

# **MODIFIED ALVARADO SCORING SYSTEM. HOW MUCH HELPFUL?**

**\*Raid E. Rassam DGS, FICMS**

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## **Abstract**

**Background:-**The Modified Alvarado Scoring System (MASS) has been reported to be a cheap and quick diagnostic tool in patients with acute appendicitis. However, differences in diagnostic accuracy have been observed if the scores were applied to various populations and clinical settings.

**Objectives:-** The purpose of this study was to evaluate the diagnostic value of Modified Alvarado Scoring System in patients with acute appendicitis in our setting.

**Methods:-**one hundred twenty eight patients, were included in this study, admitted to Al-Kindy teaching hospital from June 2009 to June 2010. Patients' age ranged from 8 to 56 years (21±10) they were divided into three groups; paediatrics, child bearing age females & adult males,. MASS was calculated for each patient included as the diagnosis & treatment were done on the bases of surgeon's clinical decision,confirmation was done by histopathological examination. Finally statistics

done included negative appendectomy rate, sensitivity, specificity, positive predictive value,negative predictive value & accuracy.

**Results: -** Our negative appendectomy rate was 19.5% (22.22% for paediatrics 40.9% for females 4.2% for males). MASS showed sensitivity of 61%(92.8% for paediatrics 38% for females & 58% for males), specificity 80% (75% for paediatrics 88% for females & 50% for males), positive predictive value 92%(92.8% for paediatrics 83% for females 50% for males), negative predictive value 33% (75%for paediatrics 50% for females 5% for males) & accuracy 65% (88.9% for paediatrics 59% for females 58% for males).

**Conclusion:-** MASS was of limited help to junior doctors in our setting,clinical assessment & experience are still the gold standard for acute appendicitis.

**Keywords:-**acute appendicitis,-modified Alvarado- score,-preoperative diagnostic aids

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## **Introduction:**

The diagnosis of acute appendicitis relies largely on clinical experience; the performance of complementary tests is oftentimes unnecessary <sup>(1)</sup>. Alvarado first developed a scoring system based on operative findings and this has been modified and improved by others <sup>(1)</sup>. For men with abdominal pain on right lower quadrant, surgeon diagnosis is more accurate than scales. For women, Fenyö-(Lindberg) scale offers a better sensitivity. Alvarado score can facilitate decision-making in patients with these abdominal symptoms <sup>(2)</sup>. In Alvarado scoring a score of 6 is suggestive of acute appendicitis while a score < 6 is suggestive of non-appendicitis <sup>(3)</sup>. The Fenyö-(Lindberg) score is an inexpensive clinical tool that may improve the diagnostic accuracy for acute appendicitis in women of childbearing age. The low specificity of the score in women of

childbearing age must, however, be kept in mind <sup>(4)</sup>, a score of  $\geq -2$  is suggestive of acute appendicitis if  $\leq -17$  suggests nonspecific abdominal pain while scores in between need observation <sup>(3)</sup>. The diagnostic Ohmann scoring system might be helpful when experienced investigators or additional diagnostic modalities such as ultrasonography are not available. It may therefore be of value in the preclinical evaluation of patients with suspected acute appendicitis and may be instrumental as a quality control tool and in clinical guidelines <sup>(5)</sup>, this score is out of 16 score; if < 6 appendicitis excluded if 6-11.5 need observation while > 11.5 need appendectomy <sup>(3)</sup>. Despite a marked decline in associated mortality over the past 50 years, rates of perforation and negative appendectomy remain unchanged because they are influenced strongly by factors untouched by the intervening technologic advances <sup>(6)</sup>. A more focused utilisation of preoperative

imaging in females of reproductive age and patients at the extremes of age is suggested. Long-term follow-up should be offered to patients with granulomatous appendicitis and neoplastic appendiceal diseases<sup>(7)</sup>. The value of ultrasound in the diagnosis of acute appendicitis is increasing and, particularly in the hands of experienced investigators, is an important imaging modality which delivers important and decision-making findings. Nevertheless, the final decision for appendectomy depends on the findings of the physical examination<sup>(8)</sup>. Acute appendicitis is a common surgical emergency and the diagnosis can often be made clinically; however, many patients present with atypical findings. For these patients, there are multiple imaging modalities available to aid in the diagnosis of suspected appendicitis in an effort to avoid a negative appendectomy. Barium enema examination is a safe technique for the prompt and accurate diagnosis of acute appendicitis<sup>(9)</sup>. Computed tomography is the test of choice in most patients in whom the diagnosis is not certain. Ultrasonography is particularly useful in children and pregnant women. Magnetic resonance imaging is recommended when ultrasonography is inconclusive. Appropriate use of these imaging studies avoids delays in treatment, prolonged hospitalization, and unnecessary surgery<sup>(10)</sup>. Radiolabeled leukocyte imaging and Neutrophil-specific 99mTc-labeled anti-CD15 monoclonal antibody imaging also can play a role in the diagnosis of atypical presentation of acute appendicitis<sup>(11, 12)</sup>. Diagnostic laparoscopy also had been used to diagnose acute appendicitis especially in women<sup>(13)</sup>. By

instituting a guideline for the diagnosis and treatment of possible acute appendicitis, we were able to decrease our rate of normal appendectomies. Although statistical significance was not reached, there is a trend toward decreasing the rate of normal appendectomies in females after the guideline was instituted<sup>(14)</sup>. The Modified Alvarado Scoring System (MASS) has been reported to be a cheap and quick diagnostic tool in patients with acute appendicitis. However, differences in diagnostic accuracy have been observed if the scores were applied to various populations and clinical settings<sup>(15)</sup>.

### **Methods: -**

This is a prospective observational study of 132 patients presented to the emergency department of AlKindy teaching hospital / Baghdad for the period from June 2009-June 2010.

The inclusion criteria were any patient with right lower quadrant (RLQ) pain suspected to be acute appendicitis of any age & both sexes. Exclusion criteria were any patient with non-RLQ pain as suprapubic or right hypochondrial pain, appendicectomised patients as part of emergency laparotomy, pregnant females & appendicular mass. MANTRELS score of (10) of the (Alvarado Scoring System) after dropping out the S for shifting of WBC to the left had been tabulated which stood for migratory RLQ pain, anorexia, nausea & vomiting, tenderness, rebound tenderness, elevated temperature, & leukocytosis; which would have a total score of 9 instead of 10 as shown in **table I**.

**Table I Modified Alvarado Scoring System (Mass)**

SYMPTOMS	SCORE
Migratory right iliac fossa pain	1
Anorexia	1
Nausea/Vomiting	1
SIGNS	
Tenderness in right iliac fossa	2
Rebound tenderness in right iliac fossa	1
Elevated Temperature	1
LABORATORY FINDINGS	
Leukocytosis	2
<b>TOTAL</b>	<b>9</b>

Temperature of  $> 37.2^{\circ}\text{C}$  considered elevated<sup>(16)</sup>. WBC count of  $>4.0 \times 11.0 \times 10^9/\text{l}$  were considered raised count<sup>(17)</sup>. All appendices resected were sent for histopathological examination.

We failed to retrieve the histopathology reports of 4 patients who then were excluded, so we ended with 128 patients included in this study who were in addition divided into three groups; paediatric age group with all females in premenarche age, child bearing age females & adult males.

All decisions for operation were considered depending on clinical assessment, while the data for the scoring were written on a proforma already designed for this purpose.

Statistical analysis done calculating sensitivity as true positive (TP)/TP+false negative (FN), specificity as true negative (TN)/TN+false positive (FP), positive predictive value (PPV) as TP/TP+FP, negative predictive value (NPV) as TN/TN+FN & accuracy as TP+TN/TP+TN+FP+FN. Those were tabulated that patients with score  $\geq 7$  & histopathological diagnosis of acute appendicitis are (TP), those with score  $< 7$  & histopathological diagnosis of acute appendicitis are (FN), those with score  $\geq 7$  & histopathological diagnosis of non-inflamed appendix are (FP), and those with score  $< 7$  & histopathological diagnosis of non-inflamed appendix are (TN).

### Results: -

The age incidence was ranging from 8-56 years with a (mean 21 years  $\pm 10$ ). Sixty eight males (51.5%) & 64 females (48.5%) with a male:female ratio is 1.06:1. Thirty six patients (27.3%) were of the paediatric age group ( $\leq 13$  years), 20 males (15.2%) & 16 females (12.1%). Ninety six patients (72.7%) were adults  $> 13$  years, 48 males (36.35%) & 48 females of child bearing age (36.35%) as shown in table II.

**TABLE II Incidence of appendectomy through age & sex**

SEX	AGE			TOTAL(%)
	Paediatric Years(%)	$\leq 13$	Adult $> 13$ Years(%)	
Male	20(15.2%)		48(36.35%)	68(51.5%)
Female	16(12.1%)		48(36.35%)	64(48.5%)
<b>TOTAL</b>	<b>36(27.3%)</b>		<b>96(72.7%)</b>	<b>132(100%)</b>

The MASS of this study group of 128 patients ranged from 4 to 9 (mean 6.63±1.48).In this study 68(53.13%) patients had MASS seven and above with the remaining 60(46.87%) patients had MASS below seven. Histopathology of the appendectomy specimens showed 103(80.46%) patients had inflamed appendix of them 63(92.64%) had

score  $\geq 7$  & 40(66.66%) had score  $< 7$ .Twenty five(19.54%) patients had normal appendix of those 5(7.36%) had score  $\geq 7$  & 20(33.34%) had score  $< 7$  as shown in **table III**,consequently,in this study group negative appendectomy rate was (19.5%), sensitivity was (61%),specificity (80%),PPV (92%),NPV (33%), accuracy (65%).

**Table III Mass versus Histopathological Findings**

MASS	HISTOPATHOLOGICAL FINDINGS		TOTAL (%)
	Appendicitis (%)	Non-inflamed appendix (%)	
$\geq 7$	63(49.22%)	5(3.9%)	68(53.12%)
$< 7$	40(31.25%)	20(15.63%)	60(46.88%)
<b>TOTAL</b>	<b>103(80.46%)</b>	<b>25(19.54%)</b>	<b>128(100%)</b>

In 36 patients of paediatric age group; 28(77.77%) had appendicitis, 26(72.2%)out of the 28 patients had score  $\geq 7$  & 2(5.55%) had score  $< 7$ . The remaining 8(22.23%) had normal appendix,2 of them (5.6%) had score

$\geq 7$  & 6(16.65%) had score  $< 7$  as shown in **table IV**. And hence the negative appendectomy rate was (22.22%), sensitivity was (92.8%), specificity (75%), PPV (92%), NPV (75%), accuracy (88.9%).

**Table IV Mass versus Histopathological Findings In Paediatric Age Group**

MASS	HISTOPATHOLOGICAL FINDINGS		TOTAL (%)
	Appendicitis (%)	Non-inflamed appendix (%)	
$\geq 7$	26(72.2%)	2(5.6%)	28(77.8%)
$< 7$	2(5.55%)	6(16.65%)	8(22.2%)
<b>TOTAL</b>	<b>28(77.77%)</b>	<b>8(22.23%)</b>	<b>36(100%)</b>

In 44 females of child bearing age; 26(59.1%) had appendicitis divided into 10(22.73%) had score  $\geq 7$  & 16(36.36%) had score  $< 7$ . The remaining 18 patients(40.9%) had normal appendix divided into 2(4.55%) with score  $\geq 7$

& 16(36.36%) with score  $< 7$  as shown in **table V**.So the negative appendectomy rate was (40.9%), sensitivity was (38%),specificity (88%),PPV (83%),NPV (50%),accuracy (59%).

**Table V Mass versus Histopathological Findings In Females Of Child Bearing Age**

MASS	HISTOPATHOLOGICAL FINDINGS		TOTAL (%)
	Appendicitis (%)	Non-inflamed appendix (%)	
$\geq 7$	10(22.73%)	2(4.55%)	12(27.28%)
$< 7$	16(36.36%)	16(36.36%)	32(72.72%)
<b>TOTAL</b>	<b>26(59.1%)</b>	<b>18(40.9%)</b>	<b>44(100%)</b>

In 48 adult males group 46(95.83%) had appendicitis which split into 27(56.2%) of score  $\geq 7$  & 19(39.6%) of score  $< 7$ . Two patients (4.27%) had normal appendix 1(2.1%)

scored  $\geq 7$  & 1(2.1%) scored  $< 7$ . On calculation negative appendectomy rate was (4.2%), sensitivity was (58%), specificity (50%), PPV (96%), NPV (5%), accuracy (58%).

**Table VI Mass versus Histopathological Findings In Adult Males**

MASS	HISTOPATHOLOGICAL FINDINGS		TOTAL (%)
	Appendicitis (%)	Non-inflamed appendix (%)	
$\geq 7$	27(56.2 %)	1(2.1 %)	28(58.3%)
$< 7$	19(39.6%)	1(2.1%)	20(41.7%)
<b>TOTAL</b>	<b>46(95.8%)</b>	<b>2(4.2%)</b>	<b>48(100%)</b>

In this study the negative appendectomy rate was (19.5%) [22.22% in paediatric group, 40.9% in child bearing age females & 4.2% in adult males] sensitivity was (61%)[92.8% in paediatric age group, 38% in child bearing age females & 58% in adult males], specificity (80%)[75% in paediatric age group, 88% in child bearing age females &

50% in adult males], PPV (92%)[92% in paediatric age group, 83% in child bearing age females & 50% in adult males], NPV (33%)[75% in paediatric age group, 50% in child bearing age females & 5% in adult males], accuracy (65%)[88.9% in paediatric age group, 59% in child bearing age females & 58% in adult males]; all shown in **table VII**.

**Table VII Statistical Percentages In The Study Groups**

STATISTICS	WHOLE STUDY GROUP	PAEDIATRIC AGE GROUP	CHILD BEARING AGE FEMALES	ADULT MALES
NEGATIVE APPENDECTOMY RATE	19.5 %	22.22 %	40.9 %	4.2 %
SENSITIVITY	61 %	92.8 %	38 %	58 %
SPECIFICITY	80 %	75 %	88 %	50 %
PPV	92 %	92 %	83 %	50 %
NPV	33 %	75 %	50 %	5 %
ACCURACY	65 %	88.9 %	59 %	58 %

**Discussion: -**

Differences in sensitivities and specificities were observed if the scores were applied to various populations and clinical settings<sup>(1, 18)</sup>.

In this study the negative appendectomy rate was (19.5%) [22.22% in paediatric group, 40.9% in child bearing age females & 4.2% in adult males] this was lower than 27.3% in Al-Hashemy AM et al<sup>(19)</sup>, compatible with the low rate in adult males & paediatrics with high rate in women shown by

Bahattacharjee PK et al<sup>(20)</sup>, on the other hand Macklin CP et al showed 11.6% in paediatrics<sup>(21)</sup> while Lamparelli MJ. et al showed 18% rate in adult women going down with it to 0% by combining diagnostic laparoscopy to MASS<sup>(22)</sup> and Kanumba ES. et al showed higher rate 33.1% affected mainly by the high rate in males 26.8% & almost same rate 38.3% in females<sup>(23)</sup> as shown in **table VIII**.

**Table VIII Comparison Of The Negative Appendectomy Rate To Others**

STATISTICS	STUDY GROUPS	Kanumba ES. et al 2011	Al-Hashemy AM et al 2004	Lamparelli MJ. et al 2000	Macklin CP et al 1997
NEGATIVE APPENDECTOMY RATE OF WHOLE GROUP	19.5 %	33.1%	27.3%	-	-
NEGATIVE APPENDECTOMY RATE IN PAEDIATRIC GROUP	22.22%	-	-	-	11.6%
NEGATIVE APPENDECTOMY RATE IN CHILD BEARING AGE FEMALE GROUP	40.9%	38.3%	-	18%	-
NEGATIVE APPENDECTOMY RATE IN ADULT MALE GROUP	4.2%	26.8%	-	-	-

Sensitivity was (61%)[92.8% in paediatric age group,38% in child bearing age females & 58% in adult males] almost same as Al-Hashemy AM et al 53.8% which was higher in females 56.4% & lower for males

48%<sup>(14)</sup> while Kanumba ES et al showed high sensitivity of 94.1% with 95.8% for males & 88.3% for females<sup>(18)</sup> Macklin CP et al showed higher 76.3% sensitivity in paediatrics<sup>(16)</sup> as shown in **table IX**.

**Table IX Comparison of the Sensitivity to Others**

STATISTICS	STUDY GROUPS	Kanumba ES. et al 2011	Al-Hashemy AM et al 2004	Macklin CP et al 1997
SENSITIVITY OF WHOLE GROUP	61 %	94.1%	53.8%	-
SENSITIVITY IN PAEDIATRIC GROUP	92.8%	-	-	76.3%
SENSITIVITY IN CHILD BEARING AGE FEMALE GROUP	38%	88.3%	56.4	-
SENSITIVITY IN ADULT MALE GROUP	58%	95.8%	48%	-

Specificity (80%)[75% in paediatric age group,88% in child bearing age females & 50% in adult males] here KanumbaES et al gave specificity of 90.4% with92.9% for males & 89.7% for females<sup>(18)</sup> while Horzić M et al

had 100% specificity<sup>(13)</sup>also Al-Hashemy AM et al 80% specificity with 100% for males & 62.5% for females<sup>(14)</sup> Macklin CP et al had 78.8% specificity in paediatrics<sup>(16)</sup> as **table X** show.

Table X Comparison of Specificity to Others

STATISTICS	STUDY GROUPS	Kanumba ES. et al 2011	Horzić M et al 2005	Al-Hashemy AM et al 2004	Macklin CP et al 1997
SPECIFICITY OF WHOLE GROUP	80 %	90.4%	100%	80%	-
SPECIFICITY IN PAEDIATRIC GROUP	75%	-	-	-	78.8%
SPECIFICITY IN CHILD BEARING AGE FEMALE GROUP	88%	89.7%	-	62.5	-
SPECIFICITY IN ADULT MALE GROUP	50%	92.9%	-	100%	-

PPV (92%)[92% in paediatric age group,83% in child bearing age females & 95% in adult males],Kanumba ES et al PPV was 95.2%

with 95.5% for males 90.6% for females<sup>(19)</sup> as shown in **table XI**.

Table XI Comparison of Ppv To Others

STATISTICS	STUDY GROUPS	Kanumba ES. et al 2011
PPV OF WHOLE GROUP	92 %	95.2%
PPV IN PAEDIATRIC GROUP	92%	-
PPV IN CHILD BEARING AGE FEMALE GROUP	83%	89.7%
PPV IN ADULT MALE GROUP	50%	92.9%

NPV (33%) [75% in paediatric age group, 50% in child bearing age females & 5% in adult males] Kanumba ES. et al showed NPV 88.4% with 89.3% for males & 80.1% for females as in **table XII**.

Table XII Comparison of Npv to Others

STATISTICS	STUDY GROUPS	Kanumba ES. et al 2011
NPV OF WHOLE GROUP	33 %	88.4%
NPV IN PAEDIATRIC GROUP	75%	-
NPV IN CHILD BEARING AGE FEMALE GROUP	50%	80.1%
NPV IN ADULT MALE GROUP	5%	89.3%

accuracy (65%)[88.9% in paediatric age group,59% in child bearing age females & 58% in adult males] while Kanumba ES. et al had accuracy of 92.9% with 91.5% for males & 87.6% for females as in **table XIII**.The wide differences in this study compared to

Kanumba et al in tables XI,XII & XIII may be attributed to the different study group populations<sup>(1,18)</sup>or ethnic related causes.

Table XIII Comparison of Accuracy to Others

STATISTICS	STUDY GROUPS	Kanumba ES. et al 2011
ACCURACY OF WHOLE GROUP	65%	92.9%
ACCURACY IN PAEDIATRIC GROUP	88.9%	-
ACCURACY IN CHILD BEARING AGE FEMALE GROUP	59%	87.6%
ACCURACY IN ADULT MALE GROUP	58%	91.5%

### **Conclusion:**

The low sensitivity except in general, low specificity in adults & low accuracy render its use of limited help to junior doctors in our setting. History, clinical examination & cumulative experience remain the gold standard for the diagnosis of acute appendicitis.

### **Recommendation:**

Appraisal of other scoring systems or even new ones has to be tested to figure out the best aid in the diagnosis of acute appendicitis in our setting.

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*\*From the Department of surgery, Lecturer In Alkindy College Of Medicine, University of Baghdad, Baghdad, Iraq.*

*Correspondence Address to :Dr. Raid E. Rassam*

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