

Diagnostic Accuracy of the Alvarado Scoring System in Patients Undergoing Appendicectomy at the University Teaching Hospital in Lusaka

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ABSTRACT

Background: The use of the Alvarado scoring system as a tool for diagnosing acute appendicitis has been associated with a reduction of negative appendicectomies. This study aimed to assess the diagnostic accuracy of the Alvarado scoring system at predicting acute appendicitis in patients undergoing appendicectomy at the University Teaching Hospital (UTH).

Methods: A prospective study was done to evaluate the diagnostic value of the Alvarado score in patients undergoing appendicectomy at the UTH. Data was collected from the participants diagnosed with acute appendicitis and undergoing appendicectomy. The Alvarado scores for all the participants enrolled into the study were tabulated and correlated with the histopathology results. The sensitivity and the specificity of the Alvarado score was determined and used to construct the ROC curve using the SPSS version 20. The area under the curve was used to determine the diagnostic accuracy of the Alvarado score in this study.

Setting: The University Teaching Hospital in Lusaka, Zambia.

Results: To determine the diagnostic accuracy of the Alvarado score the ROC curve test was run in SPSS version 20. The results showed that the area under the curve was $C=0.842$ with $SE=0.047$ and 95% CI from 0.750 to 0.934. The area under the curve represents the probability that the Alvarado score result for a randomly chosen positive case will exceed the result for a randomly chosen negative case. It shows from the ROC that the Alvarado score is a good indicator to anticipate acute appendicitis. In other words, these results have confirmed that the Alvarado scoring system has very high predictive ability to discriminate acute appendicitis from normal appendix subjects.

Conclusion: The use of the Alvarado scoring system as a tool for diagnosing acute appendicitis at UTH will reduce the rate of negative appendicectomies. This will lead to a reduction in unnecessary operations, which are a burden on the health care system.

Keywords: Appendicectomy, negative appendicectomy, Alvarado Scoring System, Zambia

BACKGROUND

Acute appendicitis is the most common cause of acute abdomen worldwide¹. Approximately 6% of the population will suffer from acute appendicitis during their lifetime; therefore, much effort has been directed toward early diagnosis and intervention². Acute appendicitis is a clinical diagnosis, relying almost entirely on the history and physical examination despite the availability of special investigative modalities like the CT scan¹. Patients who have right iliac fossa pain with equivocal signs usually pose a challenge to the clinician and the decision to admit or discharge is not always straight forward³. Atypical presentation of acute appendicitis often leads to a delay in diagnosis, perforation, prolonged hospitalization and increased morbidity¹. Early diagnosis and prompt operative intervention is paramount to successful management of acute appendicitis⁴

There is no definitive test for the confirmation or exclusion of appendicitis and thus a proportion of unnecessary appendicectomy operations are unavoidable⁵. The absolute diagnosis is only possible at operation and histopathologic examination of the specimen and for this reason it is impractical to have a definitive preoperative diagnosis by gold standard, histopathology⁶. Different diagnostic aids have appeared recently and among these laparoscopy, ultrasonography and appendiceal CT scan have shown good results but they also have limitations and drawbacks which

include high cost and availability⁷. Currently, various scoring systems are being used to aid the diagnosis of acute appendicitis and bring down the negative appendectomy rates⁸. One such scoring system is the Alvarado score, which is based on analysis of symptoms, signs and laboratory data and is easy to apply⁹. The Alvarado scoring system is said to be an objective tool for the assessment of right lower quadrant pain².

The Alvarado score was first described by Alfredo Alvarado in 1986 as an accurate diagnostic tool for acute appendicitis⁹. The Alvarado score, is a simple scoring system that can be instituted easily in out-patient setting to decrease negative appendectomies¹⁰. The Alvarado scoring system is a cheap, convenient and extremely useful diagnostic tool for aiding the diagnosis of appendicitis^{6,11}. It has been shown to be consistently sensitive and specific, therefore, should be used as a routine part of the assessment of any patient with right lower quadrant pain. The score has 6 clinical features and 2 laboratory features from a full blood count. The two most important factors, tenderness in the right iliac fossa and leukocytosis, are assigned two points, and the six other factors are assigned one point each, for a possible total score of ten points⁹. According to Alvarado, a score of 5 or 6 is compatible with the diagnosis of acute appendicitis, a score of 7 or 8 indicates a probable appendicitis, and a score of 9 or 10 indicates a very probable acute appendicitis⁹. A score of less than 5 is 100% sensitive for ruling out the diagnosis of appendicitis⁹. This diagnostic score is used as a guide to decide if the patient needs observation or surgery: a patient with a score of 5 or 6 may be observed while a patient with a score of 7 or more requires surgery⁹.

The diagnostic accuracy of the Alvarado scoring system for acute appendicitis is reported to range between 83.79% and 90.2% with the negative appendectomy rate ranging between 9.7% and 16.21%^{2,6,7,12,13}. In centres where the Alvarado score is not in use, negative appendectomy rates as high as 33.1% have been reported⁴.

Despite the availability of radiological (ultrasound/CT scan) investigative modalities, a population-based study in the USA indicated that there was essentially no change in the frequency of negative appendectomy¹⁴. Similar results were also reported, where the authors found that ultrasonography did not have any additional benefit

over Alvarado score and were of the opinion that ultrasonography is unnecessary in diagnosis of acute appendicitis⁵. Ultrasound is particularly well suited for evaluating right lower quadrant or pelvic pain in paediatric and female patients⁵.

MATERIALS AND METHOD

A cross sectional study was conducted at UTH in Lusaka to determine the diagnostic accuracy of the Alvarado scoring system. Based on the expected 95% sensitivity of the Alvarado score of 7 and above at predicting acute appendicitis¹⁴ and the 67% prevalence of acute appendicitis among the patients undergoing appendicectomy at UTH (histopathology register between 1st July, 2011 and 30th June, 2012), the study needed to enroll **109** participants in order to identify the true sensitivity of the Alvarado score with precision of +/-5% and 95% confidence interval.

A total of 110 participants were enrolled consecutively. All the patients who presented with acute appendicitis and undergoing appendicectomy during the study period were enrolled provided they gave consent. The patients with a right iliac fossa mass and those who failed to provide consent were excluded.

The patient with acute appendicitis was first seen by the admitting unit, who made the diagnosis and the decision to perform appendicectomy. Consent to enrol into the study was only sought after the patient consented for appendicectomy. For the participants below the age of 18 years, the assent form was provided for them to sign whilst the consent for the study was signed by their guardians. A coded, pretested questionnaire was administered to all the participants. The questionnaire had three parts namely; symptoms, signs and laboratory parameters corresponding to the parameters on the Alvarado score. Blood for a full blood count (FBC) was collected from all the participants before the operation. The appendix was sent to the histopathology laboratory to determine the diagnosis.

The data collected from the questionnaires and the histopathology results was entered onto a spread sheet on statistical software, SPSS version 20 for analysis. The results of the Alvarado score were cross-tabulated against histopathology, the gold standard. Then, the sensitivity and specificity were determined in males and females. The diagnostic accuracy was determined using the receiver operating characteristics curve (ROC curve).

Ethics approval for this study was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC)

RESULTS

110 participants were enrolled. 62 were males while 48 were females. The youngest participant was 10 years old while the oldest was 60 years old. The average age was 28.6 years. 39.1% of the participants were aged between 21 and 30, 33.6% were aged between 31 and 40 and 20% were aged between 10 and 20. There were 7.2% of the participants above the age of 40.

Histopathology results

Thirty-one (28.2%) participants were diagnosed with normal appendix while 79 (71.8%) were diagnosed with acute appendicitis. These results, therefore, showed a negative appendectomy rate of 28.2%. The rate of negative appendectomy was 41.7% among the females and 21.6% among the males.

Accuracy of the Alvarado score

To determine the diagnostic accuracy of the Alvarado score, the ROC curve test was run in SPSS version 20. The results showed that the area under the curve was $C=0.842$ with $SE=0.047$ and 95% CI from 0.750 to 0.934. The area under the curve represents the probability that the Alvarado score result for a randomly chosen positive case will exceed the result for a randomly chosen negative case. It seems from the ROC curve that Alvarado score results is a good indicator to anticipate acute appendicitis.

Sensitivity and Specificity of the Alvarado score

The results of the Alvarado score were cross-tabulated against the histopathology results, the gold standard. The result showed that the Alvarado score had a sensitivity of 84.8% and a specificity of 87.1%. Further analysis on the ROC curve showed that 7 was the best cut off point for deciding whether or not a patient should be operated on.

DISCUSSION

In this study, a total of 110 participants were enrolled consecutively. Of the enrolled participants, 62 (56.4%) were males whilst 48(43.6%) were

females. The male to female ratio was 1.3:1. The sex distribution was comparable to that in a study done in India which had a male to female ratio of 1.2: 1⁶.

The majority of the participants were aged between 20 and 40 years. The average age was 28.6 years which is similar to the mean age seen in other studies ^{2,4,6}. In this study, the participants between 10 and 20 years accounted for only 20%. The literature reviewed ^{15,16} showed this as a dominant age group. A study which was done in Nigeria had 56% of its participants between 10 and 19 years¹⁵. The factors that led to the shift in the age distribution have not been established.

The negative appendectomy rate in this study was 28.2%. 31 participants had normal appendix diagnosed by histopathology. Of these, 20 were females and 11 males giving a negative appendectomy rate of 41.7% and 21.6% for females and males respectively. This shows that there was over diagnosis of acute appendicitis among the female participants. The reasons for the high negative appendectomy rate among the female participants are not clear. We can, however, speculate that there were challenges with differentiating pelvic inflammatory disease (PID) from acute appendicitis. This is so because ultrasonography, which is one of the investigative modalities used to differentiate the two disease entities, cannot be performed at night at UTH due human resource challenges. A similar type of results was seen in a study conducted in Tanzania, where the negative appendectomy rate was 38.3% and 26.8% for females and males respectively⁴. A negative appendectomy rate of 28.2% is too high for a public funded hospital like UTH. A lower appendectomy rate is more desirable as it would reduce the theatre costs incurred by the public funded hospital and the burden of undergoing an unnecessary appendectomy by the patient. Sometimes patients develop intestinal obstruction caused by adhesions that develop after the appendectomy which might lead to more abdominal surgeries. All this can be avoided using an accurate diagnostic tool for diagnosing acute appendicitis.

According to this study, if the Alvarado score was used as a diagnostic tool at the cut-off point of 7, the negative appendectomy rate would have reduced to 12.9%. This is in agreement with the study which was conducted in India by Dey et al,

which showed a negative appendectomy rate of 13%⁶. Most studies which were conducted to evaluate the Alvarado scoring system demonstrated a negative appendectomy rate ranging between 9.7 and 16.2%^{2,6,7,12,13}. With an appendectomy rate of 12.9%, unnecessary operations would be reduced and thus reduce the cost of running theatres. At this negative appendectomy rate, literature has shown that, the rate of perforations of the appendix is kept low but increases when the rate is below 10%¹⁷.

In this study, in order to determine the diagnostic accuracy of the Alvarado score, the ROC curve test was run in SPSS version 20. The AUC was 0.842 with Standard error =0.047 and 95% CI giving 0.750 to 0.934 as the lower and upper bounds respectively. With an AUC above 0.8, it shows that the Alvarado score is accurate and is better than guessing.

The ROC curve was further analysed to determine the sensitivity and specificity of the Alvarado score at the cut-off of 7. The sensitivity was 84.8% while the specificity was 87.1%. These values were comparable to other studies done on the Alvarado score^{4,6,11}. In this study, the sensitivity was lower because the patients with the Alvarado scores of 5-6 who had probable acute appendicitis were not accounted for. The sensitivity and specificity were calculated at the cut-off of 7. According to the Alvarado score, these patients were supposed to be observed and reassessed after 24hrs, if the Alvarado score had dropped to 4 and below, these patients were to be discharged, while those with the score of 7 and above to be operated on⁹.

Four of the participants had *Schistosoma mansoni* ova isolated from the appendix. This finding was consistent with the results seen in the studies done in Nigeria^{18,19}. None of the participants had a tumour isolated from the appendix.

The main limitation of the study design was the fact that it was an observational study. If the study was interventional, the assessment of the Alvarado score could have been more accurate, in particular, for the patients who had a score of 5 or 6. According to the Alvarado scoring system, these patients had probable appendicitis and were supposed to be observed for 24 hours within which they were supposed to be reassessed and the new Alvarado score determined. If new Alvarado score rose to 7 and above, the patient would be operated on and if the score had dropped to less than 5, the

patient would be discharged⁹. The inability to deal with this group of patients, led to an increase in the number of false negatives which negatively affected the sensitivity of the Alvarado scoring system in this study.

This study was prospective. This made the scoring of the participants easy and more reliable as all the information needed to determine the Alvarado score was obtained there and then. A retrospective study was not going to produce accurate information because record keeping is still a challenge for most hospitals in sub Saharan Africa.

CONCLUSION

The Alvarado scoring system is an accurate, cheap and easy to use diagnostic tool which if applied to our practice can reduce the negative appendectomy rate. This tool can help reduce the number of unnecessary appendectomies, in turn, reduce the running costs in our overburdened health facilities.

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TABLES

Table 1: Alvarado Scoring System

Feature	Score
Symptoms	
Migratory right iliac fossa pain	1
Anorexia	1
Nausea / Vomiting	1
Signs	
Tenderness in the right iliac fossa	2
Rebound tenderness	1
Elevated temperature > 37.3°C	1
Laboratory tests	
Leukocytosis (>10 x 10 ⁹ /L)	2
Neutrophils > 75% or Left shift	1
Total	10

Table 2: Histology results

	Frequency	Percent
Acute appendicitis	79	71.8
Normal appendix	31	28.2
Total	110	100.0

The negative appendectomy rate is 28.2%.

Table 3: Distribution of histology results by gender

		Histology		Total
		<i>Normal appendix</i>	<i>Acute appendicitis</i>	
Sex	Female	20	28	48
	Male	11	51	62
Total		31	79	110

The rate of negative appendectomy was 41.7% among the female participants and 21.6% among the male participants.

		Histology		Total
		Normal appendix	Acute appendicitis	
Sex	Female	20	28	48
	Male	11	51	62
Total		31	79	110

FIGURES

Figure 1: Gender ditribution of participants

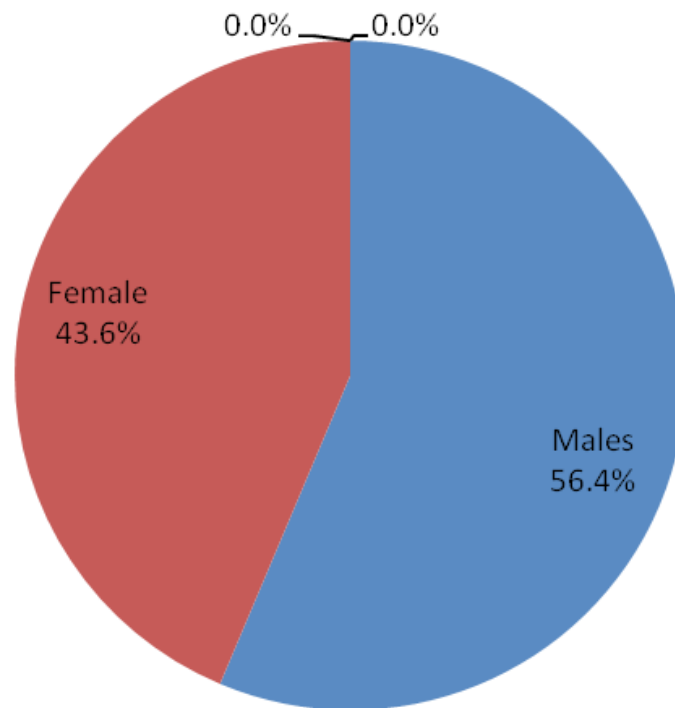


Figure: Age distribution of the participants

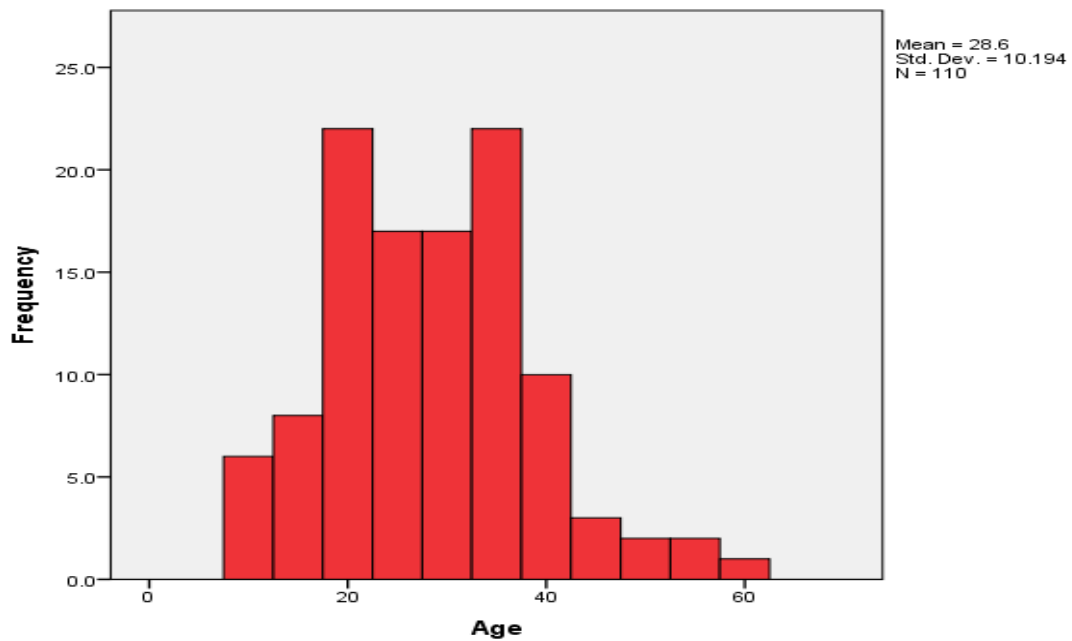
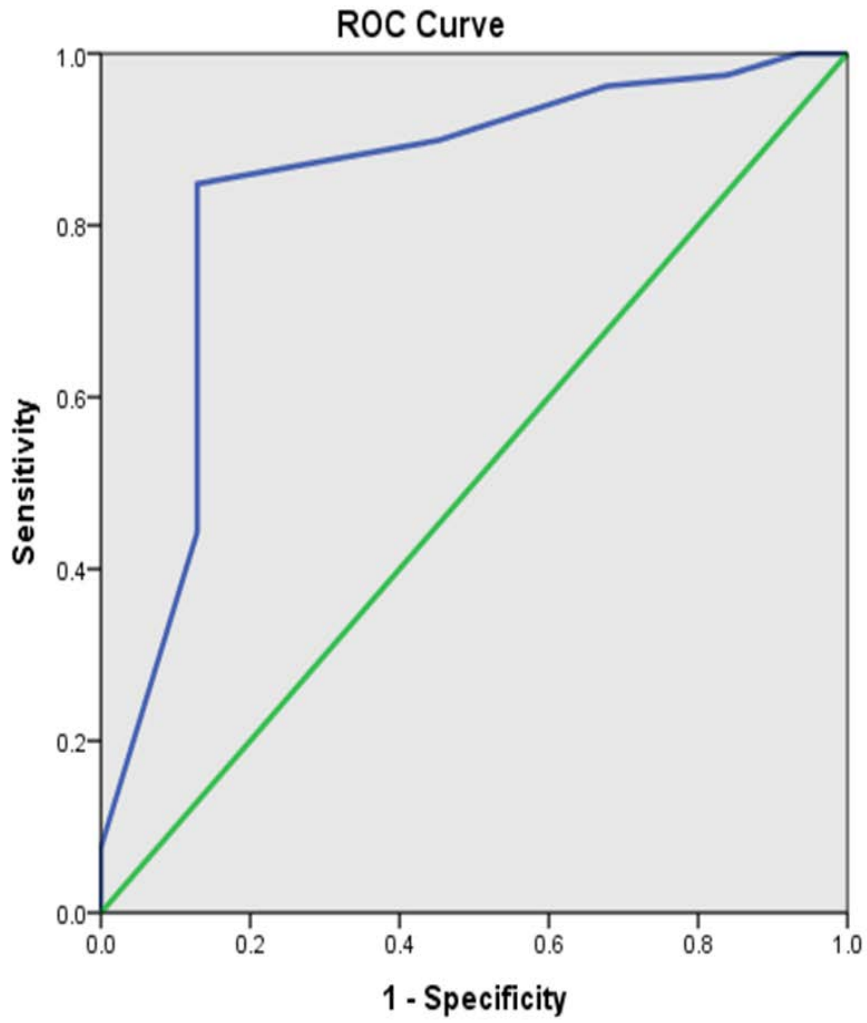


Figure 3: Receiver operating characteristic curve for Alvarado scores



Diagonal segments are produced by ties.