VALIDATION OF MODIFIED ALVARADO SCORE IN HARGEISA GROUP HOSPITAL (HGH) SOMALILAND: DIAGNOSTIC ACCURACY IN ACUTE APPENDICITIS

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2015

DECLARATION

I declare that this dissertation is my own original work and has not been presented at any other University.

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This research dissertation has been presented at the department of surgery meeting and is hereby approved for presentation to the Kenyatta national hospital ethics and research committee

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DEDICATION

I dedicate this work to my loving family. Deep gratitude goes out to my wife for her unwavering support and encouragement.

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I give all honour to ALLAH for this wonderful opportunity to pursue my dreams.

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LIST OF ABBREVIATION

AA	Acute appendicits
CRP	C - reactive protein
CO	Clinical Officers
CT	Computed tomography scan
ERC	Ethics and Research Committee
HGH	Hargeisa Group and Teaching Hospital
IQR	Interquartile Range
KNH	Kenyatta National Hospital
MAS	Modified Alvarado scoring system
MO	Medical Officers
NPV	Negative predictive value
PPV	Positive predictive value
RIF	Right Iliac fossa
ROC	Receiver Operating Characteristic
SD	Standard Deviation
SPSS	Statistical package for social sciences
UON	University of Nairobi
US	Ultrasonography

ABSTRACT

Background: In the diagnosis of Acute appendicitis (AA), its clinical supported by laboratory and radiologic investigation. Confirmatory (Gold standard) test is histopathology. There is need for an easily available protocol pre-operatively to improve the analysis of severe appendicitis. Numerous scoring systems have been introduced in the literature. The Modified Alvarado scoring (MAS) system is one of the validated tools used in the diagnosis of acute appendicitis in several centers; it has not been validated in the Hargeisa Group Hospital.

Objective: To establish diagnostic validity of the modified Alvarado score in the diagnosis of acute appendicitis at the Hargeisa Group Hospital (HGH).

Methodology: This was a prospective cross sectional study carried out for seven months at Hargeisa Group Hospital general surgical unit. Patients with possible acute appendicitis who met the inclusion criteria were included. They were scored using the MAS system, and were categorized into 3 groups. ***Group A:*** patients scoring 7 and above, ***Group B***: patients with a score of 4-6, and ***Group C***: patients with a score of less than 4. Further investigation with ultrasound was performed in Group B. Those having ultrasonic features of appendicitis were operated on; those not having ultrasonic features of appendicitis were observed for at least 48hours. If they improved, they were followed up for 7 days as those in group C. In order to verify the diagnosis, confirmation was based on histopathology. Data was collected in a structured pretested questionnaire. Statistical analysis was performed using the statistical package for social sciences (STATA 12/SPSS 21.0). The sensitivity, specificity, positive predictive value and negative predictive value of the modified Alvarado score, and the MAS combined with US in acute appendicitis were determined. Graphs, tables and pie charts were employed for results presentation.

Results: In the seven month period from March 2016 to September 2016, 100 patients were studied . The male to female ratio was 1.2:1 the peak incidence of AA was in the third decade with a mean age of 31.7 years. The sensitivity, specificity, PPV and NPV values of the diagnostic protocol were 100%(95% CI, 96.2.5-100*), 50 %(95% CI, 18.7 – 81.3), 94.7%(95% CI, 88.1 – 98.3) and 100 % (95% CI, 47.8 – 100*) respectively, where (*) is one sided 97.5% CI. The calculated crude negative appendectomy rate with the protocol factored in was 10%. The overall accuracy of the protocol in the diagnosis of acute appendicitis was 95%.

Conclusion: The Modified Alvarado Score is a noninvasive, secure analytical procedure and are basic, quick, consistent & repeatable apparatus to utilize in emergency units to part in acute appendicitis. It can aid clinicians in this setup specially juniors to diagnose appendicitis. This study suggests MAS application in order to increase the diagnostic sureness of clinical examination in diagnosis of AA especially by junior doctors and interns in HGH setting.

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INTRODUCTION

Acute appendicitis (AA) is a relatively common abdominal surgical emergency with a lifetime prevalence of 14.3%[1]. The diagnosis is primarily made clinically and may only be correct in 80% of the patients[2]. As the consequences of a missed diagnosis are increased morbidity and mortality, the surgical practice has been to operate on uncertain cases rather than to wait and see. As a result of this, there is a 20 to 30 % negative appendectomy rate which is commonly considered acceptable[3]. In the present day, this concept is being challenged due to quality assurance issues. Diagnostic aids exist however it is often inaccessible in resource limited environments. Scoring systems have been introduced to improve diagnostic accuracy. The modified Alvarado scoring system (MASS) is easy to apply and is based on clinical assessment and a limited number of laboratory tests[4,5,6] This tool has not been validated at Hargeisa Group Hospital. The aim of this study was to validate the modified Alvarado score system in the diagnosis of acute appendicitis at Hargeisa Group Hospital.

LITERATURE REVIEW

Acute Appendicitis is the most common acute abdominal condition around the world[7,8]. Naaeder from Ghana, and Mungadi, in an audit of pediatric surgical crises from Ethiopia, observed that appendectomy was the most commonly encountered abdominal surgical case in their clinics[9,10]. Awori from Nairobi found out that a ruptured appendix was at 63% of patients who presented with acute abdomen[11]. In the investigation of Asefa from Ethiopia, a ruptured appendix was the second most common cause of acute abdomen[12]. The rate may diminish to some degree in facilities where ectopic pregnancy surgery and cesarean section are incorporated into the measurements[11]; however, AA represents a significant proportion of patient with acute abdomen in Africa today.

To distinguish between acute appendicitis and other non-specific abdominal pain clinically, the most common instruments used are scoring systems[13]. The Modified Alvarado Scoring system that is based on clinical assessment, laboratory tests, and it is very easy to apply [14]. In addition to scoring systems, ultrasonography (US) is also important in the diagnosis of acute appendicitis; it was first described by Puylaert in 1986. [16,17] The sensitivity and specificity of ultrasound in the diagnosis of acute appendicitis is about 94.7% and 88.9%, respectively[18].

Appendectomy is preferred course of action once a diagnosis of AA is made clinically; however, morbidity is significant as a result of negative appendectomy rate of 20 to 30%. [3,15] This has traditionally been considered acceptable due to differences in surgeon experience [3,18]. The sensitivity of clinical assessment in AA ranges between 71% - 97% and depends upon the experience of the surgeon as established by John et al[19,20]. Both the CRP and the Alvarado score estimations were quoted as being of significant worth when applied by junior doctors [20].

Different scoring systems have been updated to help with enhancing diagnostic performance, examples include: Alvarado, Teicher, Christian, Fenyo and Lindberg.[4,14,20]

Modified Alvarado score (MAS)

This is a clinical scoring scheme applied in the diagnosis of appendicitis; it takes in account three symptoms, three signs and single laboratory test in table 1. Patients are classified into groups according to their score card. Patients who score 1-3 are unlikely to have acute appendicitis; patients scoring 4-6 could have appendicitis. Patients scoring above 7 are assumed to suffer from acute appendicitis and undergo emergency surgery [21, 22] .

Table 1 Modified Alvarado score (MAS)

SYMPTOMS	**SCORE**
Migratory of right iliac fossa pain	**1**
Anorexia	**1**
Nausea and vomiting	**1**
SIGNS	
Tenderness of iliac fossa	**2**
Rebound tenderness	**1**
Elevated temperature	**1**
RESEARCH LABORATORY FINDINGS	
Leukocytosis (>10,000)	**2**
Total points	**9**

This has been validated in many settings[23], and there exists little dissention on dealing with patients who score 7 and above. A high MAS score is a simple guide in the diagnosis of acute appendicitis; however, there is high false positive rate of 33% among women compared to 22% in other groups. [24]

A prospective study by Ongaro at KNH in 2005 showed that the use of MAS in patients suspected to have acute appendicitis provides a high degree of diagnostic precision and subsequently there is a 25% to 11.2% reduction rate of negative appendicectomy rate; the sensitivity of the scoring system was found to be 91 %. [25,26] A study of 127 patients by Kanumba et al at Bugando Medical Centre in 2011 had negative Appendectomy rates of 33.1%. A study by Khan and Rehman in 100 patients, found a negative Appendectomy rate of 15%, and they recommended that MAS was very easy and simple way to diagnose AA particularly for junior surgeons who are less experienced [27,28].

Ultrasonography (US) in appendicitis

In 1986, Fitz and Puylaert described the use of ultrasound in diagnosing acute appendicitis. The sensitivity of ultrasound is about 88% and 83% respectively as indicated by a meta-analysis[28]. These qualities make US a great “rule in” test to certify acute appendicitis. Balthazar compared ultrasound with computed tomography (CT) scanning; the CT had better accuracy, negative predictive value (NPV), and sensitivity [29].

US’s inferior sensitivity in comparison to CT (76% for US, 96% for CT) does not empower it to be used as a “rule out" test, calling for more tests if the ultrasound result is not positive for appendicitis. The parameters used for diagnosis of AA included: an external diameter of at least 6mm, aperistalsis, non-compressibility and peri-appendiceal fluid.

As an imaging modality, ultrasonography is available at referral centers in Somaliland. However, it is not available in most district hospitals. It is available in private facilities across Somaliland.

Ultrasound fundamentally decreases the negative laparotomy rate to 8-15%.

At HGH, the Modified Alvarado score has not been adopted as the standard way of diagnosing acute appendicitis, hence, this study.

Study Question

What is the negative appendectomy rate in Hargeisa Group Hospital following the utilization of the modified Alvarado score ?

Study Justification

In Africa, roughly 6% of the population will experience acute appendicitis in their lifetime[27].

Diagnosis of acute appendicitis mostly depends on the experience of the clinician, and in Hargeisa Group Hospital, the majority of them are clinical officers (CO) and less experienced medical officers (MO). In Kenya, the negative appendectomy rate in is between 12.5% - 25% overall and it is higher in women.[32]; In Somaliland, there is no data.
The availability of a validated tool to help in the diagnosis of acute appendicitis is therefore highly desirable in all HGH.

The Modified Alvarado Score has been validated elsewhere and it is simple and cheap. This study sought to validate the modified Alvarado scoring systems at the HGH.

Study Objectives

Main objective

To determine the validity of modified Alvarado score system to diagnose acute appendicitis at Hargeisa Group Hospital (HGH).

Specific objectives

1. To determine the sensitivity, specificity, negative predictive value, and positive predictive value of modified Alvarado scoring system for the diagnosis of acute appendicitis at HGH.
2. To assess the Receiver-operating characteristic (ROC) of MAS (with and without US) for the diagnosis of acute appendicitis at HGH.

MATERIALS AND METHODS

Study Design and duration:

This was a prospective analytical study conducted over seven months

Study Area

Somaliland is located northwest of Somalia. It borders Djibouti to the Northwest, Ethiopia to the South-west and Puntland region to the east. It has an area of 137,600km square. The population of Somaliland is 3.5million; it has twelve regions, six have a regional hospital.

Figure 1 Study Area

Hargeisa group hospital is the largest and it is a referral hospital. The hospital was established in 1953 to serve a population of 30,000, but now serves more than 3 million. It offers primary and specialty care. The surgical department in this Hospital has male, female and pediatric wards. It's run by visiting surgeons and experienced medical officers. It has a total of 3-4 permanent doctors. Surgeons perform more than 1800 surgeries in four operating rooms each year.

The study was carried out in the accident/ emergency and surgical wards in Hargeisa Group and Teaching Hospital (HGH). The diagnosis of AA is mainly dependent on ultrasound with or without clinical findings in this center.

Study population:

Patients Five years old and above who are suspected of having acute appendicitis seen both at the emergency division and the surgical wards.

Exclusion criteria

- Those who had generalized peritonitis
- Patients with past abdominal surgery
- Patients with abdominal trauma
- Patients who declined to be involved in the study.

Sample Size

An assumption of the prevalence negative laporotomy was made of 30% from studies in Kenya by Mungai and mwangi.[21] Buderer's mathematical formula was incorporated to obtain the correct sample size for given data values of specificity, sensitivity and complete accuracy:

$$\text{Sample size ( )based on sensitivity} = \frac{Z^2_{1-\alpha/2} \text{ X } S_N \text{ X } (1-S_N)}{d^2 \text{ X Prevelance}} \text{ and,}$$

$$\text{Sample size (n)based on specificity} = \frac{Z^2_{1-\alpha/2} \text{ X } S_P \text{ X } (1-S_P)}{d^2 \text{ X } (1-\text{Prevalance})}$$

Where;

S_N= expected sensitivity

S_P=expected specificity

$Z_{1-\alpha/2}$= 95%, 1.96 statistical confidence

d = complete accuracy anticipated (half the confidence interval width)

The prevalence estimates for appendicitis is taken to be 30%, an average for the Somalia (24.9%) and Kenya's (35%) an average of retrospective and prospective arms of a study carried out in Kenya setup. Taking the sensitivity and specificity of the score, the ultrasound and/or both combined to be above 70% [22], calculation is done for the required sample size for 0.1 value of precision.

For sensitivity or specificity above 90%, sample sizes of about **100** or even less will achieve a considerable precision of 10%. Using the formulae above Malhotra and Indrayan (2010) have developed a nomogram where different samples sizes can easily be read of the scale for different values of prevalence, sensitivity and precision.

Recruitment

Patients over 5 years who were suspected of having AA were enrolled at the accident and emergency section of HGH as well in the surgical ward over a period of seven months between March and September 2016. Consent from minors (below 18years of age), was obtained from the guardian or parents, by medical officers (MOs) on duty or me (investigator). The MO interviewed and examined the patients and on suspecting acute appendicitis filled the MAS form (see appendix VI and VII) and completed this form after the result (Appendix VIII).

Patients who scored 7 and above (emergency Surgery Group) had an open appendectomy while those who scored between 4 and 6 (Observational Group) had ultrasonography. Those who scored 3 and below on the MAS were discharged home or managed as established patient care protocol for the hospital. They were not included in the analysis. The ultrasound was performed based on radiology protocols in radiology department of HGH. Appendectomy was performed at the surgical theaters based on established surgical protocols in HGH. The intraoperative findings

were recorded in the patients file. Handling, processing, and reporting on the appendicular specimen was performed at Hargeisa Diagnostic center or Needle pathology center, which is a collaborating institution with HGH. Postoperative management proceeded as is standard in the surgical wards. The confirmation of diagnosis was based on the histopathology findings of the specimen of appendix. Histopathology findings were recorded as acute appendicitis regardless of whether the actual findings are reported as catarrhal, phlegmonous or gangrenous. A histopathology report was regarded as the true positive (Gold standard) and formed the basis for calculation of negative appendectomy rate, sensitivity, specificity, PPV, NPV and accuracy in this study.

Data Management And Analysis

Data was collected and recorded on data sheet (Appendix VI) by two trained MOs who works in this center and one theatre technician who was responsible for specimen collection. The MAS was calculated and the findings of US were recorded into a standard data sheet. The data was consequently entered into a custom-made Microsoft Access database containing in-built checks to reduce error during data entry process. STATA version 12/SPSS version 21.0 was used to do Statistical analysis.

Ethical Considerations

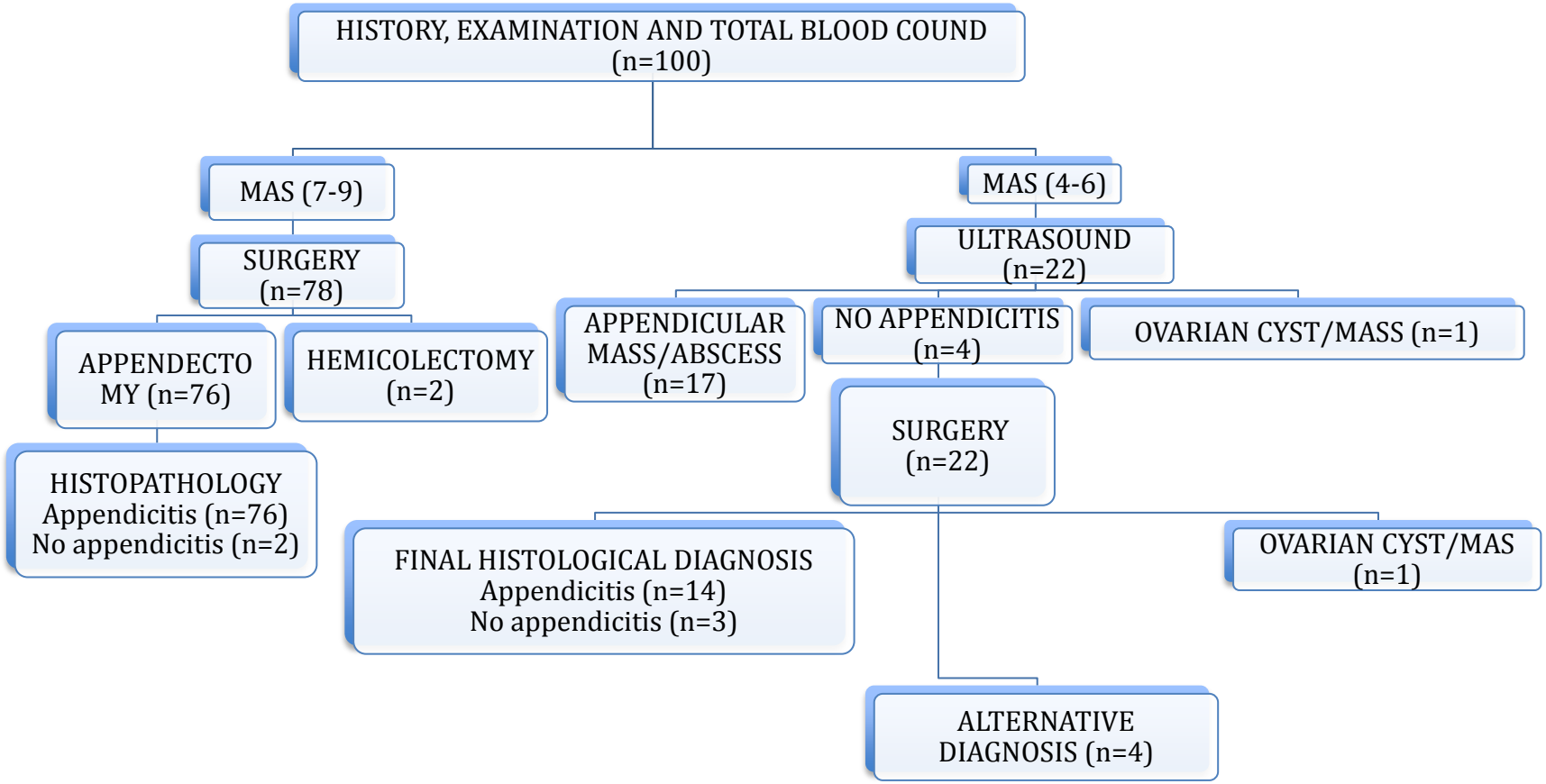
The Kenyatta National Hospital/University of Nairobi – Ethics and Research Committee (KNH/UoN-ERC), the University of Hargeisa as well as Hargeisa Group Hospital (HGH) Ethics and Research Committee under ministry of Health and Labor in Somaliland all approved the study. This study data is the property of University of Nairobi because the study is performed as part of the degree offered at the University but is also a property of the HGH given the patients

are from the hospital and the data was collected by the permission of the administration. Patients between 7 – 17 years of age gave an **informed assent** before seeking an informed consent from their parents/guardians. (Appendix V). The laboratory test and Ultrasound scan are considered standard investigations.

RESULTS

In the seven months period between March 2016 and September 2016 a total of 100 patients were recruited into the study.

Figure 2 The patient flow chart during the study is as shown in Figure 2



Baseline demographic patient characteristics

This study included 100 patients,the male to female ratio was 1.2:1. The ages ranged from 14 to 80 years with a median age being 28 years. The mean age is 31.7 years (SD= 15.4). Table 2 and figure 3 summarize the baseline demographic characteristics.

Figure 3 Distribution of patient population by gender

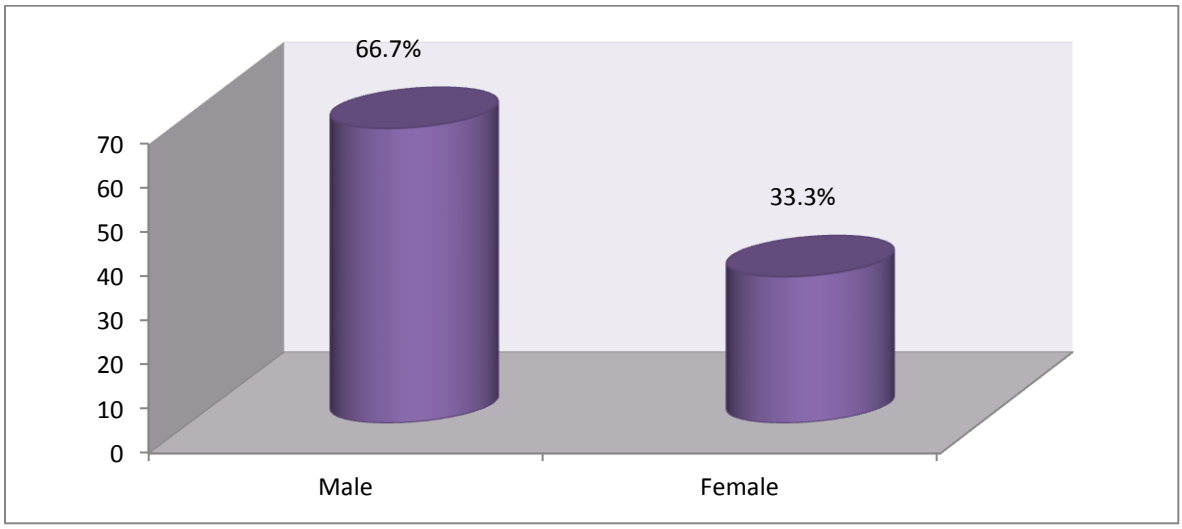
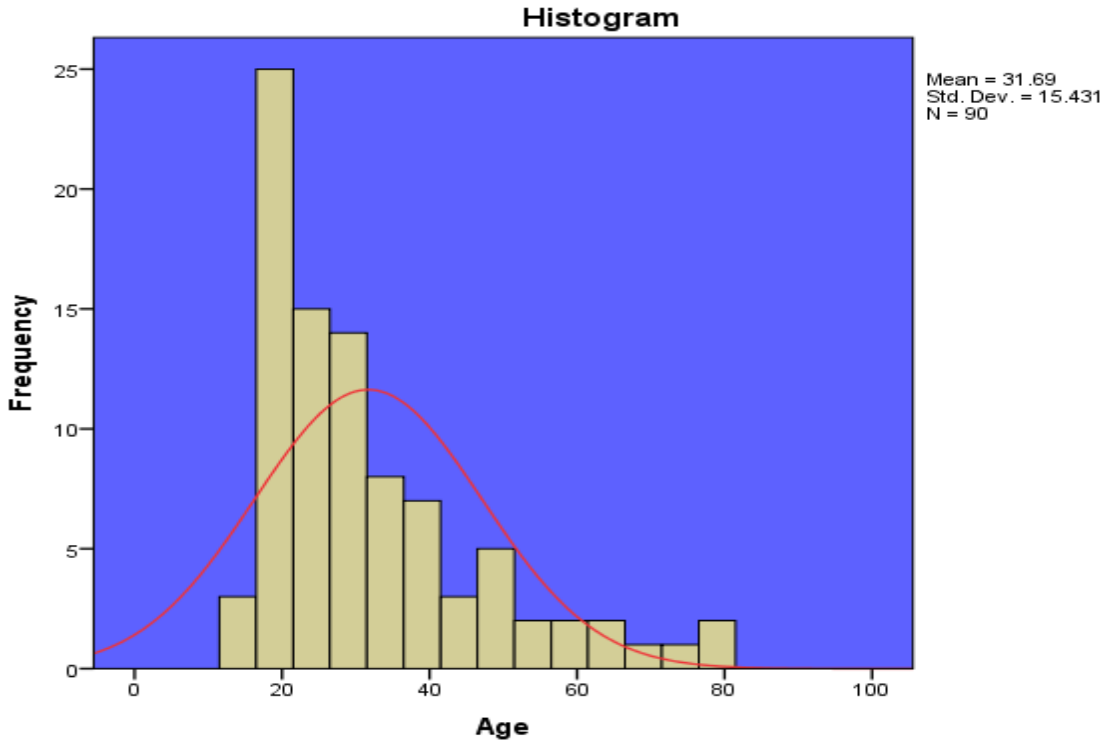


Table 2. Measures of central tendency in the ages of recruited patients

Variable	**Age in years**
Mean (SD)	31.69 (15.4)
Median (IQR)	28.00 (22-35)
Min-Max	14-80

Figure 4 Age distribution by frequency



The frequency graph shows a main peak in incidence of acute appendicitis in the third decade.

Seventy-eight (78%) percent scored above 7 in the modified Alvarado score while 22 (22%) percent fell in the equivocal 4 to 6 range. All the 22 patients in the equivocal range underwent ultrasonography.

Results of patients scored by modified Alvarado score

All 78 patients who scored between 7 and 9 on the modified Alvarado score underwent surgery. 76 out of 78 patients became positive appendicitis on histology. In addition to appendicitis, two patients were found to have carcinoid and Crohn disease.

Table 2 summarizes the findings of the patients who scored above 7 on the MAS based on histopathology of appendectomy specimen and alternate diagnosis at surgery.

Table 3. Results of patients with modified Alvarado score (7-9) seen at surgery for patients (n=78)

	Histopathology Appendicitis	Histopathology Normal appendix	Additional diagnosis at surgery	Total
Positive for appendicitis based on MAS 7-9	76	0	1. Cancinoid tumor 2. Crohn's disease (ileocecal)	
	76 (True positives)	2 (False positives)		78

Positive predictive value = **76/78** (True positives / Total test positives)

PPV=97.4% (95% CI 93.6-100%)

Results of patients with Alvarado score of between 4 and 6

Twenty two patients had a modified Alvarado score of 4 to 6 and were regarded as equivocal. These underwent ultrasonography as per the protocol. Fourteen out of twenty two patients who underwent appendectomy were confirmed as positive on histology. Three patients who diagnosed appendicitis on US become negative on histology. Five patients were found to have alternative diagnoses at surgery as mentioned in table 3.

Results of subset of patients who underwent ultrasonography Diagnosis

A total of 22 patients had Modified Alvarado Score (MAS) between 4 and 6 and therefore underwent ultrasonography. The results indicated that 17 patients had appendicular abscess/mass an indicator of positive appendicitis findings on ultrasonography. Four patients reported no Appendicitis and 1 patient was ovarian cyst mass in US.

On management decision of MAS between 4- 6 patients, exploratory laparotomy was performed on 19 patients, Appendectomy done 17 of them. Three of these individuals were established to have a unusual appendix and therefore had appendectomy. Two cases, intra operative diagnosis indicated ectopic pregnancy in one of the cases and ovarian cyst/mass in the other. Further, 3 patients had acute appendicitis symptoms, intra operatively they were found to have gangrenous gut, gastric perforation and perforated duedonal ulcer (table 3). In these groups, 14 cases were ruled positive appendicitis on final histological diagnosis.

A summary of the findings of ultrasonography in relation to the histopathology findings and alternative intra-operative findings is shown in Tables 3.

Table 4 Findings of ultrasonography for equivocal cases (MAS between 4-6) of suspected acute appendicitis (n=22)

Variable	Histopathology results			Total
	Appendicitis	Normal	Alternative diagnoses	
Ultrasonography Appendicitis	14	3	1. Gangrenous gut 2. Perforated gut 3. Perforated Deudonal ulcer 4. Ectopic pregnancy	
	14 (true positives)	**7**(false positives)		**21**
Ultrasonography No appendicitis	0 (false negatives)	0 (true negatives)	1. Ovarian cyst mass	1
	0 (false negatives)	**1**(true negatives)		**1**
Total	**14**	**8**		**22**

Key: Figures in **bold** used to calculate the performance of the ultrasonography

P=0.002 (McNemar test), Agreement = 74.2%, Kappa=0.239, p=0.056

PPV = 14/21 (true positives / total test positives)

NPV = 1/1 (true negative/ total test negative)

Sensitivity = 14/14 (true positives / true positives + false negatives)

Specificity = 1/8 (true negatives / true negatives + false positives)

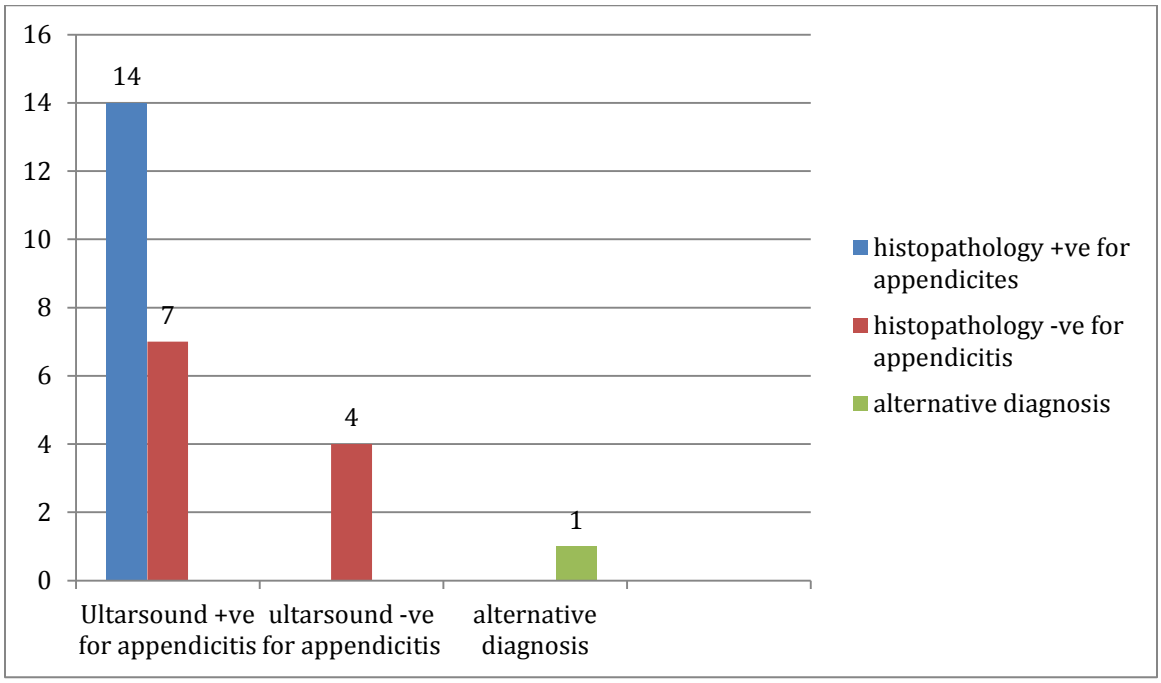
Accuracy = 14+1/22 (true positives + true negatives /total test population)

The calculated PPV, NPV, sensitivity and specificity of ultrasonography are summarized in table 4.

Table 5: Sensitivity, specificity, PPV, NPV and confidence limits for ultrasonography

Measure	Proportion	95% CI	
		Lower	Upper
Sensitivity	100%	76.8%	100%*
Specificity	12.5%	3.2%	52.7%
PPV	66.7%	43.0%	85.4%
NPV	100%	2.5%	100%*
* One sided 97.5% CI			

Figure 4: Summary of ultrasonography findings in comparison to intra-operative and histopathology findings (n=22)



Overall results of patients using modified Alvarado score 4-9

All the 100 patients recruited into the study underwent modified Alvarado scoring. Figure 4 and 5 summarizes the findings of the scoring system compared with histopathology and intra-operative diagnoses.

Figure 5. Overall results of patients using modified Alvarado score 4-9

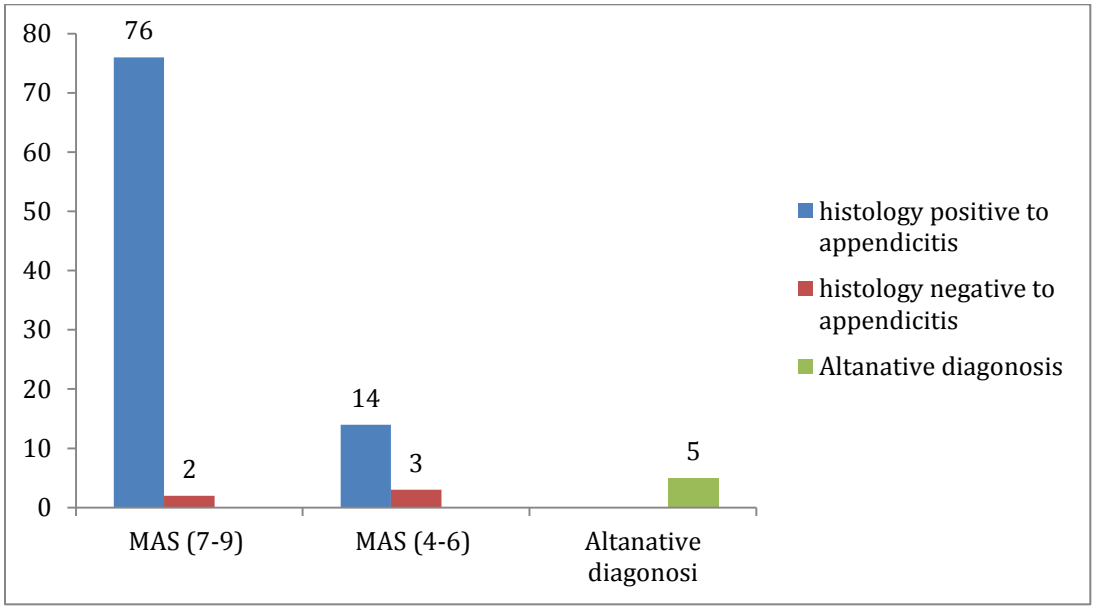


Figure 6: Summary of findings using the protocol of combined MAS and ultrasonography in comparison to intra-operative and Histopathological findings (n=100)

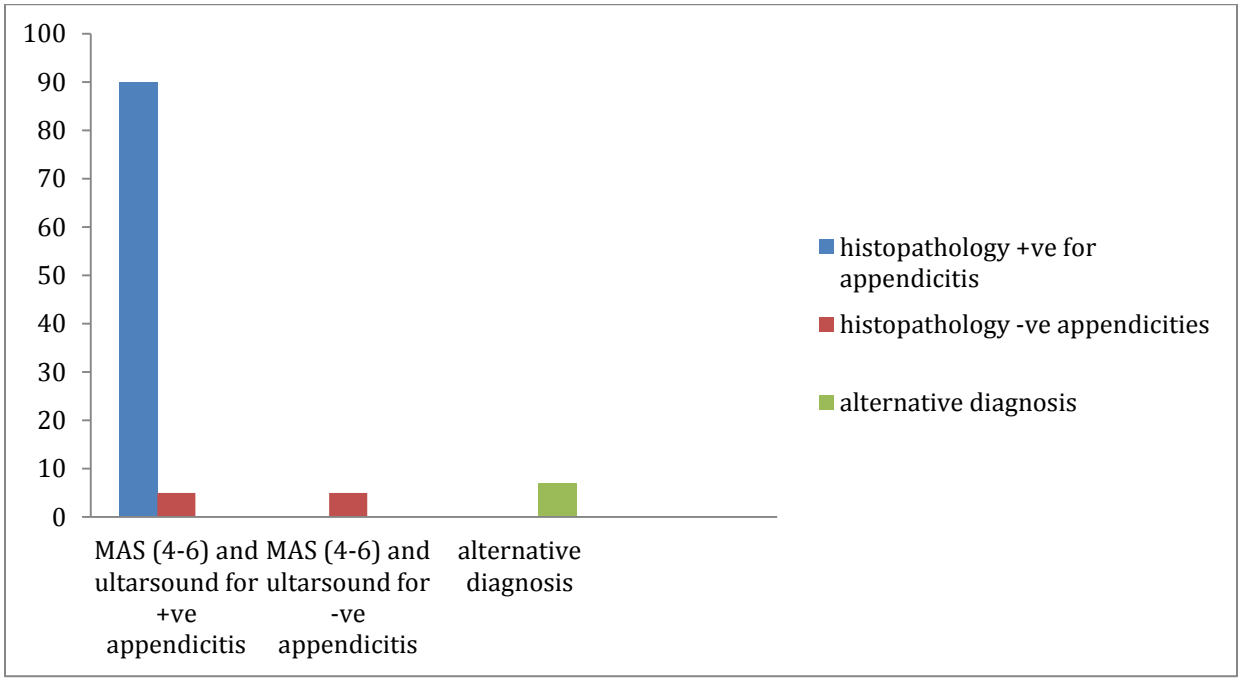


Table 6: Findings of combined MAS and ultrasonography for diagnosis of acute appendicitis (n=100)

MAS+Ultrasonography (diagnostic test)	Histology or alternative diagnoses			Total
	Appendicitis	No appendicitis	(alternative diagnosis)	
Appendicitis	**90**(true positives)	**5** (false positives)	(2)	95
No appendicitis	**0**(false negatives)	**5**(true negatives)	(5)	5
Total	**90**	**10**	(7)	100

P=0.001 (McNemar test), Agreement = 81%, Kappa=0.224, p=0.005

The figures in brackets represent the alternative findings intra-operatively.

Sensitivity=**90/90** (true positives/true positives + false negatives)

Specificity= **5/10** (true negatives/true negatives + false positives)

PPV= **90/95** (true positives/ total test positives)

NPV= **5/5** (true negatives/total test negatives)

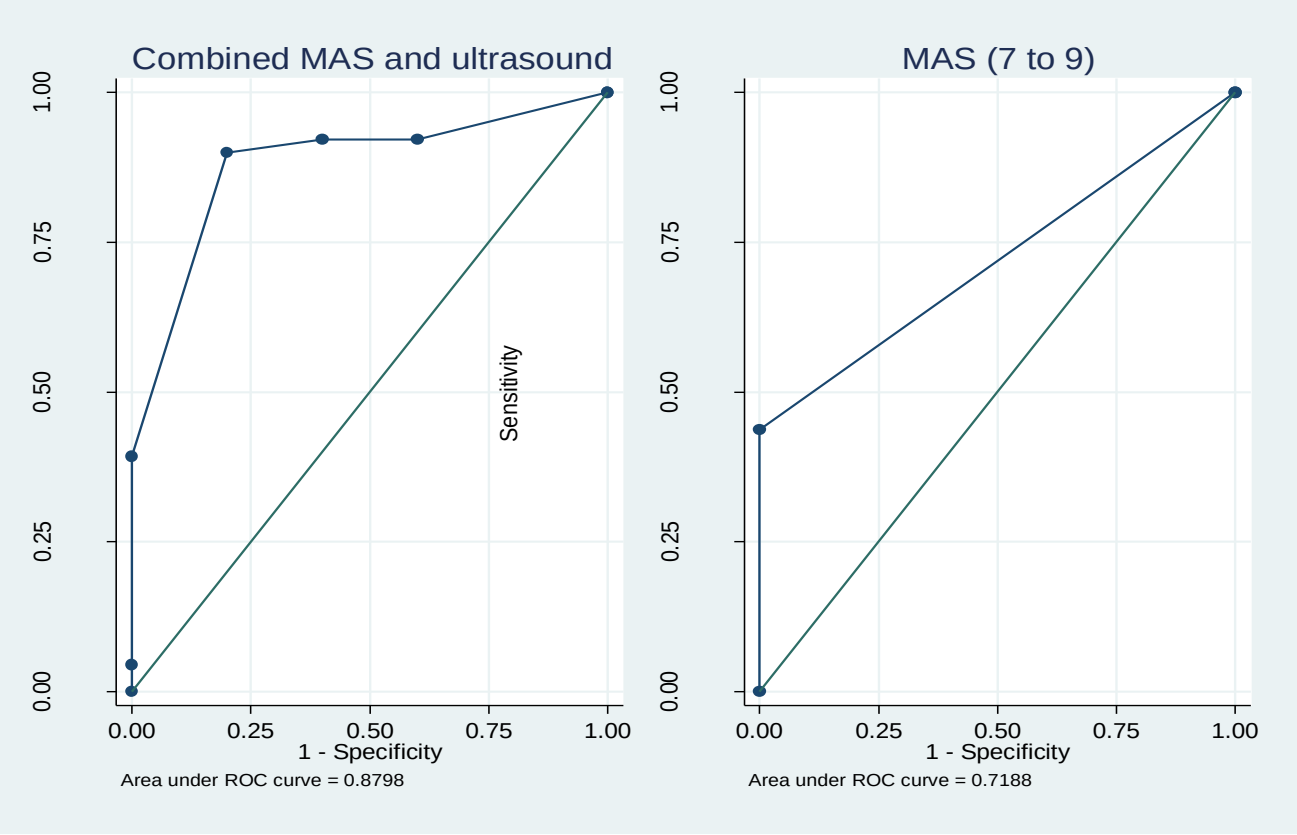
Table 7: Summary of sensitivity, specificity, PPV, NPV and confidence limits for the diagnostic protocol.

Measure	Proportion	95% CI	
		Lower	Upper
Sensitivity	100%	96.2%	100%*
Specificity	50%	18.7%	81.3%
PPV	94.7%	88.1%	98.3%
NPV	100%	47.8%	100%*
*One sided 97.5% CI			

Receiver- operating characteristic curves

Receiver operating curves were drawn using the calculated sensitivities and specificities for a) MAS group (78 patients) and b) the protocol combining MAS and ultrasonography for the study (100 patients). Figure 7 and 8 shows the ROC curve for ultrasonography in the equivocal group**.**

Figure 7. ROC curve for combined MAS and ultrasonography (left side) and MAS group (right side)



The ROC curves for both MAS cases and the protocol combined MAS and US as a whole were 0.718 and 0.88 respectively.

Overall accuracy of the protocol

The sensitivity, specificity, PPV and NPV values of the diagnostic protocol were 100%(95% CI, 96.2.5-100*), 50 %(95% CI, 18.7 – 81.3), 94.7%(95% CI, 88.1 – 98.3) and 100 % (95% CI, 47.8 – 100*) respectively.

Overall accuracy=90+5/100 (true positives+ true negatives / true positives + true negatives + false negatives + false positives)

The overall accuracy of the protocol was 95%.

Negative Appendectomy Rate

The overall crude negative appendectomy rate during the study period was 10%. This was an Analytical observational study and therefore there was no interventional arm. There were 5 patients who, though reported as acute appendicitis by the protocol both MAS and MAS plus ultrasound had no appendicitis on histology. A further 5 patients fell in the category of true negatives; 4 who did not have appendicitis on ultrasonography and 1 patient who had ovarian cyst mass. These were found to be true to the intra-operative diagnosis and histology findings.

Adjusting for use of the MAS and ultrasonography protocol, the total number of patients who would have gone for surgery with acute appendicitis as the diagnoses would have been 95patients (MAS> 7 78pts + 17pts of MAS between 4 – 6). This takes into account the 2 patients who were reported as positive on MAS alone but became negative on histology. Out of the 95 patients, 90 were confirmed as acute appendicitis on histology. The adjusted negative appendectomy rate was calculated as 5.26%.

DISCUSSION

This study set out to validate Modified Alvarado Score at Hargeisa Group Hospital (HGH) Somaliland. One hundred patients were involved in the research over a 7 months period commencing March 2016 to September 2016. The demographic characteristics revealed the ratio of male to female to be 1.2:1 and a peak incidence in the third decade with 31.7 years being the mean age. These findings were similar to two studies done previously at KNH. Ongaro found a

mean age of 27.1 years and a similar interquartile range[26]. Kimaro's study also showed nearly similar findings with a male to female ratio of 1.9:1[32]. A study on the epidemiology of appendicitis in the United States of America surveyed 250,000 patients and a 1.4:1 male to female ratio was obtained. However the peak incidence was in the second decade this differed from the findings in our setup[33]. A survey conducted by Paterson, et al suggested insignificant variance in male to female ratio in the United Kingdom[34].

From the study findings, seventy-eight (78%) patients scored above 7 in the modified Alvarado score while 22 (22%) fell in the equivocal 4 to 6 range. All the 22 patients in the equivocal range underwent ultrasonography. Seventy eight patients who scored between 7 and 9 on the modified Alvarado score underwent appendectomy. In this study 76 (PPV 97.4%) of the patients who were predicted to have appendicitis by a high score had confirmed appendicitis on histopathology. In addition to appendicitis, two patients were found to have carcinoid tumor and Crohn disease on histology. This gave a negative appendicectomy rate of 2.6% on patients having MAS>7 alone, that is different from what Mwangi and Ongaro found in their studies in 2011 and 2007[21,26]. A high Alvarado score was however unable to distinguish between appendicitis and other mimicking diagnosis in 2 cases. A systematic review by Ohle et al found out that a high Alvarado score was less sensitive as a 'rule in' score than as a 'rule out' for those below 4-5[35]. Our study suggests that a high Alvarado score is a useful tool to set aside patients for immediate appendectomy without further diagnostics. This contrasts with a study by Saidi and Chavda that suggested that the scoring system has no value over clinical acumen[36].

The study also established that Twenty two patients had a modified Alvarado score of 4 to 6 and were regarded as equivocal. These underwent ultrasonography as per the protocol. Fourteen out

of twenty two patients who underwent appendectomy confirmed as positive appendicitis on histopathology. In this subset of 22 patients, the negative appendectomy rate was above 36%. As has been observed by numerous other studies, this subset has continued to pose diagnostic challenges for the clinician [37].

Combined use of a protocol based on modified Alvarado score and ultrasonography has been studied and been advocated by a number of authors. The overall results for the protocol based on modified Alvarado score and ultrasound in our study were sensitivity, specificity, PPV and NPV values 100%(95% CI, 96.2.5-100*), 50 %(95% CI, 18.7 – 81.3), 94.7%(95% CI, 88.1 – 98.3) and 100 % (95% CI, 47.8 – 100*).

The crude negative appendectomy rate in our study was 10%. This indicates a better performance than what has been generally accepted over the years, with negative appendectomy rates being about 18% and 20% by Mbuthia and Jones[21,35]. A study by Emmanuel et al in Tanzania had an overall negative appendectomy rate of 33.1%[27]. Khan and Rehman found a negative appendectomy rate of 15.6%. They advocated for the scoring system as an easy, cheap and complimentary tool for diagnosis of appendicitis. [22,27]. A study by Stephens and Mazucco achieved a false positive of zero by combining modified Alvarado score and ultrasonography[1]. Debnath et al showed that graded compression ultrasonography was an accurate means of diagnosing or excluding appendicitis in clinically equivocal cases [39]. In our study the specificity was lower and therefore ultrasonography could not be advocated as a tool for excluding appendicitis. However the positive predictive value and high sensitivity suggest that the use of the combined protocol is a good tool to enable the clinician to make a timely decision.

The area under ROC curve was 0.71 when data for which MAS >7 was used in analysis and increased to 0.88 (above 0.5), when MAS was combined with ultrasonography overall including those MAS <7. Therefore, the protocol can usefully distinguish between patients with and without AA. This study thus provides evidence of the validity of MAS > 7 in diagnosing Acute Appendicitis. As was expected the AUC improved with use of a combination of ultrasonography with a group of MAS <7).

Conclusion and Recommendations

Modified Alvarado Score is cheap and easy to use. It has a high sensitivity in our patients as mentioned above. It allows observation & critical re-evaluation of the clinical picture evolution. We suggest its use in order to increase the diagnostic accuracy in the diagnosis of acute appendicitis by clinicians, especially junior doctors, MOs and interns.

The Modified Alvarado Score appeared efficient in male mature patients, while in adult female patients, especially those in child bearing age, additional investigations may be required, so we suggest the provision of (24) hours ultrasound facility to confirm or exclude the possibility of other pathologies in doubtful cases. As this study involved only a small number of children we suggest that a prospective study to be conducted purely on patients within the pediatric age group to evaluate precisely the validity of the Modified Alvarado Score in these cases.

The study demonstrates comparable results of negative appendectomy rate with that quoted in the literature. This suggests that the application of Modified Alvarado Score improves diagnostic accuracy in AA.

Study Limitations

The Ultrasound scans was carried by different sonographers and radiologists and may have caused operator errors. This however, could also be thought of as a strength in the study as it reflected the reality of practice in our set up.

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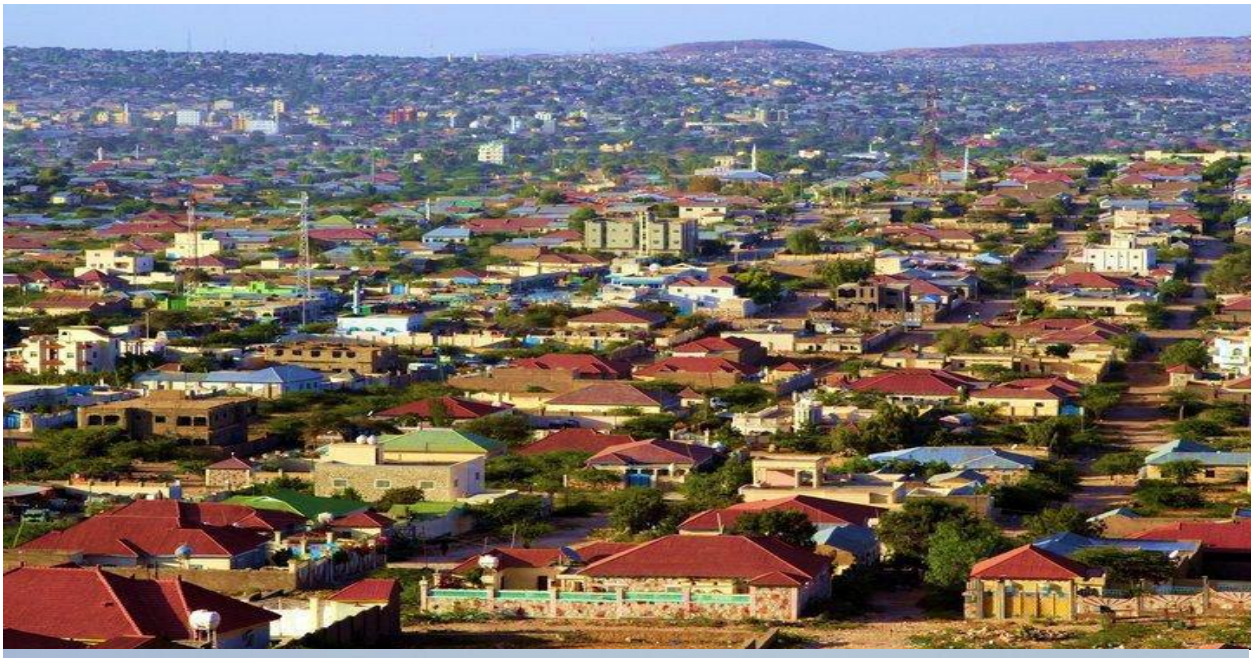
APPENDIX I

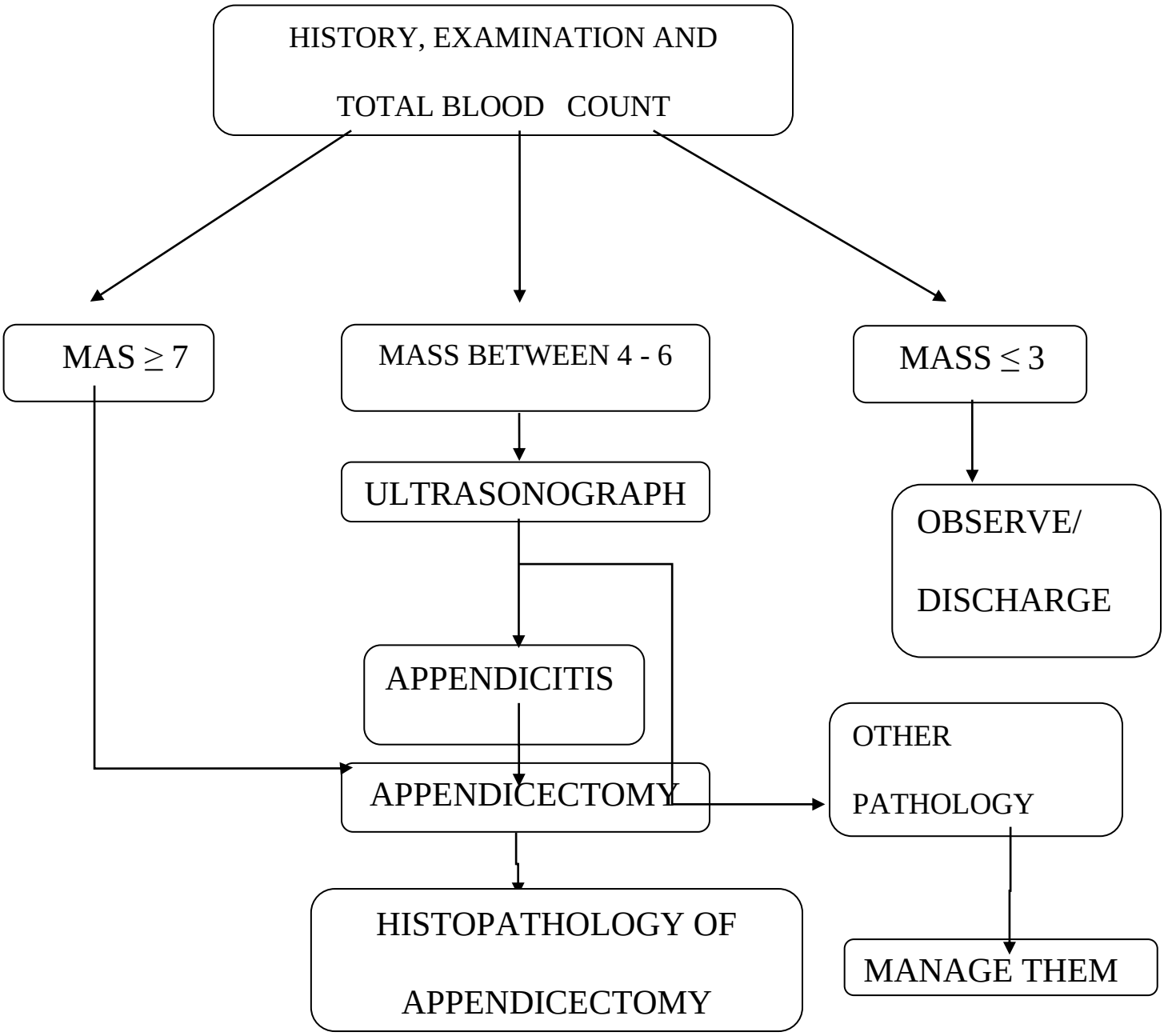
Hargeisa city, Somaliland



Website: *http://hargeisagrouphospital.com/*

APPENDIX II

PATIENT FLOW DIAGRAM



APPENDIX III:

INFORMED CONSENT.

VALIDATION OF MODIFIED ALVARADO SCORE IN HARGEISA GROUP HOSPITAL (HGH) SOMALILAND: DIAGNOSTIC ACCURACY IN ACUTE APPENDICITIS.

English version.

This Informed Consent form is for general surgical patients admitted at the Kenyatta National Hospital surgical wards. This consent will be administered to the patients or next of kin. We are requesting these patients to participate in this research project whose title is "VALIDATION OF MODIFIED ALVARADO SCORE IN HARGEISA GROUP HOSPITAL (HGH) SOMALILAND: DIAGNOSTIC ACCURACY IN ACUTE APPENDICITIS."

Principal investigator: Dr. Mohamed A. Elmi

Institution: Medicine school, - University of Nairobi Department of surgery

Supervisors:

1. Dr Daniel K. Ojuka
2. Dr. Mark N Awori
3. Dr. Ahmed A Abdi

This knowledgeable consent contains the following:

- Information page
- Credential of Consensus
- Declaration by the researcher

You will be issued with the full copy of the Conversant Consent Form.

Part I: Information sheet

Introduction

I am Dr. Mohamed A. Elmi. Currently I am carrying out a study to study the diagnostic correctness of a protocol based on the modified Alvarado score in diagnosis of acute appendicitis at Hargeisa Group Hospital (HGH) surgical wards. The information gathered will be useful both in your treatment and for other patients in future who will present in a similar manner and have suspected acute appendicitis.

Purpose of the Research

The purpose of this survey is to examine the diagnostic validity/exactness of a protocol created on the modified Alvarado score in diagnosis of acute appendicitis at Hargeisa Group Hospital.

Voluntary participation/right to refuse or withdraw

An invitation to contribute towards the study is hereby extended to you. You will have the chance to ask questions before you decide on your participation. You may seek clarification regarding any bit of the study from me should any part be unclear.

Confidentiality

The entire information obtained in regarding yourself or kin will be kept confidential; only the researcher will access this information. The questionnaire will be identified by a number and only the researcher can relate the number to the patient. All the information you give us will be used for research only.

Sharing of the results

The information will not be shared with anyone else unless authorized by the Kenyatta National Hospital/University of Nairobi – Ethics and Research Committee (KNH/UoN-ERC).

This proposal has been reviewed and approved by the KNH/UoN-ERC which is a committee whose work is to make sure research participants are protected from harm.

Risks

This study will not expose you or your kin to any risk.

Cost and compensation

There will be no extra cost incurred for participating in this study nor is compensation offered.

Who to contact

The contact information is given below if you wish to contact any of them for whatever reason;

Secretary, KNH/UoN-ERC

P.O. Box 20723 KNH, Nairobi 00202

Tel (254-020) 2726300-9

Email: uonknh_erc@uonbi.ac.ke

University of Nairobi research supervisors

1. Dr. D. K. Ojuka

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2. Dr. Mark N. Awori

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3. Dr. Ahmed A Abdi

   General Surgeon in HGH

   Lecturer in University of Hargeisa (UoH)

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   Tel # (+252) 634456550

Principle researcher:

Dr. Mohamed A Elmi

Department of Surgery, School of Medicine, University of Nairobi

P.O. Box 19676 KNH, Nairobi 00202

Mobile phone: (+254) 718374593

Part II certificate of consent.

I have read and understood the above information, or it has been read to me. I have also had the chance to probe about it and any questions that I have requested have been answered to my full pleasure. I consent voluntarily to participate as a participant in this research.

Print Name of Participant _____

Signature of Participant _____

Date _____

If Illiterate;

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print Name of witness_____

Signature of witness _____

Date _____

PART III: Statement by the researcher

I have precisely read the information contained in the sheet to the entire participants, and to the best of my ability made sure that the participant understands that the following will be done:

- Refusal to contribute towards the survey will not in any way compromise the care of treatment.
- The entire information obtained will be handled with confidentiality.
- The outcomes of this survey might be printed to facilitate knowledge of protocol based on the MAS in diagnosis of acute appendicitis in general surgical patients at HGH.

I acknowledge that the participant was awarded an opportunity to ask questions related to the study, and satisfactory answers have been given towards the participant questions. The participating individual has not been pressured into giving consent, and the consent has been obtained freely and voluntarily.

A copy of this Informed Consent Form has been provided to the participant.

Name of researcher taking consent _____

Signature of researcher taking consent _____

Date_____

APPENDIX IV:

INFORMED CONSENT

CIWAANKA: VALIDATION OF MODIFIED ALVARADO SCORE IN HARGEISA GROUP HOSPITAL (HGH) SOMALILAND: DIAGNOSTIC ACCURACY IN ACUTE APPENDICITIS.

Somali version.

Foomka ogolaanshaha qaliinka waxaa loogu talo galay bukaanada qaliinka Hargeisa Group Hospital waadhka qaliinka. Saxeexan waxaa samayn doona qofka ka masuulka ah bukaanka. Waxaan kaa codsanaynaa in aad nagala qayb qaadato cilmi baadhistan ciwaankeedu "VALIDATION OF MODIFIED ALVARADO SCORE IN HARGEISA GROUP HOSPITAL (HGH) SOMALILAND: DIAGNOSTIC ACCURACY IN ACUTE APPENDICITIS."

Cilmi baadhaha: Dr. Mohamed A. Elmi

Institution: School of Medicine, Department of surgery- University of Nairobi

Horjoogayaasha :

4. Dr Daniel K. Ojuka
5. Dr. Mark N Awori
6. Dr. Ahmed A Abdi

Foomkan saxeexu waxuu ka kooban yahay 3 qaybood:

- Qaybta sharaxaysa cilmibaadhista si aad u fahanto
- Foomka saxeexa hadii aad aqbasho
- Kalmada ka socota cilmibaadhaha

Waxaa lagu siin doonaa foorma saxeexa oo dhamaystiran

Part I: qaybta sharaxaysa cilmibaadhista

Hordhac

Magacaygu waa Dr. Mohamed A. Elmi. Waxaan ahay nin takhasus ka sameeya qaybta caafimaadka qaliinka ee Jaamacada Nairobi. Waxaan samaynayaa cilmibaadhis ku saabsan qabsinka sida saxda ah ee loo garan karo marka qofka uu xanuunsado. Waxaan ka wadaa cisbitaalka guud ee hargeisa (HGH) waadhadhka qaliinka. Warka aan ka helo cilmibaadhistan waan isku ururin oon ka soo saari mid xaqiiq ah ee sida saxda ah loogu ogaan karo looguna daweyn karo qabsinka adiga ku haya ama mustaqalka qof adiga oo kale ah ku dhaca.

Ujeedada cilmibaadhistan

Ujeedadu waa sidii loo heli lahaa sida ugu dhibta yar een lacagi ku bixin ama loo garan lahaa qabsinka iyadoo la isticmaalaya Modified Alvarado score (MAS) , bukaanada cisbitaalka guud ee hargeisa (HGH).

ka qayb galka cilmibaadhistan/ xuquuq waxaad u leedahay inaad diido hadaanay ku cajibin.

Waxaa kugu marti galinaynaa inaa nagala qayb qaadato cilmibaadhistan. Waxaad I weydiin kartaa su'aalo ku saabsan cilmibaadhistan intaanad go'aan ku gaadhin inaad igala qaybqaadato. Waad raadsan kartaa jawaab hadii wax mugdi ah kaaga jiraan.

Sir

Gabi waxii faahfaahin ee xanuunkaaga iyo adigaba kugu saabsan waxay noqon doontaa sir aan lala wadaagi doonin xitaa qofka kuugu dhow illaa adiga ogolaansho kaa yimaad mooyee. Foomka su'aalaha waxaa lagu cadayn doonaa numberkaaga , cilmibaadhaha ayuunbaana hayn doonaa bukaan numberka. Faahfaahinta kugu saabsan eed na siin doontona waxay noqon mid loo isticmaalo cilmi baadhista uun oo aan cid kale ogaan doonin.

Ogeysiinta natiijada

Sheekadaada eed noo sheegtay ee xanuunka ku saabsan waa sir aan lala wadaagi Karin qof kale ilaa laga helo ogolaansho Kenyatta National Hospital/University of Nairobi – Ethics and Research Committee (KNH/UoN-ERC).

Proposalkan waxaa eegay oo xaqiijiyay oo saxay KNH/UoN-ERC taasoo shaqadoodu tahay inay hubiyaan cilmibaadhistani ina ay tahay mid la ilaaliyay oo dhib ku keenayn bini'aadamka.

Khatarta.

Cilmibaadhistani kuma khashifayso ama khatar kugu ah .

Kharashka / daynta

Wax kharash ah oo kugu kordhayaa ma jiro inta cilmibaadhista laguu wado oon ahayn kharashka cisbitaalka.

Cida aad la xidhiidhayso

Magacyadan hoos ku qoran ayaad la xidhiidhi hadii ay dhacdo inaad u baahato cida cilmibaadhista wada ama aad hayso sababo aad doonayso inaa ogaato;

Secretary, KNH/UoN-ERC

P.O. Box 20723 KNH, Nairobi 00202

Tel (254-020) 2726300-9

Email: uonknh_erc@uonbi.ac.ke

University of Nairobi research supervisors

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   DHL Somaliland, Hargeisa

Tel # (+252) 634456550

Principle researcher:

Dr. Mohamed A Elmi

Department of Surgery, School of Medicine, University of Nairobi

P.O. Box 19676 KNH, Nairobi 00202

Mobile phone: (+254) 718374593

Part II : foomka saxiixa

Waxaan akhriyay waxa xaga sare ku qoran ama waa la ii akhriyay. Su'aalihii aan ka qabay een waydiiyayna si fiican ayaa la iigu jawaabay waanan ku qanacsanahay. kadibna waxa aan si mutadawac nimo leh u aqbalay inaad ka qayb qaato cilmi baadhistan oon saxeexo xagan hoose.

Magaca bukaanka _____

Saxiixa bukaanka _____

Taariikhda _____

Hadii aanuu aqoon lahayn;

Aniga oo ah bukaanka ,sexeexayga hoos Ayaan ku cadeeyey, kadib markaan goobjooge ka ahaa la ina fahansiiyey xogtan kor ku saabsan, kadibna waxa aan si mutadawac nimo leh u aqbalay inaad ka qayb qaato cilmi baadhistan .

Magaca goobjoogaha_____

Saxiixa goobjoogaha _____

taariikhda _____

PART III: kalmada cilmibaadhaha

Waxaan si saxa oo cad ugu akhriyay waxa foomka ku qoran bukaanka ka qayb qaadanaya cilmibaadhistan, waxaan intii karaankay ahaa hubiyay in bukaanku fahmay waxyaabahan hoos ku xusan:

- Hadii uu diido inuu ka qayb qaato cilmi baadhistan inuu wali xaq u leeyahay in uu daawayntii caadiga ahayd loo sameeyo oo aan cilmi baadhistani dhib u keenayn.
- Warkii oo sheegay ee xanuunkiisa ku saabsanaana ay tahay sir aan cid kale ogaan doonin.
- Natiijada cilmibaadhistana ay ahaan doonto mid la daabici doono kaliya in laga faa'iidaysto waxna ka bedesho protocolka ku salaysan in MAS si dhib yar loogu ogaan karo xanuunkan qabsinka ee bukaanada waadhadhka cisbitaalka.

Waxaan cadaynayaa in bukaanka aan siiyay fursad uu iga weydiin karo su'aalo ku saabsan cilmibaadhista , ugana jawaabay si saxa dhamaantood intii karaankaygu ahaa. Waxaanan cadaynayaa in aan bukaanka lagu qasbin inuu ka qayb qaato , una bixiyay oglaansho go'aan isaga ka soo go'ay awgeed inuu ku tabaruco.

Koobi foomka saxiixa ahna la siiyay bukaanka.

Magaca cilmi baadhaha qaadaya saxiixa _____

Saxiixa cilmibaadhaha qaadaya saxiixa _____

Taariikhda _____

APPENDIX V

ASSENT FORM FOR CHILDREN BETWEEN 7 to 17 YEARS

My name is Dr Mohamed A Elmi. I am doing a study about "VALIDATION OF MODIFIED ALVARADO SCORE IN HARGEISA GROUP HOSPITAL (HGH) SOMALILAND: DIAGNOSTIC ACCURACY IN ACUTE APPENDICITIS."

I am carrying out a study to examine the diagnostic correctness of a protocol centered on the modified Alvarado score in diagnosis of acute appendicitis at Hargeisa Group Hospital (HGH) surgical wards. The information gathered will be useful both in your treatment and for other patients in future who will present in a similar manner and have suspected acute appendicitis.

If you agree to participate in my study, you and your mother will be asked some questions, and required to go through a questionnaire with me or my research assistant. You will also undergo a physical examination

There are no risks involved in this study; you will not incur any extra costs for participating in this study.

Other individuals will not know if you are participating in this survey. Your answers and your progress will be kept private. When I present my research to other people, I will not use your name, thus, no one can tell who I am talking about.

Your parents or guardian will have to consent your participation towards the survey. After they decide, you get to decide whether you want to do it too. If you are unwilling to participate towards the study, you will not get into any trouble. You can stop being in the study at any given time.

My phone number is 0718374593. You can contact in the event you have any question about the survey or in case you decide to withdraw from the study. I will provide you with a copy of this form in case you want to ask questions later.

Sign this form only if you:

- Have understood what you will be doing for this study,
- Have had all your questions answered,
- Have talked to your parent(s)/legal guardian about this project, and
- Agree to take part in this research

Parent(s) or Legal Guardian(s)

Name: _____

Signature : _____

Date: _____

Researcher explaining study

Name: _____

Signature : _____

Date: _____

APPENDIX VI

DATA COLLECTION SHEET AND MODIFIED ALVARADO SCORING.

Patient IP. Number: _____ Study No.: _____

Age: _____ Sex: _____

Modified Alvarado scoring

SYMPTOMS	**yes**	**No**	**SCORE**
Migratory of right iliac fossa pain			**1**
Anorexia			**1**
Nausea and vomiting			**1**
SIGNS			
Tenderness of right iliac fossa			**2**
Rebound tenderness			**1**
Elevated temperature			**1**
LABORATORY FINDINGS			
Leukocytosis (>10,000)			**2**
Total points			**9**

APPENDIX VII

ULTRASONOGRAPHY FINDINGS

Name _____ Study number_____

IP number_____ Age ____

Sex ___

	Yes	No
Appendix visualized	☐	☐
Appendix compressible	☐	☐
Appendicular diameter (6mm and above)	☐	☐
Periappendicular fluid present	☐	☐
Peristalsis present	☐	☐
Phlegmon seen	☐	☐

CONCLUSION_____

_____

APPENDIX VIII

CONSOLIDATED FINDINGS FORM

Name: _____ Study no: _____

IP number: _____ Age: _____

Sex: _____

Modified Alvarado score

Ultrasonography diagnosis

Management decision

Intra-operative findings

Final histological diagnosis:

_____