A Comparative Study of RIPASA and Alvarado Scores for the Diagnosis of Acute Appendicitis in Patients at University of Abuja Teaching Hospital, Abuja: A Prospective Cohort Study

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Abstract:-
Introduction: The incidence of Acute appendicitis, a major cause of acute abdomen, in Africa is low but is said to be progressively increasing. Accurate diagnosis of acute appendicitis, amidst different clinical conditions that mimic it, is challenging and fraught with pitfalls. Clinical scoring systems, developed to aid prompt diagnosis, prevent possible perforations with its challenges and limit negative appendectomies, play a pivotal role in Sub-Saharan Africa where paucity of funds abounds, and novel investigation modalities are lacking. The Alvarado scoring system, the first of such aids, is reported to have varying diagnostic outcomes alongside high perforation rates in sub-Saharan Africa compared to other climes. Better diagnostic tools are still being sought after, and a new scoring system, the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA), was compared with Alvarado to bridge this gap and solve this challenge at the University of Abuja Teaching Hospital (UATH), Gwagwalada.

Objective: To prospectively determine and compare the diagnostic accuracy, specificity, and sensitivity of the RIPASA and Alvarado scoring systems in the diagnosis of acute appendicitis.

Patients and Methods: A One-year prospective comparative cross-sectional study in which seventy-nine patients between 7-62 years of age, of both sexes, presenting with pain in the right lower abdominal quadrant and suspected to have acute appendicitis were enrolled. Each patient's clinical details, alongside their Alvarado and RIPASA scores, were obtained at presentation and a decision for surgery was exclusively based on the clinical findings and the investigations. Only seventy-six patients had surgery based on clinical assessment and these patients were correlated with the histologic diagnoses. Data collated was analyzed using SPSS 25 and the diagnostic accuracy, sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV) and negative appendectomy rates (NAR) of the scoring systems were determined.

Results: The sensitivity, specificity, PPV, NPV and diagnostic accuracy of RIPASA was 97.1%, 71.4%, 97.1%, 71.4% and 94.7% respectively while Alvarado had sensitivity, specificity, PPV, NPV and diagnostic accuracy of 66.7%, 57.1%, 93.9%, 14.8% and 65.8% respectively. The negative appendectomy rate (NAR) based on clinical evaluation was 9.2%.

Conclusion: The RIPASA scoring system outperforms the Alvarado scoring system as a diagnostic tool for acute appendicitis. Surgery decisions can be influenced by the RIPASA grading system, and this can help avoid unnecessary procedures.

Keywords: Acute Appendicitis, RIPASA Scores, Alvarado Scores, Diagnostic Accuracy, Negative Appendectomy, Sensitivity, Specificity.

I. INTRODUCTION

Acute appendicitis is a frequently occurring surgical problem confronting young surgeons and emergency room physicians. It is a frequently occurring surgical condition that needs to be identified quickly to reduce morbidity and prevent major sequelae[1,2]. With a prevalence in the general population ranging from 7 to 12 percent, it is one of the most common conditions requiring abdominal surgery.[1,2]. Despite being a common surgical concern, the diagnosis may still be problematic since it can mimic several different acute abdominal conditions. Acute appendicitis, if untreated promptly or undiagnosed, could lead to a higher risk of adverse outcomes, including death[3]. The statement made by Sir William Osler that "medicine is a science of uncertainty and an art of probability" is exemplified in the diagnosis of appendicitis [4].

It is not always simple to accurately identify individuals who will benefit from active observation or those who require immediate surgical intervention [5]. Several diagnostic tests for appendicitis have a lot of potential for use in clinical settings. It is still difficult to diagnose atypical appendicitis early enough to prevent needless surgery and lower healthcare costs as it mimics so many acute abdominal conditions [6,7]. A surgeon's expertise and familiarity with comparable cases is largely required for the accurate diagnosis of acute appendicitis. Using a clinical grading system can help overcome the challenges associated with diagnosing acute appendicitis and improve the prognosis of affected individuals [8].

Whether or not to perform surgery is the actual, core clinical decision in diagnosing a patient with probable appendicitis [4]. There are many clinical grading systems available to facilitate the diagnosis of acute appendicitis. The purpose of all the previously stated scores has been to improve the diagnosis accuracy by simply assigning numerical values to specific signs and symptoms. The use of clinical rating charts can help healthcare providers in improving decision-making, patient management, and identification of suspected appendicitis [2]. Moreover, several lines of evidence suggest that the integrated use of clinical scoring systems and diagnostics images correctly identifies cases of acute appendicitis [2,3,9].

The Alvarado score, developed in 1986 by Alvarado, who processed appendectomy patient data retrospectively, is one of the most well-known grading systems. It includes eight diagnostic criteria such as historical data, physical examination, and laboratory values [7,10,11]. Another scoring system is the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA)[5] score, which is a rather recently developedeasy-to-apply scoring system that has been proposed to have a significantly higher sensitivity, specificity, and diagnostic accuracy than other scoring systems in some other climes. Several parameters missing from the Alvarado score is included in the e RIPASA score, such as age, gender, and the duration of symptoms before presentation [5]. It has been demonstrated that these factors impact the Alvarado scoring system's sensitivity and specificity in the diagnosis of acute appendicitis[10].

These scoring systems were developed to lower the risk of a negative appendectomy while also assisting in the early detection and timely treatment of acute appendicitis. An appendicitis preoperative diagnosis that is treated with surgery and yields a normal histology specimen is referred to as a negative appendicectomy [8,12]. Generally, most scoring systems make use of clinical history, physical examination, and laboratory findings [2,13]. These scoring systems work well in many different clinical contexts and are easy to apply. However, if the scores were applied to different populations and clinical contexts, disparities in sensitivities and specificities were noted, generally performing poorly when used outside the population in which they were originally created[5]. Furthermore, their usefulness may be hampered by regional variations in the prevalence and clinical pattern of the differential diagnosis of acute abdominal discomfort [5]

Table 1 uses eight predictive factors of diagnostic value in acute appendicitis and allots each factor a value of 1 or 2 based on their diagnostic weight [4]. Elevated temperature >37.3°C, rebound tenderness, migration of pain to the right lower quadrant (RLQ), anorexia, nausea, vomiting, and leukocyte left shift all receive a score of 1. Leucocytosis that is more than 10,000 and RLQ tenderness receive a score of 2. Based on the overall score, the chance of appendicitis and specific management advice are provided[5]. It is advised to observe or examine the patient repeatedly if the patient receives a score of 5 or 6. Appendicitis is considered "likely"

An effective scoring system for the diagnosis of acute appendicitis strikes a balance between a more limited approach, which aims to lower the risk of needless surgery, and early operative intervention, which seeks to prevent perforation[3,14,15]. Moreover, physicians must ponder the accuracy, delay-to-surgery, and radiation risks of using computed tomography (CT) imaging, as well as the reliability of laboratory results and clinical scoring systems. It is often known that even with its widespread incidence, diagnosing acute appendicitis remains difficult for medical professionals., suggesting the need for novel advances to improve patients' management [3,14,15].

Most appendicitis scores have been shown to be quick and inexpensive diagnostic tests. Nonetheless, variations in diagnostic precision have been noted when applying the ratings to different patient populations and healthcare environments. The purpose of this study was to compare the diagnostic accuracy of Alvarado and RIPASA to see which can give us a better option in our setting. The ideal course of action is to treat every instance of appendicitis as soon as possible without requiring needless surgical procedures [4]. An ideal scoring system would work as a tool that speeds up and increases the accuracy of decision-making, and at the same time reduces the need for potentially harmful and expensive imaging [16].

II. THEORETICAL FRAMEWORK

Acute appendicitis is a common surgical complication that needs to be identified quickly to reduce morbidity and prevent major complications[5,10]. It is not always straightforward to correctly identify those who will benefit from active observation and those who require urgent surgery [5]. Quite a few scoring systems have been developed to assist decision-making in questionable cases, including the Eskelinen, Ohmann, Alvarado, Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and a few others[10]. These scoring systems are easy to apply in a range of clinical settings and make use of routine clinical and laboratory data. This study is assessing two of the scoring systems, the Alvarado and the RIPASA at UATH, Gwagwalada, Abuja, Nigeria.

A. Alvarado
Alvarado score

for a score of 7 or 8, and "extremely probable" for a score of 9 or 10, which indicates the need for surgical intervention [5,14].

One of the bottlenecks of the use of the Alvarado score is that young children must identify factors like migratory pain, nausea, and anorexia in their history—variables that are relatively difficult for them to recognize[3,14,17]. It is also believed that the Alvarado score is deficient in several areas, including age, gender, and length of symptoms, all of which have been demonstrated to be important in the diagnosis of acute appendicitis [3,14,17].

Table 1: Alvarado Scoring System

	THE ALVARADO SCORING SYSTEM	SCORE
SYMPTOMS	Migratory RIF Pain	1
	Anorexia	1
	Nausea/ Vomiting	1
SIGNS	Tenderness RLQ	2
	Rebound Tenderness RLQ	1
	Elevation of Temperature >37.3ºC	1
LABORATORY	Leucocytosis > 10 X 10 ^{9}/L	2
	Neutrophilic shift to the left >75%	1
TOTAL		10

➢ *Interpretation Alvarado Score*
- Score 1- 4:Acute appendicitis is very unlikely; keep for observations.
- Score 5-6:Acuteappendicitis is probable; admit the patient for close observations andrescoring.
- Score 7-8:Acute appendicitis is likely; operate.
- Score 9-10:Acute appendicitis definite; operate immediately.

Numerous academic institutions have researched the Alvarado scoring system, with differing results [3,14,18].

B. Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) Score

One of the newest scoring methods is called RIPASA (Table 2), and it is based on six factors around the clinical and personal characteristics of the patient that are not included in the Alvarado score: age, gender, duration of symptoms, guarding, Rovsing's sign, and negative urinalysis[3]. The RIPASA score was created by looking back at 312 patients who had appendicectomies performed at the Department of Surgery at the Raja Isteri Pengiran Anak Saleha (RIPAS) hospital in Brunei Darussalem between October 2006 and May 2008[19]. The researchers, who were dissatisfied with the diagnostic accuracy, low sensitivity, and specificity levels of the Alvarado scoring system (as well as the Modified Alvarado scoring system) when applied to Asian, Middle Eastern, and Oriental populations, developed RIPASA to get a better diagnostic aid for acute appendicitis [12,19].

In addition to fourteen predefined generalized criteria, the RIPASA score also includes one extra parameter unique to the Asian population, to which individual scores are assigned according to their diagnostic weight. With a thorough history, a physical examination, and two quick blood tests, these criteria can be quickly and simply determined in any population. These are the scores and parameters referred to in

Table **Error! No text of specified style in document.**:.

Table **Error! No text of specified style in document.**: The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) Score[12,19]

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) Score		Score
PATIENTS	Female	0.5
	Male	1.0
	Age < 39.9 years	1.0
	Age > 40 years	0.5
SYMPTOMS	RIF pain	0.5
	Pain migration to RIF	0.5
	Anorexia	1.0
	Nausea & Vomiting	1.0
	Duration of symptoms < 48 hrs.	1.0
	Duration of symptoms > 48 hrs	0.5
SIGNS	RIF tenderness	1.0
	Guarding	2.0
	Rebound tenderness.	1.0
	Rovsing's sign	2.0
	Fever > 37° C < 39° C	1.0
INVESTIGATIONS	Raised WBC	1.0
	Negative urine analysis	1.0
ADDITIONAL SCORE	Foreign national resident in the country	1.0
TOTAL		17.5

Total Score is achieved by adding all the scores for each category together.

An additional score is added for patients who are foreign nationals resident in the country (FNRIC).

➤ *Management Guidelines Based on the Total Score:*
  • **< 5** = Probability of acute appendicitis is unlikely.

Monitor patients in accident and emergency (A&E) and repeat scoring afterwards 1–2 hrs.

If there is a dropping score, discharge. If there is an increasing score, treat according to score level.

  • **5–7.0** = Low probability of acute appendicitis.

Observe in accident and emergency and repeat scoring system after 1–2 hrs.

Or perform an abdominal ultrasound to rule out acute appendicitis.

Patients may require admission for observations, discuss with the surgeon on-call[16].

  • **7.5–11.0** = Probability of acute appendicitis is high.

Refer patient to surgeon on-call for admission and repeat score in 1–2 hrs. time.

If it stays high, prepare the patient for appendectomy.

Abdominal ultra sonography should be performed in female patients to rule out gynaecological reasons for RIF discomfort.
  • **> 12** = Definite acute appendicitis; refer to surgeon on-call for admission and appendectomy

Despite having numerous criteria, the RIPASA scoring system is equally user-friendly andis believed to have superior diagnostic accuracy than the Alvarado and most other score systems when applied among Asians.[3,19]

➤ *Acute appendicitis diagnosis cut-off points for scoring systems:*
Different cut-offs were used in each study to generate the diagnostic parameters for RIPASA and Alvarado scores. Most of the research employed the standard cut-offs for Alvarado and RIPASA scores, which are 7.0 and 7.5, respectively. As a result, if a patient's score was higher than these cut-off points, they were diagnosed with acute appendicitis.

C. Two by Two (2x2) Contingency Table
A 2x2 contingency table can be used to demonstrate the diagnostic power of both the Alvarado and RIPASA scores for negative appendectomy rate (NAR) using histology report as the gold standard

Table 1.

Table 1: A 2x2 Contingency Table for Alvarado Scoring System

Alvarado Score	Histology Appendicitis Present	Histology Appendicitis Absent	Total
≥7	True Positives (TP)	False Positives (FP)	TP + FP
<7	False Negatives (FN)	True Negatives (TN)	FN + TN
Total	TP + FN	FP + TN	Total

➤ *Interpretation:*
- **True Positives (TP):** Patients with appendicitis who scored ≥7 and had it confirmed by histology.
- **False Positives (FP):** Patients without appendicitis who scored ≥7 but histology showed no inflammation.
- **False Negatives (FN):** Patients with appendicitis who scored <7 but histology confirmed it.
- **True Negatives (TN):** Patients without appendicitis who scored <7 and histology confirmed it.

D. Calculating Diagnostic Measures:

Table 2: Diagnostic Measure Formulae

VARIABLE	CALCULATION
Sensitivity	(TP / (TP + FN)) * 100%. This shows the test's ability to correctly identify true cases of appendicitis (≥7 score).
Specificity	**(TN / (FP + TN))** * 100%. This shows the test's ability to correctly identify true cases of non-appendicitis (<7 score).
Positive Predictive Value (PPV)	**(TP / (TP + FP)) * 100%**. This is the proportion of true positives among all the cases that the test identified as positive.
Negative Predictive Value (NPV)	**(TN / TN + FN)) * 100**. The proportion of true negatives among all the cases that the test identified as negative.
Accuracy Rate	[(True Positives + True Negatives) / Total] * 100%

Negative Appendectomy Rate (NAR)	(FP / (TP + FP)) * 100%. This indicates the percentage of unnecessary surgeries among patients scoring ≥7.

With the help of 2 × 2 table, the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy can be calculated individually, and then compared with each other

Table 2[20–23]. Histological examinations that reveal transmural neutrophil infiltration in the appendix are typically used to diagnose acute appendicitis [16]. Histopathological diagnosis is considered the final arbiter. TheAlvarado scores and RIPASA scoresgenerated are compared to the histopathology report in this study.

III. STATEMENT OF THE PROBLEM

The ability to correctly separate right iliac fossa pain caused by appendicitis from other abdominal pains that mimic it is a problem young surgeons and emergency room physicians often face. Avoiding negative appendicectomies, with their associated morbidity, death, and higher medical expensesis essential to good surgical practice. The harrowing sequelae resulting from a missed diagnosis of acute appendicitis is an unacceptable disaster[5,14,17]. To address this issue, surgeons require a strong grading system with a high level of diagnostic precision.

IV. JUSTIFICATION

Comparing the RIPASA and Alvarado scoring systems for the diagnosis of acute appendicitis in our context is a relatively new area of research[4,7,9,15]. There is an ongoing quest for a cost-effective, efficient, easy-to-use, and reliable diagnostic aid that will minimize overt dependency on high radiology investigations for accurate diagnoses of common surgical problems like acute appendicitis in our setting- sub-Saharan Africa. Patients' productivity and quality of life will be greatly impacted by understanding and contrasting the diagnostic profiles of RIPASA and Alvarado. The diagnostic accuracy of RIPASA and Alvarado scores in patients with acute appendicitis has not yet been studied at our hospital. That is why this research is being done.Hence, we prospectively compared Alvarado and RIPASA scores by applying them to the patients attending our hospital with right iliac fossa pain with suspected acute appendicitis during the period July 2016 and June 2017 and cross examined them with the histologic diagnoses. These formed the base of our research.

V. RESEARCH QUESTIONS

A. Primary Question:
Does the RIPASA scoring system demonstrate superior diagnostic accuracy compared to the Alvarado scoring system for identifying acute appendicitis in patients presenting to UATH, as measured by sensitivity, specificity, and positive and negative predictive values?

B. Secondary Question:
Can the use of the RIPASA score influence surgical decision-making and potentially reduce negative appendectomies at UATH?

VI. RESEARCH HYPOTHESIS

A. Primary Hypothesis

➢ *Null Hypothesis (H0):*
There is no statistically significant difference in the diagnostic accuracy (sensitivity, specificity, positive predictive value, and negative predictive value) between the RIPASA and Alvarado scoring systems for diagnosing acute appendicitis in patients at UATH.

➢ *Alternative Hypothesis (H1):*
There is a statistically significant difference in the diagnostic accuracy of the RIPASA and Alvarado scoring systems for diagnosing acute appendicitis in patients at UATH, but the direction of the difference is unknown.

B. Secondary Hypothesis:
- **Ho:** The use of the RIPASA scoring system does not significantly influence surgical decision-making for suspected acute appendicitis at UATH compared to the Alvarado scoring system.
- **H1:** The use of the RIPASA scoring system influences surgical decision-making at UATH, leading to a reduction in the proportion of negative appendectomies compared to the Alvarado scoring system.

VII. PURPOSE OF STUDY

This study sets out to investigate the diagnostic profiles of Alvarado and RIPASA in patients with suspected acute appendicitis at UATH, Gwagwalada Abuja.

VIII. SIGNIFICANCE OF THE STUDY

The results from this study will reveal which of these two is a better diagnostic scoring system in patients with suspected acute appendicitis in our setting and so aid young surgeons in the accurate diagnosis of acute appendicitis, as well as effect reductions in missed diagnoses, and negative appendectomies.

IX. AIMS AND OBJECTIVES

A. Aim
To compare and evaluate the diagnostic profiles of RIPASA and Alvarado Scores in co-relation to histopathology report for the diagnosis of acute appendicitis.

B. Objectives:

➢ Primary Objectives.

To find out how different the RIPASA and Alvarado scores are in terms of sensitivity, specificity, positive predictive value, and negative predictive value when it comes to identifying acute appendicitis in patients at UATH.

➢ Secondary Objective

To determine if the RIPASA score can influence surgical decisions better than the Alvarado score.

X.   RESEARCH DESIGN

This research was a prospective study.

XI.   DESCRIPTION OF THE STUDY AREA:

This study was conducted at the University of Abuja Teaching Hospital's surgery department in Gwagwalada, Abuja, Nigeria. The hospital can accommodate five hundred beds and acts as a referral centre for medical facilities run by the Federal Capital Territory Administration as well as the states that border it—Kogi, Niger, Nasarawa, Kaduna, Benue, and Plateau states[24].

XII.   POPULATION OF THE STUDY

All patients who gave their consent and presented to UATH between July 2016 and June 2017 with a diagnosis of probable acute appendicitis were included in this study. Patients who did not give their consent, those who had an acute abdomen from another reason (such as trauma, bowel blockage, etc.), and any instances of appendicitis or appendectomies that were unintentional were not included.

XIII.   SAMPLE AND SAMPLING PROCEDURE

All patients undergoing appendectomies in the Department of Surgery, University of Abuja Teaching Hospital, Gwagwalada, Abuja, Nigeria, over a period of one year and who consented to participate in the study. Patients with complicated appendicitis were excluded from the study. Patients who satisfied the requirements for inclusion were sequentially added to the trial. They were evaluated on admission using the Alvarado and RIPASA scores as well as clinical evaluation to determine whether they had acute appendicitis or not.All patients underwent appendectomy according to the hospital protocol. The judgement to operate was the prerogative of the surgeon or surgical resident based on total clinical assessment and not the Alvarado and RIPASA scores.

Surgical residents collected the basic data for the construction of the score during the initial examination at the emergency department. The collected data included clinical findings (tenderness in RLQ, guarding in RLQ, and body temperature), and symptoms (pain in RLQ, migration of pain, vomiting, and anorexia), as well as laboratory test results. The Alvarado and RIPASA scoring system

proformas were implemented. The diagnosis of acute appendicitis was based on the report of the histopathological report.

XIV.   RESEARCH PROTOCOL

A clinical suspicion of acute appendicitis was a requirement for patient admission and surgical treatments. Based on clinical signs and symptoms, consultants from the Department of Surgery at UATH made the clinical diagnosis of acute appendicitis. Patients who were thought to have acute appendicitis underwent a thorough assessment that included clinical information, ultrasonography, and investigation. Care was provided to the patients not according to their RIPASA and Alvarado scores, but rather according to the results of the clinical assessment and the investigative report. On a proforma, however, the Alvarado and RIPASA scores of every patient suspected of having appendicitis were noted. Age, gender, height, weight, length of hospital stays, previous medical history, results from operations or follow-up care, and results from lab and imaging tests were all documented along with other patient data.

A diagnosis of appendicitis was given macroscopically during the operation (purulent formations, and oedematous-necrotic changes on the appendix wall). The results were confirmed with histopathological findings [5]. We compared prospectively the RIPASA and Alvarado scoring systems by applying them to the seventy-six patients enrolled. A score of 7.5 was the optimal cut-off threshold for RIPASA and seven for the Alvarado scoring system for this study. Intraoperative findings were noted, and each specimen obtained was preserved in 10% formalin solution and sent to the histopathologist for histological diagnosis. The histology reports were subsequently retrieved and correlated with the findings obtained. Sensitivity, specificity, positive predictive value (PPV) and negative predictive (NPV) for RIPASA & Alvarado system were calculated using a 2 x 2 possibility table. Even though all the patients had concurrent RIPASA and Alvarado scores, these patients were assessed and operated on based on the clinical findings of the surgeons as well as some extra imaging. Histological results related to how well the scoring systems performed.

XV.   RESEARCH INSTRUMENT

The researcher created a questionnaire that was employed as the research tool in this investigation. The proforma was used to collect data on patients who came to UATH, Abuja with a suspected case of acute appendicitis. A pre-tested, coded questionnaire was used to gather data, and SPSS statistical software version 25 was used for the analysis.

XVI.   DATA ANALYSIS

Data collection utilized a proforma and Microsoft Excel. IBM SPSS version 25 was used to analyze categorical variables with frequencies and percentages, while continuous variables were summarized using means and standard deviations. Results were presented in tables,

and line graphs. Statistical tests, including chi-square and t-tests, were used to compare variables between study groups. Significance was determined at p<0.05. The sample size calculation was based on a significance level of 0.05. We needed a sample of at least 43 patients to achieve 80% power. Cross tables were prepared for sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the diagnostic accuracy values of the scoring systems.

XVII. RESULTS

Seventy-nine patients were recruited initially into the study group during this period. Thirty-seven (37) males

(46.8%) and forty-two (42) females (53.2%) were assessed as having acute appendicitis during this study period giving a male–female ratio of 1:1.14. These patients cut across the diverse ethnic groups in Nigeria. Fifty-five (70%) were Christians and 24 (30%) were Muslims. The ages of the patients range from 7-62 years. The majority were between the 2nd to the fourth decade of life. The peak, however, was in the third decade of life (39.2%). The mean age is 27.1266 years with a standard deviation of +/- 10.8620. Many of these patients were students (46.8%), civil servants (17.7%), businessmen (10.1%), artisans (10.1%) and health workers (6.3%). However, only seventy-six were analyzed as three patients were excluded on clinical grounds of not having acute appendicitis and therefore no histological report was available for analysis. The different histological pattern is presented in Table .

Table 5: Correlating the histologic diagnosis with clinical scores (Alvarado vs RIPASA)

Histologic Diagnosis	Alvarado Score <7	Alvarado Score ≥7	RIPASA <7.5	RIPASA ≥7.5	Total
Acute Appendicitis	12	8	1	19	20
Acute Recurrent Appendicitis	8	13	1	20	21
Acute Gangrenous Appendicitis	1	7	0	8	8
Perforated Appendicitis	0	18	0	18	18
Schistosoma Appendicitis	2	0	0	2	2
Non-Appendicitis	4	3	5	2	7
TOTAL	27	49	7	69	76

A 2x2 table demonstrating the diagnostic power of Alvarado scores using histology as the gold standard is shown in Table , Table 7 Similar parameters for the RIPASA scores are likewise presented in

Table , and

Table . The diagnostic profiles were compared in Table 10.

Table 6: Alvarado Patient Score Sheet

Alvarado Score	Histology (Appendicitis Present)		Histology (Appendicitis Absent)		Total
≥7	True Positives (TP)	46	False Positives (FP)	3	49
<7	False Negatives (FN)	23	True Negatives (TN)	4	27
Total		69		7	76

Table 7: Alvarado Diagnostic Profile

Parameter	Alvarado Scores in %
Sensitivity	66.67
Specificity	57.14
Positive Predictive Value (PPV)	93.88
Negative Predictive Value (NPV)	14.8
Diagnostic Accuracy	65.79

Table 8: RIPASA Patient Score Sheet

RIPASA Score	Histology – Appendicitis Present		Histology – Appendicitis Absent		Total
≥7.5	True Positives (TP)	67	False Positives (FP)	2	69
<7.5	False Negatives (FN)	2	True Negatives (TN)	5	7
Total	TP + FN	69	FP + TN	7	76

Table 9: RIPASA Diagnostic Profile

Parameter	RIPASA Scores in %
Sensitivity	97.10
Specificity	71.43
Positive Predictive Value (PPV)	97.10
Negative Predictive Value (NPV)	71.43
Diagnostic Accuracy	94.74

Table 10: Comparison of the Diagnostic Profiles of Alvarado and RIPASA

Variables	Score in % (95% CI)		p-value
	RIPASA	ALVARADO	
Sensitivity	97.10	66.67	< 0.01
Specificity	71.43	57.14	< 0.01
PPV	97.10	93.88	
NPV	71.43	14.81	< 0.01
Diagnostic Accuracy	94.74	65.79	< 0.01
Negative Appendectomy Rate	2.90	6.52	< 0.01

Using the Independent Samples t-test, the difference between RIPASA and Alvarado was significant at a p-value of p = 0.013

Clinical assessment picked 76 patients as having positive appendicitis but only 69 were histologically confirmed leaving a false positive rate of (76-69=7/76) meaning a 9.2% rate of NAR.

Alvarado score picked 49 patients with scores =>7 but only 46 of the patients were histologically confirmed leaving NAR of 3/49 (6.12%)

RIPASA picked 69 patients with scores =>7.5 out of which 67 were histologically confirmed with a negative appendectomy rate of 2/69 (2.90%)

XVIII. HYPOTHESIS TESTING

1) Ho: There is no statistically significant difference in the diagnostic accuracy (sensitivity, specificity, positive predictive value, and negative predictive value) between the RIPASA and Alvarado scoring systems for diagnosing acute appendicitis in patients at UATH.

Using Table 10 above to evaluate this hypothesis, there is a statistically significant difference in the diagnostic accuracy (sensitivity, specificity, positive predictive value, and negative predictive value) between the RIPASA and Alvarado scoring systems for diagnosing acute appendicitis in patients at UATH. Using the Independent Samples t-test, the comparison between RIPASA and Alvarado was significant at a p-value of p = 0.013. The above hypothesis is, therefore, rejected. The alternative hypothesis is upheld.

2) Ho: The use of the RIPASA scoring system does not significantly influence surgical decision-making for suspected acute appendicitis at UATH compared to the Alvarado scoring system.

Referring to Table 10 for the testing of this hypothesis, the diagnostic accuracies of RIPASA and Alvarado are significantly different (Diagnostic Accuracy of RIPASA at 94.74 % compared to the diagnostic accuracy of 65.79% for Alvarado score with a p = value of <0.01. At this level, the RIPASA scoring system can significantly influence surgical decision-making for suspected acute appendicitis at UATH compared to the Alvarado scoring system. Therefore, the

null hypothesis that says, "The use of the RIPASA scoring system does not significantly influence surgical decision-making for suspected acute appendicitis at UATH compared to the Alvarado scoring system" is rejected and the alternative hypothesis is hereby accepted.

XIX. SUMMARY OF THE FINDINGS (FINDINGS BASED ON THE FORMULATED HYPOTHESES TESTING)

There is a statistically significant difference in the diagnostic accuracy of the RIPASA and Alvarado scoring systems for diagnosing acute appendicitis in patients at UATH.

The use of the RIPASA scoring system significantly influences surgical decision-making for suspected acute appendicitis at UATH.

The ability of the RIPASA scoring system to pick those positive for appendicitis as positive is very high (97.10%) compared to the sensitivity of Alvarado (66.67%).

XX. ANSWERING THE RESEARCH QUESTIONS

A. Primary Question:

Does the RIPASA scoring system demonstrate superior diagnostic accuracy compared to the Alvarado scoring system for identifying acute appendicitis in patients presenting to UATH, as measured by sensitivity, specificity, and positive and negative predictive values?

Answer: Yes, the RIPASA scoring system demonstrates superior diagnostic accuracy compared to the Alvarado scoring system for identifying acute appendicitis in patients presenting to UATH, as measured by sensitivity, specificity, and positive and negative predictive values. The diagnostic accuracy of RIPASA is 94.74 % compared to the diagnostic accuracy of 65.79% for the Alvarado score is significant with a p-value of <0.01.

B. Secondary Question:

Can the use of the RIPASA score influence surgical decision-making and potentially reduce negative appendectomies at UATH?

Answer: Yes, with the RIPASA ability to pick a positive case of acute appendicitis standing at 94.74 %, as compared to 65.79% of Alvarado; therefore, the RIPASA scoring system can influence surgical decision-making and potentially reduce negative appendectomies.

XXI. DETERMINING THE RESEARCH OBJECTIVES

A. Primary Objectives

To find out how different the RIPASA and Alvarado scores are in terms of sensitivity, specificity, positive predictive value, and negative predictive value when it comes to identifying acute appendicitis in patients at UATH. The sensitivity, specificity, PPV, NPV and diagnostic accuracy profiles are displayed in Table 10. The RIPASA

score is superior to the Alvarado score within the context of this study. This objective has been met.

B. Secondary Objective

To determine if the RIPASA score can influence surgical decisions better than the Alvarado score. This study has met this objective to prove within the context of this research that RIPASA can positively influence surgical decision-making with a diagnostic power of > 95%.

XXII. DISCUSSION OF THE FINDINGS

About 40% of emergency surgical procedures performed in most hospitals globally are for acute appendicitis, which is a common cause of acute abdomen [11,25]. Its lifetime risk is 6.7% for women and 8.6% for males, with an incidence of 1.17 per 100028,24,26. The estimated lifetime incidence of appendicitis, however, is 7% [26]. In Northern Nigeria, the incidence of acute appendicitis is 2.6 per 100,000 per annum [27]. Edino et al reported 142 cases over a 5-year period in Kano (1997-2002) i.e. 28 cases yearly [11]. Ahmed et al reported 382 cases of clinical suspected appendicitis over a 10-year period in Zaria. (2001-2010) [28] compared to 79 cases seen in our centre within a 12-month period (July 2016- June 2017).

The clinical diagnosis of appendicitis can be vague and full of pitfalls because of the lack of constant pathognomonic clinical features. Several scoring systems have been developed to help in the accurate diagnosis of this condition to minimize the high rate of negative appendectomies. Many have used Alvarado scoring systems to diagnose this condition, but it is not perfect hence the search for better scoring systems. Following the development of the Alvarado scoring system, the RIPASA scoring system was developed; however, its diagnostic efficacy has not been evaluated in our setting.

Identifying patients who require immediate surgery and avoiding the needless risks and expenses of surgery for patients who do not have appendicitis are the two main objectives of an optimal grading system [16]. This study compared the diagnostic characteristics of RIPASA and Alvarado scores using prospectively gathered data on our patients. The purpose of the scoring systems is to facilitate early identification, reduce the number of unfavourable appendectomies, and avoid appendicitis complications across all age groups and genders. The search for the most effective acute appendicitis scoring system in resource-poor sub-Saharan Africa continues.[28].

In this study, RIPASA has a sensitivity of 97.1%, specificity of 71.4%, PPV of 97.1%, NPV of 71.4% and diagnostic accuracy of 94.7% compared to Alvarado's sensitivity of 66.7%, specificity of 57.1%, PPV of 93.9%, NPV of 14.8% and diagnostic accuracy of 65.8%. This shows that RIPASA supersedes Alvarado in diagnosing acute appendicitis here in UATH, Gwagwalada.

Chong et al had reported similar findings in their prospective study in Brunei Darussalam, that RIPASA had a diagnostic accuracy, sensitivity, specificity, PPV, NPV of

91.8%, 98.0%, 81.3%, 85.3% and 97.4% respectively compared to Alvarado which had a diagnostic accuracy, sensitivity, specificity, PPV, NPV of 86.5%, 68.3%, 87.9%, 86.3%, 71.4% respectively [19]. Nanjundaiah N et al reported similarly in their prospective study at Kasturba Medical College Hospital, Mangalore-Karnataka, India [29]. RIPASA had sensitivity, specificity, PPV and NPV of 96.2%, 90.5%, 98.9% and 73.1% respectively. These were higher and better compared to the sensitivity, specificity, PPV and NPV of the Alvarado scoring system which were 58.9%, 85.7%, 97.3% and 19.1% respectively [29].

Erdem H et al [5] had in their study in Turkey compared the diagnostic accuracy of 4 scoring systems (Alvarado, Eskelinen, Ohhmann and RIPASA) in the diagnoses of acute appendicitis among 113 patients. They discovered that though RIPASA had a higher sensitivity of 100% compared to Alvarado's 82%, their diagnostic accuracy was similar i.e. 77% for RIPASA and 80% for Alvarad. Butt et al in their study of 267 patients at the Combined Military Hospital, Kohat, discovered that RIPASA had a sensitivity of 96.7%, specificity of 93.0%, diagnostic accuracy of 95.1%, PPV of 94.8% and NPV of 95.54% and so proposed similarly that RIPASA score at a cut-off total score of 7.5 was a useful tool in diagnosing acute appendicitis [17].

Kurane et al in their study of Modified Alvarado in sixty patients in Belgaum, Karnataka, India reported sensitivity, specificity, PPV, NPV and diagnostic accuracy of 78.26%, 83.78%, 75.00%, 86.11% and 81.00% respectively [23]. These values increased significantly with the use of Ultrasonography to 88.8%, 96.5%, 94.11%, 93.33% and 93.61% respectively. Hence, they advocate the use of Ultrasonography along with clinical scores, especially Alvarado, for all patients. [23].

The negative appendectomy rate (NAR) of 9.2% picked clinicallyin this study is better than the 14.1% reported in Kano, Northwestern Nigeria by Edino et al. [11]. It is, however, similar to 10.9% that was reported at Ile-Ife, Southwestern Nigeria by Ademola et al. [25]. Khan et al had similarly reported a NAR of 15.62% while appraising Alvarado scores alone in Pakistan. Kanumba et al in Mwanza, Tanzania reported 33.1%. Larger rates have been reported and NAR of 15- 34% is generally acceptable by most surgeons [23,30].

Tai-Hsun Huang et al reported a NAR of 5.1% in their series by making use of a CT scan in addition to the patient's clinical features in diagnosing acute appendicitis in Taiwan. [31]. A negative appendectomy rate of 9.2% in our study suggests that applying both Alvarado and RIPASA will reduce cases of needless surgeries, while providing prompt, affordable and effective health care in resource-poor settings like ours. Dependence on expensive imaging techniques with the attendant risks of radiation exposure, especially radiation-induced malignancies in young individuals and pregnant women will be avoided. [30].

XXIII. CONCLUSION

The sensitivity, specificity, and diagnostic accuracy of RIPASA (97.1%, 71.4% and 94.7% respectively) significantly outweigh that of Alvarado's (66.7%, 57.1% and 65.8% respectively). The low negative appendectomy rate (NAR) of RIPASA makes it a good scoring system to be included in our armamentarium of management of suspected cases of acute appendicitis. It is easy to apply. Its addition to our arsenal could improve the delivery of healthcare in sub-Saharan Africa's resource-poor environments. Within the context of this study, the RIPASA scoring system is a more convenient, accurate, and efficient scoring system for our population than the Alvarado scoring system. The RIPASA score, easily determined byfactors from good clinical history, physical examination, and two simple blood assays, is a helpful tool for diagnosing acute appendicitis. Thus, an operating surgeon can make a quick decision when he sees a patient with right iliac fossa pain by determining the RIPASA score. A patient with a RIPASA score > 7.5 is to be operated on, while patients with a RIPASA score < 7.0 can either be observed in the unit's day ward or discharged with an early clinic review appointment. Unnecessary and expensive radiological investigations can be avoided by using RIPASA score and thus reducing health care expenditure [21].

XXIV. RECOMMENDATIONS

As of right now, the RIPASA score outperforms the Alvarado score for acute appendicitis diagnostic scoring; in our study,the RIPASA score achieved significantly higher sensitivity and diagnostic accuracy. By gathering a thorough medical history, doing a clinical examination, and conducting investigations, we can obtain information about seventeen fixed parameters of the RIPASA score. Using the RIPASA score can also help prevent costly imaging studies and unwanted admissions. As a diagnostic aid, it can help young surgeons and emergency physicians. The present study validates that the RIPASA scoring system performs better than the Alvarado scores. We recommend the inclusion of RIPASA in our armamentarium of management of patients with suspected appendicitis in our setting.

XXV. FINANCIAL IMPLICATION AND FUNDING

XXVI. LIMITATION

This is a single centre-based study in Abuja, north-central Nigeria. A prospectivemulti-centre study will go a long way in further establishing the gains in using RIPASA scores for the diagnosis of acute appendicitis.

REFERENCES

[1]. Liang MK. The art and science of diagnosing acute appendicitis. South Med J. 2005;98(12):1159–61.

[2]. Williams R, Mackway-Jones K. White cell count and diagnosing appendicitis in adults. Emerg Med J. 2002;19(5):429–30.

[3]. Favara G, Maugeri A, Barchitta M, Ventura A, Basile G, Agodi A. Comparison of RIPASA and Alvarado scores for risk assessment of acute appendicitis: A systematic review and meta-analysis. Garzali IU, editor. PloS One. 2022;17(9): e0275427–e0275427.

[4]. Shogilev DJ, Duus N, Odom SR, Shapiro NI. Diagnosing appendicitis: evidence-based review of the diagnostic approach in 2014. West J Emerg Med. 2014;15(7):859–71.

[5]. Erdem H, Aktimur R, Cetinkunar S, Reyhan E, Gokler C, Irkorucu O, et al. Evaluation of mean platelet volume as a diagnostic biomarker in acute appendicitis. Int J Clin Exp Med. 2015;8(1):1291.

[6]. Cole MA, Maldonado N. Evidence-based management of suspected appendicitis in the emergency department. Emerg Med Pract. 2011;13(10):1–29.

[7]. Wray CJ MD, Kao LS MD, MS, Millas SG MD, Tsao K MD, Ko TC MD. Acute Appendicitis: Controversies in Diagnosis and Management. Curr Probl Surg. 2013;50(2):54–86.

[8]. Chouhan GM, Sharma MK. Application ofAppendicitis Inflammatory Response (AIR) Scoring System for diagnosis of Acute appendicitis and its comparison with Alvarado score. Int J Med Biomed Stud. 2021 [cited 2024 Jan 19];5(2).

[9]. Ghumro RA, Parveen S, Ahmed T, Hanif K, Khowaja A. Comparative Study Between Karaman Score and Modified Alvarado Score for Predictability in Avoiding Negative Appendectomy in the Suspected Cases of Acute Appendicitis. Pak J Med Health Sci. 2022;16(10):535–535.

[10]. Çetinkaya E, Bayazıtlı ŞM, Göktaş A, Akın T, Akgül Ö, Er S, et al. A new, simple marker for predicting complicated appendicitis in patients with normal white blood cell count indicator; LUC%. Turk J Trauma Emerg SurgeryUlusal Travma Ve Acil Cerrahi Derg. 2023 [cited 2023 Oct 5];29(8).

[11]. Edino ST, Mohammed A, Ochicha O, Anumah M. Appendicitis in Kano, Nigeria: A 5-Year Review of Pattern, Morbidity and Mortality. Ann Afr Med. 2004;3(1):38–41.

[12]. Khan I, ur Rehman A. Application of Alvarado scoring system in diagnosis of acute appendicitis. J Ayub Med Coll Abbottabad. 2005 Jul 1;17(3):41–4.

[13]. Nance ML, Adamson WT, Hedrick HL. Appendicitis in young children: a continuing diagnostic challenge. Pediatr Emerg Care. 2000;16(3):160–2.

[14]. Gerall CD, DeFazio JR, Kahan AM, Fan W, Fallon EM, Middlesworth W, et al. Delayed presentation, and sub-optimal outcomes of paediatric patients with acute appendicitis during the COVID-19 pandemic. J Pediatr Surg. 2021;56(5):905–10.

[15]. Gweon TG, Huh CW, Ji JS, Kim CH, Kim JJ, Park SM. Comparison of bowel-cleansing efficacy of split-dose and same-day dose bowel preparation for afternoon colonoscopy in patients with gastrectomy: a prospective randomized study. Surg Endosc Interv Tech. 2020 Oct;34(10):4413–21.

[16]. Sammalkorpi HE, Mentula P, Leppäniemi A. A new adult appendicitis score improves diagnostic accuracy of acute appendicitis - a prospective study. BMC Gastroenterol. 2014 Jun 26;14(1).

[17]. Fugazzola P, Ceresoli M, Agnoletti V, Agresta F, Amato B, Carcoforo P, et al. The SIFIPAC/WSES/SICG/SIMEU guidelines for diagnosis and treatment of acute appendicitis in the elderly. World J Emerg Surg. 2020 Dec;15(1):19.

[18]. Van Dieijen-Visser MP, Brombacher PJ. The Value of Laboratory Tests in Patients Suspected of Acute Appendicitis. Clin Chem Lab Med. 1991 [cited 2023 Oct 5];29(11).

[19]. Chong CF, Thien A, Mackie AJA, Tin AS, Tripathi S, Ahmad MA, et al. Comparison of RIPASA and Alvarado scores for the diagnosis of acute appendicitis. Singapore Med J. 2011;52(5):340–5.

[20]. Al-Hashemy AM, Seleem MI. Appraisal of the modified Alvarado Score for acute appendicitis in adults. Saudi Med J. 2004;25(9):1229.

[21]. Asad S, Bashir R, Ahmed W, Jalal-ud-din M, Afzal MZ, Khan SA. Frequency of histologically confirmed acute appendicitis in clinically diagnosed cases. Pak J Surg. 2023 Jan;39(1):230–3.

[22]. Khanafer I, Martin DA, Mitra TP, Eccles R, Brindle ME, Nettel-Aguirre A, et al. Test characteristics of common appendicitis scores with and without laboratory investigations: a prospective observational study. BMC Pediatr. 2016 Dec;16(1):147.

[23]. Kurane SB, Sangolli MS, Gogate AS. A one-year prospective study to compare and evaluate diagnostic accuracy of modified Alvarado score and ultrasonography in acute appendicitis, in adults. Indian J Surg. 2008;70(3):125–9.

[24]. Gwagwalada. In: Wikipedia [Internet]. 2023 [cited 2023 Dec 17]. Available from: https://en.wikipedia.org/w/index.php?title=Gwagwalada&oldid=1174794340

[25]. Ademola TO, Oludayo SA, Samuel OA, Amarachukwu EC, Akinwunmi KO, Olusanya A. Clinicopathological review of 156 appendicectomies for acute appendicitis in children in Ile-Ife, Nigeria: a retrospective analysis. BMC Emerg Med. 2015;15(1):7–7.

[26]. Noureldin K, Ali AAH, Issa M, Shah H, Ayantunde B, Ayantunde A, et al. Negative appendicectomy rate: incidence and predictors. Cureus 2022 [cited 2023 Oct 5];14(1).83349

[27]. Alatise O, Ogunweide T. Acute Appendicitis: Incidence and Management in Nigeria. J Obafemi Awolowo Univ Med Stud Assoc IFEMED. 2008 Sep 8.

[28]. Ahmed SA, Mohammed U, Sanda RB, Makama J, Shehu MS, Ameh EA, et al. Schistosomiasis of the Appendix in a tertiary hospital in Northern Nigeria: A 22-Year Review. J Lab Physicians. 2014;6(1):018–21.

[29]. N N, Mohammed A, Shanbhag V, Ashfaque K, S A P. A Comparative Study of RIPASA Score and Alvarado score in the diagnosis of Acute appendicitis. J Clin Diagn Res. 2014;8(11):NC03–5.

[30]. Kanumba ES, Mabula JB, Rambau P, Chalya PL. Modified Alvarado Scoring System as a diagnostic tool for Acute Appendicitis at Bugando Medical Centre, Mwanza, Tanzania. BMC Surg. 2011 Feb 17;11(1).

[31]. Huang SM, Yao CC, Tsai TP, Hsu GW. Acute appendicitis in situs inversus totalis. J Am Coll Surg. 2008;207(6):954.