) in the pre-operative diagnosis of acute appendicitis in our setting.*
METHODS: *A prospective study conducted in Usmanu Danfodiyo University Teaching Hospital Sokoto over a three year period from July 2014 to June 2017.*
All consecutive patients operated during the study period with an initial clinical diagnosis of acute appendicitis were enrolled into the study. Alvarado scores were correlated with intra operative grades of appendicitis and histopathological findings. Sensitivity, specificity and accuracy of Alvarado Scores were calculated.
RESULTS*: One hundred and eleven patients were studied with a Male: Female (M:F) of 1.5:1 and mean age of 23.89±4.93years. Patients presenting within first 24hours had a perforation rate of 15% as against 41.2% for those that presented after 24hours. The sensitivities, specificities, positive and negative predictive values and diagnostic accuracies of AS were high at 90.3%, 83.3%, 96.6%, 62.5%, 89.2% respectively. Histological analysis showed a negative appendicectomy rate (NAR) of 16.2 %. Using a presumptive cut-off point of 7 for the Alvarado score the negative appendicectomy rate will reduce to 3.45%(P<0.001) .*
CONCLUSION: *Alvarado Score has a high sensitivity, specificity, good diagnostic accuracy in patients of a predominantly Hausa-Fulani population. Routine use of Alvarado Score will significantly reduce the negative appendicectomy rate and reduce the rate of perforated appendicitis.*
KEY WORDS: *Acute Appendicitis, Appendicectomy, Alvarado Score, Northwest Nigeria, intra-operative findings, Developing Countries*

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I. Introduction

It is a popular dictum in surgical parlance that the abdomen is a magic box and poses new surprises to the surgeon each time(1). This is more so for acute appendicitis. Although clinical skills remain the mainstay of all medical practice, there are rapid changes in clinical medical practice with increased sophistication of imaging and diagnostic techniques resulting in greater diagnostic accuracy(1).

Acute appendicitis is the most common abdominal emergency in both developed and developing countries (2). The associated symptoms and signs have become a paradigm for clinical teaching(3).

Acute appendicitis has a lifetime risk of 8.6% and 6.7% for men and women respectively (4). It accounts for 1% of abdominal surgeries (5). Appendicitis is principally the disease of the young. The peak age group is 11-30years in both sexes. After the age of 50years, the incidence of this disease is 1:35 for women and 1:50 for men (1).

In 1886 Reginald Heber Fitzs described the classical signs and symptoms of acute appendicitis as a disease entity (6). With over 120 years since its first description, this common surgical disease continues to remain a diagnostic challenge and can surprise the most astute clinician. Delay in diagnosis definitely increases the morbidity, mortality and cost of treatment. The complication rate in non-perforated appendicitis is less than 1% but it is as high as 5% or more in the young and elderly patients in whom diagnosis are delayed.(7)

In equivocal cases, however, aggressive surgeries have resulted in negative appendicectomies. The clinical presentations of acute appendicitis can be confused with a variety of acute medical and surgical abdominal and/or thoracic conditions. Early diagnosis and treatment is a primary goal to prevent morbidity and

mortality. It is however important on the other hand to be reasonably sure of the diagnosis in order to decrease the negative appendicectomy rate.

Despite advancements in medical diagnostics, the diagnosis of acute appendicitis remains mainly a clinical one. Over the last two and half decades, different protocols have been introduced and tested. These include Lindberg-Fenyo[8], Lintula[9], Ohmann[10] and Alvarado[11] scoring systems to aid early and accurate diagnosis of this sometimes very elusive disease entity.

The Alvarado score was described in 1986. Alvarado followed up patients admitted to surgical wards with suspected acute appendicitis until surgery confirmed or refuted the diagnosis. He found that 8 criteria had high diagnostic accuracy for acute appendicitis [11].

A search of the pub med revealed that out of the one hundred and thirteeen articles related to appendicitis in Nigeria only two evaluated the accuracy of Alvarado score. None made such evaluation among the predominant Hausa Fulani population in Northern Nigeria. This study aims to evaluate Alvarado score among patients in a predominantly Hausa-Fulani population to determine their sensitivity, specificity and accuracy in the diagnosis of acute appendicitis. The result of this study will help to justify a policy of recommending or discouraging the use of these scores as a tool to reduce the negative appendicectomy rate among a predominantly Hausa-Fulani population.

II. Material And Methods

DESIGN

This was a prospective study conducted at the Usmanu Danfodiyo University Teaching hospital (UDUTH), Sokoto over a three year period from July 2014 to June 2017.

UDUTH is a 572-bed tertiary referral hospital for other tertiary, secondary and primary health facilities in Sokoto, Zamfara and Kebbi states all in North western Nigeria with a predominant Hausa-Fulani population.

INCLUSION CRITERIA

- All consenting consecutive patients during the study period operated with an initial clinical diagnosis of acute appendicitis.
- Patients who are 16years or older.

EXCLUSION CRITERIA

- Patients who withheld or are unable to give consent
- Patients less than 16 years.
- Patients not operated.
- Patients with demonstrable extra appendicular cause of pain in right iliac fossa.

METHOD

The demographic characteristics of the patients, history, physical examination findings, concomitant diseases, blood parameters, abdominal ultrasound findings, surgical findings and histopathological findings were recorded on a proforma.

All the individual parameters required to score the Alvarado were recorded individually and scattered in different areas of the pro forma to make spot calculation difficult. The total score was not calculated until after the appendicectomy.

The decision to perform appendicectomy was made by the unit consultant based solely on the clinical features of the patient not influenced by the score. To guarantee this the actual summation of the scores from the various parameters of the AS was not done until after the surgery.

After the appendicectomy, the Alvarado score was calculated. The patients were assigned to four groups based on the score.

- Unlikely - Alvarado score 1- 4
- Compatible - Alvarado score 5-6
- Probable - Alvarado score 7-8
- Definite - Alvarado score 9-10

Intra operative findings

On exploration the severity of the appendicitis was assessed according to the gross appearance and the grading of Ahsan et al was used[12].

Grade	Appearance of Appendix
I	Normal
II	Swollen tip, periappendicular fluid/Pus
III	Gangrenous /perforated

DATA ANALYSIS

The result were analysed on computer using statistical package for social science (SPSS) version 15 (SPSS) Inc. Chicago IL, USA.

Alvarado scores and modified Alvarado scores were correlated with operative grades and histopathological findings (these were mainly findings of predominantly acute inflammatory cells within the muscularis and serosal layers of the appendix). Negative appendicectomy rate, positive and negative predictive value, sensitivity, specificity and accuracy were calculated.

Multivariate analysis was done to determine the effect of age, sex and duration of symptoms on accuracy of Alvarado.

The level of significance was set at $p \geq 0.05$.

ETHICAL CLEARANCE

Ethical clearance was obtained from the Ethics Committee of the Usmanu Danfodiyo University Teaching Hospital, Sokoto

III. Results

One hundred and eleven patients who had appendicectomy were studied among which 66(59.5%) were males and 45(40.5%) were females giving a M:F of 1.5:1. The age range was between 16 to 38 years with a mean age of 23.89±4.93years and majority of patients were 20-24years(43.2%) age group as shown in Table 1.

Seven-two (64.9%) patients were students among which sixty-nine (62.4%) patients had a tertiary education. Majority of patients were Hausa/Fulani (78.4%) as shown in Fig 1.

Sixty (54.1%) patients presented within 24hours from onset of symptoms as shown in Fig 2. All the patients had an abdominal pain and abdominal tenderness. Eighty seven (78.4%) patients had migratory right iliac fossa pain, Eighty seven (78.4%) patients and Ninety nine patients (89.2%) had anorexia and nausea/vomiting respectively. Rebound tenderness was present in one hundred and eight(97.3%), cough sign Ninety-six (86.5%), psoas sign Sixty-six(59.5%), obturator sign thirty(27%), Rovsing's sign Fifty-one(45.9%), were found among the patients respectively. Table 2 shows the clinical findings among the patients.

Among patients presenting within first 24hours, 9(15%) out of 60 patients had a perforation as against 21 (41.2%) out of 51 patients that presented more than 24hours after onset of symptoms who had a perforation. None of the patients with an Alvarado of 6 or less had a perforated appendix.

One hundred and five (94.6%) patients had a leucocyte count of 4000-11,000cells/ml and only 42 (37.8%) patients had a shift to the left.

All patients had an Alvarado score calculated with mean score of 8.05±1.68. The sensitivity, specificity, positive/ negative predictive values and diagnostic accuracy of the score is shown in table 4.

All the patients had ultrasound done. Acute appendicitis was demonstrable by ultrasonography in 63 (56.8 %) patients.

Intra Operative findings showed that Sixty-three (56.8%) patients had an inflamed appendix while 33 (29.7%) patients had a perforated or gangrenous appendix.

Histological analysis showed a negative appendicectomy rate (NAR) of 16.2 % for all patients, Using a cut-off point of 7(as in previous studies) for the Alvarado score , the NAR will be reduced to 3.45%($P<0.001$) if Alvarado was used as a criteria for appendicectomy.

Thirty-three (33) patients (29.7%) had a perforated appendix, 21 (72.7%) of them presented twenty four hours after onset of symptoms. Analysis of intra operative findings at various Alvarado scores showed that that all the patients with perforation had a score of above 7.

Reciever operating characteristic curve (ROC) is a plot of the true positive rate against the false positive rate for the different possible cutoff points of a diagnostic test. The closer the curve follows the left hand border and then the top border of the ROC space the more accurate the test. The area under the curve is a measure of test accuracy with 0.8 and above depicts an accurate test while 0.5 a worthless test.

The ROC and AUC shows that Alvarodo Score is an accurate score in preoperative diagnosis of acute appendicitis with an area under the curve of 0.88 and the graph in the left hand side of the reference line. Fig 3 and Table 6.

IV. Discussion

Acute appendicitis is a common disease encountered in emergency clinics[13-15] . Since the 1940's the incidence of hospital admissions for acute appendicitis has been falling, but the reason for this is not clear.[13] The incidence among Africans and Asians has consistently been reported to be low. Reports from Africa put the prevalence around 1%.[14]

The finding of this study of yearly hospital based prevalence of 37 patients with a M:F ratio of 1.5:1 and a peak age incidence of 20-24 years mirrors what has been reported in previous hospital based studies from Nigeria: [15, 16, 17].

Decision-making in patients suspected of having acute appendicitis has remained a diagnostic challenge worldwide despite the advances in appendiceal surgery and the decrease in mortality because of appendicitis .[18] Ademola et al in their retrospective study of clinicopathological review of 156 appendicectomies showed that delay in presentation and intervention increased hospital stay and morbidity among the patients[19]. Furthermore according to some studies, negative appendectomy has been reported in 20% to 40% of appendectomies because of difficulties in making the diagnosis [18]. This can impose a significance burden on the health system'[20] this will be more pronounced on our already ailing system[16]. For instance, 39,901 patients underwent negative appendectomies in the US in 1997, which resulted in an estimated total hospital charge of 741.5 million dollars [21] . To assist and improve the diagnosis of acute appendicitis, a number of diagnostic modalities have been proposed, such as graded compression sonography and scoring systems . The diagnostic accuracy of pre-operative Alvarado scores in a predominantly Hausa-Fulani population was studied in this work.

The principal complaint of patients with acute appendicitis is abdominal pain. The diagnostic sequence of colicky central abdominal pain followed by vomiting and migration of the pain to the right iliac fossa as first described in 1904 by Murphy[22] was seen in this study, 78.4% of the patients had migratory right iliac fossa pain, 78.4% of the patients and 89.2% had anorexia and nausea/vomiting respectively. This study as expected showed that all patients presented with abdominal pain and had tenderness on examination. This is consistent with report in literature[23] .Other symptoms found among the patients in this study were similar to what is obtainable in literature. Physical findings in this study were not different from what is widely reported in previous studies.[17]

Anorexia, Nausea/Vomiting and Abdominal tenderness had the highest diagnostic accuracy in predicting presence of acute appendicitis among all the clinical features, however, only Anorexia was statistically significant in predicting acute appendicitis (P<0.003). This for unknown reason is strikingly different from what was reported by Alvarado where tenderness and leucocytosis had the highest diagnostic weight of 84 and 83% respectively[11].

Leukocytosis was not a common observation among the study population where only 5.4% had leucocytes count above 11,000/ml. This is lower than findings in reports from Nigeria [23] and different from what is obtainable in Western World where leucocytosis with relative neutrophilia is a common observation.[24]

The low WBC count in this study follows the trend in literature where generally Africans are known to have a lower WBC count than the Caucasians for unknown reasons.[23] . The relatively low WBC count among Africans as compared to Caucasians which was also demonstrated in this study could explain the low diagnostic weight of leucocytosis as compared to the high diagnostic weight demonstrated by Alvarado.[11].

In this study using a cut-off of 7 for the Alvarado scores the sensitivity, specificity, PPV, NPV and diagnostic accuracy of 90.3%, 83.3%, 96.6%, 62.2% and 89.2% (P<0.01) were similar to previous findings in a study among Nigerians.[25] Fente and Echem[26] in a similar prospective study evaluated the Bengezi and Al-Fallouji modification of the Alvarado score among acute appendicitis patients presenting to a tertiary hospital in south-south Nigeria and also found a high sensitivity of 92.93% and specificity of 92.93%. Similar findings were reported by studies from other parts of the world. Kanumba et al[27] in their study among Tanzanian patients showed that use of modified Alvarado score in patients suspected to have acute appendicitis provided a high degree of diagnostic accuracy and can reduce negative apppendicectomy rate and complication rates, however they concluded that additional investigations may be required to confirm the diagnosis in the case of atypical diagnosis. This study shows that the scores also has a high accuracy in diagnosing acute appendicitis among predominantly Hausa –Fulani population.

Kalan et al in a similar prospective study of 49 patients who were sick enough to warrant surgery for suspected appendicitis found that a high modified Alvarado score was easy and satisfactory aid to early diagnosis of appendicitis in children and men with sensitivity of 93% and 100% respectively, but results were disappointing in women where sensitivity was only 67%[28].Unlike what was reported by kalan et al there was no statistically significant difference in accuracy of this score between female and male patients (P<0.941) in our study. This could be explained by the fact that we excluded any demonstrable extra appendicular cause of right iliac fossa pain in our study population. It could therefore be postulated that these extra appendicular causes of right iliac fossa pain (demonstrated in this study mainly by abdominal ultrasound) is responsible for poor diagnostic accuracy of Alvarado score among females. A well designed randomized study is needed to confirm this.

The Receiver operating characteristic curve the Score showed an Area under the curve of 0.88. This further confirms the diagnostic accuracy of these score. This is similar to what was reported by previous

workers.[29,30] This is similar to findings of an Iranian study by Nasiri et al who studied 75 patients who had appendicectomy over a 9month period and also found an AUC of 0.837 [29].

Histological analysis showed a NAR of 16.2% which is similar to a finding in a previous study in our hospital by Mungadi et al[16] who carried out a 6year retrospective study of patients who had appendicectomy and histological analysis revealed a NAR of 15.9% in their study. Using a presumptive Alvarado score cut-off of 7 as a criterion for appendicectomy, by extrapolation the NAR will fall to 3.45% (P<0.001). This reduction is desirable to prevent unnecessary surgeries in our teaming patient with it's attendant morbidities and economic burden in our predominantly poor patients. This will also help reduce the burden on the already weak healthcare delivery system. The reduction in NAR was also demonstrated by Fente and Echem in their study evaluating the Bengezi and Al-Fallouji modification of the Alvarado score among acute appendicectomy patients presenting to a tertiary hospital in South-South Nigeria demonstrated a reduction of NAR to 9.09% for patients operated based on the score as against their retrospective study of patients operated without the score which showed a NAR of 26.4% and 19.05% for two consecutive years[26].

The rate of perforation in our study was 29.7% which is comparable to previous studies carried out in Northern Nigeria.[16,31]. Ali and Aliyu in their retrospective and prospective audit of all patients with acute appendicitis seen and managed over an 8- year period in university of Maiduguri hospital found a perforation rate of 23.47%[31]. Delayed presentation, misdiagnosis, severe disease, failure to accept surgical treatment were noted to be contributory to high perforation rate in those studies. In our study delay in presentation and high Alvarado score were identified as major risk factors. 72.7% of patients with perforation presented after 24 hours from onset of disease and all the patients with perforation had an Alvarado score of above 7. Therefore, a more aggressive approach should be used in patients with high scores and those presenting late.

V. Conclusion

The Alvarado score have a high sensitivity, specificity, good diagnostic accuracy and correlates well with intra-operative findings in patients of a predominantly Hausa-Fulani population. The routine use of the scoring system can be a valuable adjunct in improving pre-operative diagnosis of appendicitis and will significantly reduce the negative appendicectomy rate in our resource-poor setting and thus reduce the burden on our patients and the health system. Furthermore the score is useful in reducing the rate of perforated appendicitis with its attendant morbidity and mortality.

Recommendations

1. Alvarado should be routinely used as an adjunct in the pre-operative diagnosis in patient with clinical features suggestive of appendicitis to reduce NAR and perforated appendicitis with its attendant morbidity and mortality in our patients.
2. A clinical scoring system with a higher diagnostic weight allotted to anorexia and Nausea/vomiting should be designed and tested with the hope that this may have an improved diagnostic accuracy over the Alvarado score in our setting.

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TABLES AND FIGURES

Table 1: Demographic distribution of patients

Parameter	Frequency(n=111)	PERCENTAGE %
Age		
16-19	15	13.3
20-24	48	43.2
25-29	39	35.1
35-39	9	8.1
Sex		
Male	66	59.5
Female	45	40.5

Table 2 Clinical Findings among the patients

Symptoms/Sign	Frequency(n=111)	Percentage %
Abdominal Pain	111	100
Lower Abdominal Pain	108	97.3
Migratory RIF Pain	87	78.4
Anorexia	87	78.4
Nausea/Vomiting	99	89.2
Fever	57	51.4
Abdominal tenderness	111	100

Rebound Tenderness	108	97.3
Pyrexia	54	48.6
Psoas Sign	66	59.5
Obturator Sign	30	27
Rovsing's Sign	51	45.9
Cough sign	96	86.5

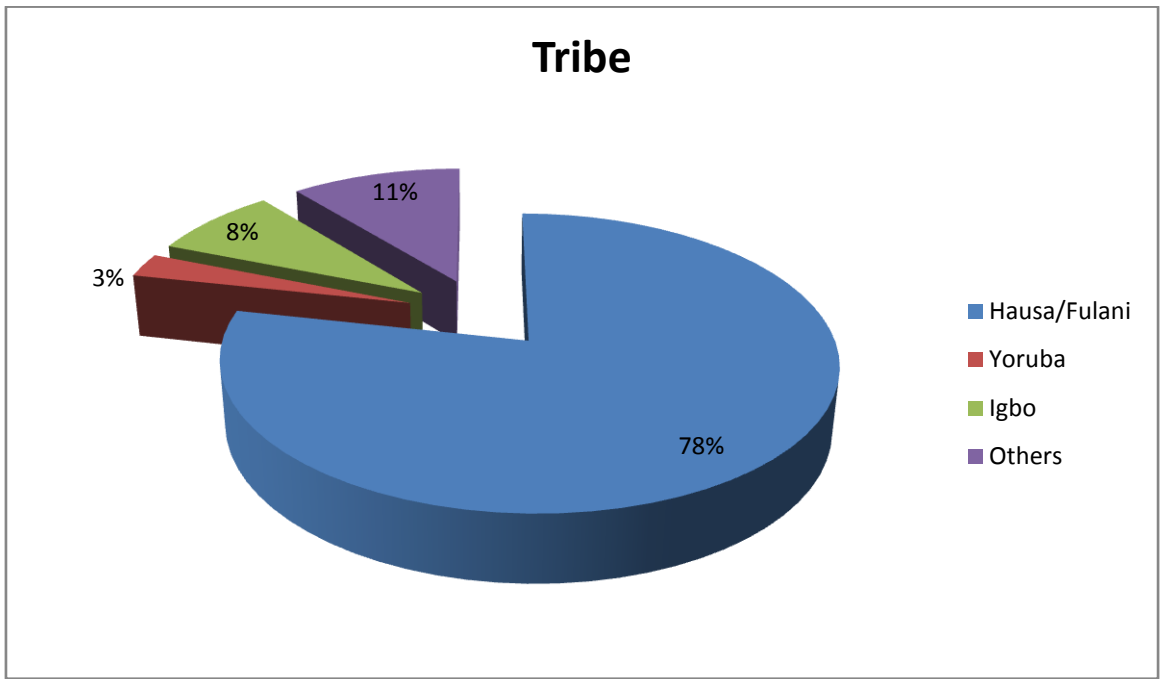

Fig 1. Distribution by tribe of origin of patients who had appendicectomy

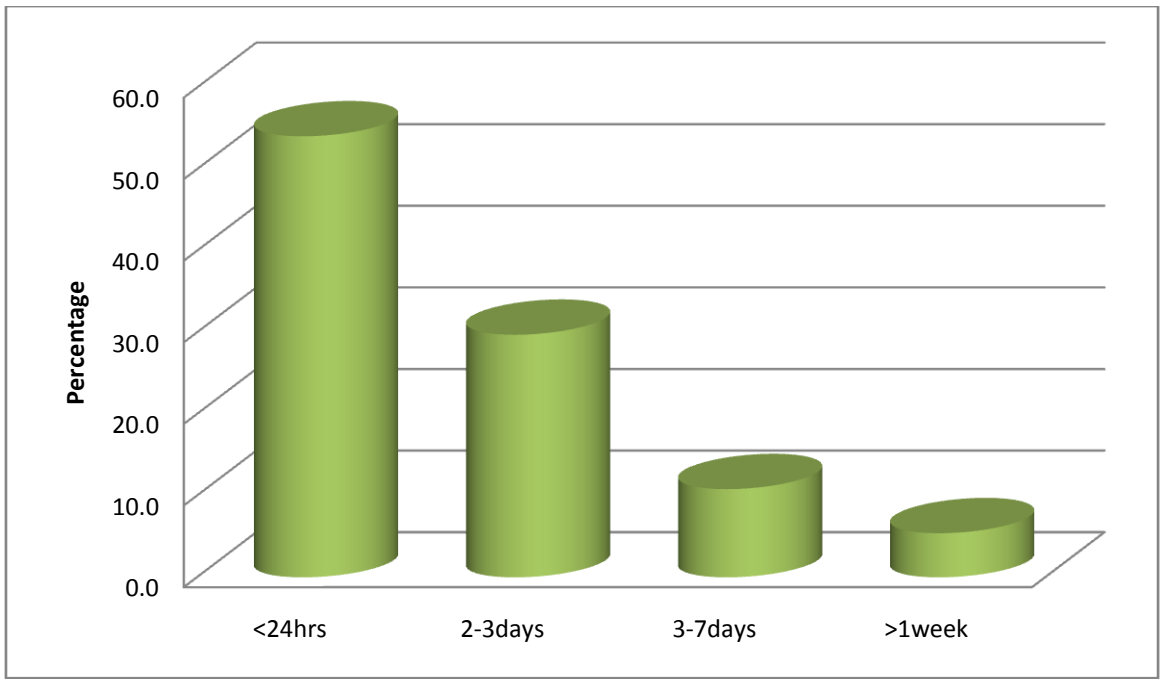

Fig 2 Duration of symptoms before presentation

Table 3 Histological Analysis

Histological Finding	Frequency(n=111)	Percentage
Normal appendix	18	16.2
Appendicitis	93	83.8

Table 4 Accuracy of Alvarado

Score	Sensitivity	Specificity	*PPV	†NPV	Accuracy	P Value
Alvarado	90.3	83.3	96.6	62.5	89.2	0.001

*PPV- Positive Predictive Value, †NPV- Negative Predictive Value
NB- Histological Analysis was used as gold standard for diagnosis
Accuracy = (true positive + true negative)/total number of patients

Table 5 Accuracy of Various Clinical Features

Clinical Findings	Sens	Spec	†PPV	‡NPV	Accuracy	P Value
Migratory *RIF Pain	83.8	50	89.7	37.5	78.4	0.065
Anorexia	87.3	66.7	93.1	50	83.8	0.003
Nausea/Vomitting	93.1	33.3	87.9	50	83.8	0.052
Tenderness	100	-	83.8	-	83.8	-
Rebound Tenderness	96.8	-	83.3	-	81.1	0.656
Elevated Temp	54.8	83.3	94.4	26.3	59.5	0.087
Leucocytosis	93.5	-	82.9	-	78.4	0.522
Shift to the left	41.9	83.3	92.9	21.7	48.6	0.243

*RIF- Right iliac Fossa † P PV- Positive Predictive Value ‡NPV- Negative predictive value
NB- Histological Analysis was used as gold standard for diagnosis because it remains the only confirmatory method for diagnosing appendicitis

Table 6 Area under the curve for Alvarado score of patients who had appendicectomy -

Test	AUC	Std Error	P Value
Alvarado	0.88	0.095	0.003

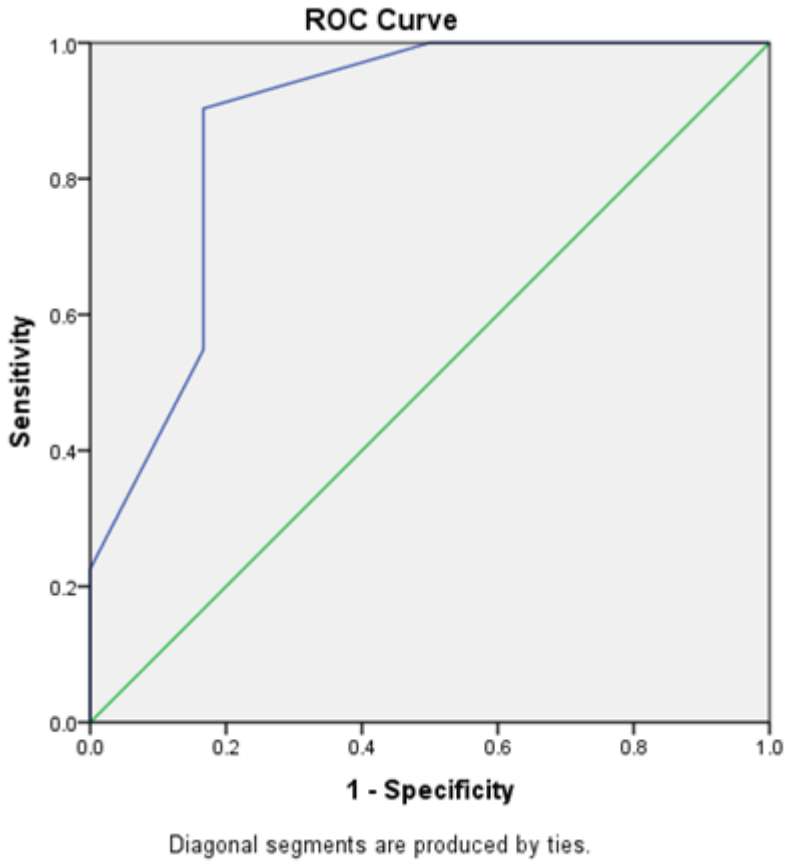

Fig 3. Receiver operating characteristics (ROC) Curve of Alvarado scores for patients who had appendicectomy. The curve on the left represents the Alvarado curve while the diagonal line is the reference line.

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