

## The Accuracy of Abdominal Ultrasound and the Modified Alvarado Score in the Diagnosis of Acute Appendicitis

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### ABSTRACT

**Background:** The illness process of appendicitis is defined as dynamic and lasts between 24 and 36 hours. Basically, a patient's medical history and clinical examination are a cornerstone for acute appendicitis diagnosis.

**Objectives:** The present study aimed to compare the diagnostic utility of abdominal ultrasound and the Modified Alvarado scoring approach with a postoperative histological analysis in the diagnosis of acute appendicitis.

**Methods:** In this study, 193 patients complaining of acute abdomen pain suspected of acute appendicitis were prospectively recruited. The study population was divided into two groups regarding the Modified Alvarado scoring  $\geq 7$  and  $< 7$ .

**Results:** Our analysis indicated overall specificity, sensitivity and accuracy of diagnosis of the Modified Alvarado score were 81%, 67.7%, and 72% chronologically. While specificity and sensitivity of pelvic pelvi-abdominal ultrasonography were 71.4% and 86.2% respectively.

**Conclusion:** When the Alvarado score is high ( $> 7$ ), there are strong indicators that the patient is experiencing right lower quadrant abdomen discomfort. The Alvarado score approach is a low-cost, dependable, and reproducible diagnostic approach that may be utilised by both primary care physicians and emergency room doctors.

**Keywords:** Alvarado score, Appendicitis, Ultrasonography, Modified Alvarado score.

### INTRODUCTION

A delay in diagnosis or failure to diagnose acute appendicitis, which affects one in seven people globally throughout their lifetime, can result in complications that increase the risk of morbidity and fatality<sup>1</sup>. The patient's medical history and physical examination are a cornerstone for acute appendicitis diagnosis. Even for an experienced practitioner, diagnosis can be difficult due to early modest clinical characteristics and atypical presentation, which have a significant role in diagnosis and therapy<sup>2</sup>.

In 1986, Alvarado provided a scoring method that Kalan *et al.* later adjusted to change Alvarado's score. The scoring system consists of nine different components. A high probability of appendicitis is regarded to be a score of 7 or higher<sup>3</sup>.

Despite the fact that certain research reported that the Modified Alvarado scoring (MAS) approach gave a greater diagnostic accuracy degree in patients query having acute appendicitis and lowered the chance of a successful appendectomy and complication rates<sup>4</sup>. According to a different study, greater scores were ineffective at detecting and predicting acute appendicitis before surgery and at preventing unnecessary appendectomies<sup>5</sup>.

Acute appendicitis is still diagnosed clinically, however abdominal ultrasound (US) is a useful imaging modality in patient assessment when the diagnosis is unsure. The least expensive and least invasive approach, graded compression US, has been shown to have an accuracy of 70-95%<sup>6</sup>. Features of acute appendicitis in Ultrasonographic study are blind-ended, non-

compressible peristaltic tubes that emerge from the caecum tip and have a diameter of more than 6 mm. No matter that the appendiceal diameter, visualising an appendix with an appendicolith is likewise regarded as a successful test<sup>7</sup>. Abdominal ultrasonography (USG) significantly improves the diagnostic accuracy of appendicitis in patients with query acute appendicitis, according to a meta-analysis of 18 trials<sup>8</sup>.

As a result of the muscularis propria's neutrophil infiltration being discovered, which can both confirm and rule out a missed pre-operative diagnosis, acute appendicitis would be diagnosed histopathologically<sup>9</sup>. In the current study, we sought to compare the diagnostic utility of the Modified Alvarado scoring approach for acute appendicitis to abdominal ultrasound, which was then connected to a postoperative histological investigation.

### PATIENTS AND METHODS

In this study, we prospectively recruited 193 patients complaining of acute abdominal pain (Rt iliac fossa pain) query having acute appendicitis admitted to Al-Ahrar Zagazig Teaching Hospital. They fulfilled our criteria within the study period from Feb 2023 to Aug 2023.

#### **Inclusion criteria:**

Appendectomy patients thought they had acute appendicitis even if the Modified Alvarado score was more than 7, regardless of abdominal ultrasound study for appendicitis.

#### **Exclusion criteria:**

Causes of acute abdominal and iliac fossa

discomfort include generalised peritonitis, gynaecology, and urology.

**Methods:**

**193 patients are subdivided into 2 groups:**

- **Group A (100 patients):**

Regardless of the pelvi-abdominal ultrasound finding and Modified Alvarado score was  $\geq 7$ .

- **Group B (93 patients):**

A positive appendicitis abdominal ultrasound and Modified Alvarado score  $< 7$ .

193 individuals have intraoperative diagnosis performed, and all cases have postoperative histological analysis.

**Each participant in the study went through the following:**

Complete medical history taking, clinical examination, standard pre-operative laboratory investigations, pelvic-abdominal ultrasound, and clinical and laboratory- based scoring method (Modified Alvarado score). MAS was discovered to be migration of pain (score 1), anorexia (score 1), nausea (score 1), right lower quadrant tenderness (score 2), rebound tenderness (score 1), pyrexia (score 1), and leucocytosis (score 1) for a total score of nine (score 2).

Diameter  $> 6$  mm, echogenic alterations in the peria-ppendicular fat, thickness of appendicular wall  $> 2$  mm, target sign, non-compressible tubular structure, and appendicolith were found during an abdominal USG.

**1. Surgical repair (one-day surgery):**

- Pre-operative preparation & informed consent.
- General or spinal anesthesia.
- Open appendectomy surgery.
- Closure with or without drain.

**2. Post-operative follow-up:**

The specificity, sensitivity, and accuracy of diagnosis of radiology, the modified Alvarado score, in Correlation with the histopathological study.

**Ethical Statement:**

The local General Organization for Teaching Hospitals and Institutes (GOTHI) Ethics Board approved the project. This research was conducted according to the Declaration of Helsinki <sup>10</sup>.

**Statistic interpretation**

We use MS Excel and SPSS version 27 to

tabulate and analyse the data. (Spss Inc., ILL Company, Chicago). The study's approved cutoff for significance was 0.05. ( $P < 0.05$  was regarded as significant). In order to present qualitative data, numbers and percentages were used. Numerical data were provided as mean  $\pm$  SD.

**RESULTS**

Sociodemographic data of the two studied groups were shown in table (1) with insignificant difference between both groups.

Overall symptoms and signs distribution according to Modified Alvarado Scoring of the study population were shown in table (2).

Table (3) represented the position of the appendix intra-abdominal during operation. Our study found that ultrasound had an overall sensitivity and specificity of 86.2% and 71.4%, chronologically. While the Modified Alvarado score's sensitivity and specificity were 67.7% and 81% chronologically as illustrated in table (4).

**Table (1):** The two study groups' participant characteristics

Variants		Group A	Group B	P-value
Age (y)		24.2 $\pm$ 9.2	23.3 $\pm$ 7.1	0.5
Gender	Male; N (%)	57(57%)	50 (53.8%)	0.7
	Female; N (%)	43 (43%)	43 (46.2%)	

**Table (2):** Distribution of symptoms and signs using the Modified Alvarado scoring.

Symptoms and signs	Total (%)	Group A (%)	Group B (%)
Migration of pain	144(74.6)	89(89)	55(59.1)
Anorexia	167(86.5)	87(87)	80(86.02)
Nausea and vomiting	150(77.7)	83(83)	67(72.04)
Tenderness	193(100)	100(100)	93(100)
Rebound tenderness	192(99.5)	100(100)	92(98.9)
Temperature $>37.2^{\circ}\text{C}$	109(56.5)	70(70)	39(41.9)
Leukocytosis	76(39.4)	51(51)	25(26.9)

**Table (3):** Appendix position

	Total (%)	Group A	Group B
Retro-cecal	137(70.9)	72(72)	65(69.9)
Pelvic	33(17.1)	15(15)	18(19.4)
Sub-cecal	10(5.2)	7(7)	3(3.2)
Pre-ileal	9(4.7)	2(2)	7(7.5)
Post-ileal	4(2.1)	4(4)	0.00

**Table (4):** Diagnostic accuracy of study tools in correlation to histopathology

Positive	Appendicitis	Normal	Sensitivity	Specificity	Accuracy
MAS	88/193	12/193	67.70%	81.00%	72.00%
US	112/193	18/193	86.20%	71.40%	81.30%

## DISCUSSION

Abdominal pain frequently results from appendicitis and is a typical presenting symptom for people seeking care in emergency departments. In equivocal instances, the diagnostic decision to operate results in the removal of 20% of normal appendices to prevent the repercussions of missed or delayed diagnosis <sup>11</sup>.

Different scores have been proposed and investigated to avoid missing cases and accurately establish a diagnosis. The Alvarado score is based on the right iliac fossa localised tenderness, leucocytosis, pain migration, shift neutrophils to the left, temperature increase (low-grade fever), anorexia, nausea, vomiting, and acetone <sup>12</sup>.

In order to diagnose acute appendicitis, the US is frequently used. Puylart first claimed that his graded compression approach had a sensitivity of 89% and a specificity of 100%. Later, numerous additional researchers confirmed the same conclusions <sup>13</sup>.

Our study included 193 patients suspected to have acute appendicitis at Al-Ahrar Zagazig Teaching Hospital. The patients were distributed according to MAS in  $\geq 7$  (100 patients) and  $< 7$  (93 patients). While in the **Gujar et al.** <sup>14</sup> studies, the distribution of patients according to MAS was 158 in the  $> 7$  and 192  $< 7$ .

In our study population, anorexia was the most prevalent symptom of acute appendicitis (86.5%) and the right iliac fossa tenderness was the prominent sign of acute appendicitis (100%). **Gujar et al.** <sup>14</sup> reported migrating discomfort to the right iliac fossa and right iliac fossa tenderness to be the most frequent sign, which was displayed in all studied patients, while the most frequent symptom was the right iliac fossa pain, which may be related to differences in patient numbers and socioeconomic status between the two patients' groups.

In our work, we found that the sensitivity and specificity of the Modified Alvarado score were 67.7% and 81% chronologically, and diagnostic accuracy was 72%, which was lower as compared to the **Gujar et al.** <sup>14</sup> study, which demonstrated that sensitivity and specificity of the Modified Alvarado score were 98.44% and 94.44% chronologically. However, this was higher as compared to the work of **Nautiyal et al.** <sup>15</sup> and **Tandi et al.** <sup>16</sup> studies, which demonstrated a sensitivity of 48-77% and specificity of 73-87%.

Also, MAS had better sensitivity and specificity than ultrasonography as reported by **Seda Ozkan et al.** <sup>17</sup> at 71.2%, and 46.7% respectively, the accuracy rate was judged to be 65.7%, with the positive predictive value (PPV) at 82.2%, the negative predictive value

(NPV) at 31.8% and the accuracy of diagnosis was calculated to be 90%, which outperformed the MAS score in the same study previously mentioned. The sensitivity of the US was decided to be 97.2%, the specificity to be 62.5%, the PPV to be 92.1%, and the NPV to be 83.3%.

In our study for  $MAS \geq 7$ , the histopathological positives were in 88 cases of the recruited individuals, while 12 cases had normal appendix. It resembles the **Gujar et al.** <sup>14</sup> studies which showed a Modified Alvarado score of more than 7 in 158 patients and the histopathological findings were positive in 95.6% of participants, and 4.43% of patients had negative histopathological findings.

In our study, the diagnostic approach for ultrasound demonstrates a sensitivity of 86.2% and specificity of 71.4%, and diagnostic accuracy of 81.3%. This result is slightly different (lower) from the **Gujar et al.** <sup>14</sup> study, which demonstrated sensitivity of 98.44%, Specificity of 94.44% of the ultrasound, and the study of **Nautiyal and his colleague** <sup>15</sup> reported that diagnostic sensitivity and specificity were 97.14%, and 88.57% chronologically in ultrasonography approach. Because in certain instances an inflamed appendix could not be seen because of intestinal gases, it can only be used as a supplement to clinical scores or clinical judgment.

Our results are consistent with numerous other studies where preoperative ultrasonography enhanced clinical results, while **Stefan Pug et al.** <sup>18</sup> reported a negative appendectomy rate of 36.6% without US and 13.2% with US in 2003.

## CONCLUSION

We may conclude that using the Modified Alvarado score approach is an effective diagnostic score for acute appendicitis. When used in conjunction with ultrasound, it improves appendicectomies by reducing the number of false-negative results.

- **Conflict statement:** Nil.
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