

## Evaluation of Alvarado Score in the Diagnosis of Acute Appendicitis

SAMY G. AKHNOKH, M.D.\*; RAMEZ M. WAHBA, M.D.\*\* and ARMIA S.F. KAMEL, M.Sc.\*

The Departments of General Surgery\* and Vascular Surgery\*\*, Faculty of Medicine, Ain Shams University

### Abstract

**Background:** Acute Appendicitis (AA) remains the most frequent abdominal surgical emergency in the developed world. Failure to make an early diagnosis is a primary reason for the persistent rate of morbidity and mortality. Decision making in cases of acute appendicitis may be a problematic experience in developing countries where the facilities for investigations lack, especially in rural and semi-rural areas. Alvarado Score (AS) may be used as a guide.

**Aim of Study:** To evaluate the effectiveness of Alvarado Score in diagnosing acute appendicitis by correlating it with the operative findings, and the pathologic findings if it is feasible. Also, to know the specificity and sensitivity of Alvarado Score as a diagnostic tool of acute appendicitis in both genders and all age groups, so we can apply it to all patients suspected to have acute appendicitis. To save time and money by diagnosing Acute Appendicitis with the help of Alvarado Score and using it as a guide in requesting a CT Abdomen for suspicious appendicitis. So, we can eventually reduce the number of negative appendices or complications of undiagnosed appendicitis.

**Patients and Methods:** The study was conducted on 50 patients complaining of lower abdominal pain with a provisional diagnosis of acute appendicitis, selected non-randomly, in the Emergency Department of Harpur Memorial Hospital in Menof City, Menofeya Governorate-Egypt. Patients were assessed pre-operatively by the Alvarado scale. Post-operative histological examination of removed specimens was done.

**Results:** The results showed that 60% of the patients were males. The mean age was 27.54, range (9-62) years old. 100% of cases had Right Lower Quadrant tenderness (RLQ) as well as Rebound tenderness, followed by; anorexia in (96%) of cases. The migration of pain to the right lower quadrant was present in (68%) of cases.

**Conclusion:** We concluded that in our local setting, efficacy (sensitivity, specificity, and diagnostic odds ratio) of Alvarado Score, using a conventional cut off value of 7 for high-risk group, in the diagnosis of Acute Appendicitis is a good initial evaluation of patients with acute lower abdominal pain. Also, it is a cheap and quick tool to apply in Emergency Departments to rule our acute appendicitis.

**Key Words:** Acute appendicitis – Alvarado score.

**Correspondence to:** Dr. Armia S.F. Kamel,  
[E-Mail: Jermiah@yahoo.com](mailto:Jermiah@yahoo.com)

### Introduction

IN 1886, Reginald Heber Fitz described the classical signs and symptoms of acute appendicitis as a disease entity [1]. Since then, acute appendicitis has remained one of the most common causes of acute abdominal pain in all ages and the most common surgical emergency [2] with a lifetime risk of 7% [3,4].

Appendicitis is defined as inflammation of the inner lining of the vermiform appendix that spreads to its other parts [5]. Its symptoms are nonspecific, and they overlap with many other medical conditions making the diagnosis a challenge, particularly in the early stage of presentation [6].

A delay in the diagnosis of acute appendicitis may allow progression to perforation and a significant increase in morbidity and mortality. Thus, some surgeons prefer “to take out when there is doubt” based on clinical suspicion alone, which can lead to the removal of the normal appendix in about 15-30% of the cases and subject the patient to unnecessary operation with all its pre-operative risks, especially in older people [7].

Imaging techniques such as Ultrasound (US) and Computerized Tomography (CT) and diagnostic laparoscopy have been used with the hope of yielding a rapid and accurate diagnosis [8]. Computed Tomography (CT) scan has emerged as the dominant imaging modality for the evaluation of suspected appendicitis in adults. It has decreased negative appendectomy rates to less than 10% [9].

The main problems with the routine use of diagnostic imaging are examiner-dependent efficacy (US), and technique-associated morbidity (diagnostic laparoscopy) [10]. Also, the radiation exposure with CT poses a concern, particularly in appendicitis, which occurs predominantly in young patients most susceptible to the adverse effects of

radiation. Available literature has estimated that at least 25% of CT scans are not clinically warranted and may pose more harm than benefit. Rules for clinical decisions guiding CT use are thus essential to reduce unnecessary CT scans [9].

In Egypt, like other developing countries, we face another problem like lack of some radiological facilities, especially in rural areas, or the patient cannot afford to pay for these investigations. Many clinical based scoring systems have been devised to assist diagnosis, and Alvarado score is the most commonly used one [7].

Three symptoms (migration of the pain, anorexia, and nausea-vomiting), three physical signs (tenderness, rebound pain, and elevation of temperature), and two laboratory findings (leukocytes and shift to the left) appear to be useful in the diagnosis of acute appendicitis. We will assign one point for each symptom, sign, and lab value except the right lower quadrant pain and leukocytes, which will be given 2 points each making the total value be 10 [11].

Based on this score, three groups of patients are identified. Patients with a score of 1-4 can be discharged home, those with a score of 5-6 should be admitted, and those with a score of 7-10 should be considered candidates for surgery [12].

#### *Aim of the work:*

To evaluate the effectiveness of Alvarado Score in diagnosing acute appendicitis by correlating it with the operative findings, and the pathologic findings if it is feasible. Also, to know the specificity and sensitivity of Alvarado Score as a diagnostic tool of acute appendicitis in both genders and all age groups, so we can apply it to all patients suspected to have acute appendicitis. To save time and money by diagnosing Acute Appendicitis with the help of Alvarado Score and using it as a guide in requesting a CT Abdomen for suspicious appendicitis. So, we can eventually reduce the number of negative appendices or complications of undiagnosed appendicitis.

### **Patients and Methods**

A prospective study, non-randomized, non-probability, and purposive sampling from the Emergency Department at Harpur Memorial Hospital in Menof City-Menofeya Governorate. Through one year starting from 1<sup>st</sup> of July 2018 to 31<sup>st</sup> of June 2019.

Fifty patients present were enrolled in this study with symptoms suspected of acute appendicitis

including acute onset abdominal pain mainly in the right lower quadrant, nausea, vomiting, anorexia, elevated temperature, and right lower quadrant tenderness and rebound tenderness (by physical examination). Also, pre-operative consents were discussed and obtained from all patients according to approved standards of The Ethical Committee of Ain Shams University.

Pre-operatively a record of their medical history, physical examinations, lab values, Pelvi-abdominal ultrasound, and CT abdomen if it is possible were done. Alvarado score was calculated for all patients with suspected acute appendicitis and was recorded in their file and classify them by their total Alvarado score into three groups High risk (>7), intermediate-risk (5,6) and low risk (<5).

Three symptoms (migration, anorexia, and nausea-vomiting), three physical signs (tenderness, rebound pain, and elevation of temperature), and two laboratory findings (leukocytosis and shift to the left) appear to be useful in the diagnosis of acute appendicitis. We assigned one point for each symptom, sign, and lab value except the right lower quadrant pain, and leukocytosis, which were given 2 points each according to Alvarado Score. All these data were documented in the patient's file.

#### *Inclusion criteria:*

Patients from both genders at any age. Patients present with symptoms and signs suggestive acute appendicitis, as we mentioned before.

#### *Exclusion criteria:*

Pregnant patients, patients who did not have appendectomy at the hospital, patients who refused to be admitted at the hospital, patients who have other causes of pain, or had appendectomy before. Patients with right iliac fossa mass or a diagnosed appendicular lump and patients who came with generalized peritonitis proven by clinical evaluation, labs, and radiological examination.

We did an open appendectomy for all our 50 patients. The appendix was grossly examined in the operating room. Some specimens were sent for histopathological examination for more evaluation. We excluded the obvious suppurative, necrotic, and a perforated appendix for cost benefits, recorded the outcomes of the operation, surgical wounds, and improvement of symptoms. Then, we followed up the patients weekly for one month postoperatively.

#### *Statistical analysis:*

All data were collected, tabulated and statistically analyzed according to the type of data ob-

tained from each parameter using the Statistical Package for Social Science (SPSS 20).

### Results

The present study was conducted on 50 patients complaining of lower abdominal pain with a provisional diagnosis of acute appendicitis.

Alvarado score was calculated for each patient preoperatively, and all patients had an open appendectomy procedure. The appendix was grossly checked post-operatively and by histopathological examination in another lap.

#### 1- Demographic data results (Table 1):

Table (6) demonstrates the age and gender distribution of the studied cases; cases were distributed as 30 patients (60%) males and 20 patients (40%) females. The mean age was 27.54, range the youngest is nine years old, and the oldest is 62 years old without statistical differences between both groups.

Table (1): Age and gender distribution of the studied cases; (N=50).

Descriptive statistics	
<i>Gender:</i>	
Male	0 (60%)
Female	20 (40%)
<i>Age (years):</i>	
Mean ± SD	27.54 11.5
Minimum	9
Maximum	62

#### 2- Distribution of the parameters of Alvarado score among the studied patients (Table 2):

Right Lower Quadrant tenderness (RLQ) as well as Rebound tenderness; were present in all of the cases (100%). Then anorexia in 48 patients (96%) of cases. The migration of pain to the right lower quadrant was present in 34 patients (68%) of cases. Leukocytosis in 34 patients (68%) and Leukocyte left shift in 37 patients (74%). Nausea and vomiting were in 33 patients (66%) of cases, and finally, the least frequent symptom was the elevated temperature (37.3°C or 99.1°F), which was present in 31 patients (62%) of studied cases.

#### 3- Classification of cases by total Alvarado score (Table 3):

According to Alvarado Score, we gave 2 points for right lower quadrant pain and leukocytosis, and we gave 1 point for Migration of the pain, Anorexia, fever (more than 37.5c), right lower quadrant rebound tenderness, shift to left of the

leukocytosis and finally to nausea or vomiting. So, the total is 10.

We classified the risks as high risk which is Alvarado score equal to or more than 7 Intermediate risk which is Alvarado score 5,6 low risk which is Alvarado score equal to or less than 4.

The most frequent score of the patient was 10 in 14 cases, followed by 9 and 8, then 7. None of the patients had a score of less than 1. The majority of the studied cases was classified as high risk (41 cases out of 50) 82% of the studied cases, and as the intermediate-risk, we had 5 cases (10% of studied cases) and only 4 cases classified as low risk by total Alvarado score or 8% of the studied cases.

Table (2): Distribution of the parameters of Alvarado score among the studied patients; (N=50).

	Frequency	Percentage
Migration of the pain	34/50	68
Anorexia	48/50	96
Nausea and vomiting	33/50	66
RLQ tenderness	50/50	100
Rebound tenderness	50/50	100
Elevated temp	31/50	62
Leukocytosis	34/50	68
Shifting to the left	37/50	74

Table (3): Classification of cases by total Alvarado score; (N=50).

	Frequency	Percentage
High risk (≥7)	41	82.0
intermediate risk (5,6)	5	10.0
low risk (<5)	4	8.0
Total	50	100.0

#### 4- Distribution of the studied cases according to post-operative pathological assessment (Table 4):

Evaluation of studied cases according to the histopathological examination of the removed specimens revealed that; some patients with proven acute appendicitis were 45 (90%), and some patients with negative Appendectomy were 5 cases (10%).

In all, 22 cases were catarrhal appendicitis, 20 were suppurative appendicitis (40% of the cases), and 3 were complicated appendicitis (6%).

Complicated appendicitis was distributed as, one case with a gangrenous appendix, one with retro-caecal impending rupture, and one case with a perforated appendix.

Table (4): Distribution of the studied cases according to post-operative pathological assessment; (N=50).

	Frequency	Percentage
Negative appendectomy	5	10.0
Acute appendicitis	45	90.0
Suppurative inflammation	20	40.0
Catarrhal inflammation	22	44.0
Complicated appendicitis	3	6.0
Total	50	100.0

5- Evaluation of the Alvarado score according to the post-operative results (Table 5):

The highest percentage of patients with proven acute appendicitis had an Alvarado score of  $\geq 7$  as 37 patients out of 45 patients with proven acute appendicitis (82.2%) had Alvarado score equal to or more than 7 (high risk).

The next group was both with intermediate-risk (score 5, 6) and low-risk group patients (score less than and equal to 4). Both groups had 4 out of 45 proven acute appendicitis (8.9%).

Also, the highest percentage of negative Appendectomy patients had an Alvarado score of 7 or more (4 out of 5 or 80% of the negative appendectomies). One patient out of 5 who had negative appendectomy has a score of (5) which represents 20% of the negative appendectomies (1 out of 5).

Overall, 37 of 41 patients with high-risk Alvarado score (7 or more) had appendicitis (90%). Also, 4 out of 5 patients with an intermediate-risk score of Alvarado score had appendicitis (80%).

Table (5): Evaluation of the Alvarado score according to the post-operative results.

Alvarado score	Post-operative pathological assessment		Total N=50
	Acute Appendectomy N=5	Negative Appendectomy N=5	
• High risk ( $\geq 7$ )	37 (82.2%)	4 (80.0%)	41 (82.0%)
• Intermediate risk (5,6)	4 (8.9%)	1 (20.0%)	5 (10.0%)
• Low risk ( $<5$ )	4 (8.9%)	0 (0.0%)	4 (8.0%)

6- The results of the ROC curve analysis of Alvarado score in the studied cases (Table 6):

Receiver Operating Characteristic (ROC) curve analysis was used to assess the clinical diagnostic accuracy of Alvarado score in patients with lower abdominal pain with a provisional diagnosis of acute appendicitis. The overall sensitivity (true positive cases) for Alvarado score at the cutoff value of  $\geq 7$  was 68.9% (75% for male individuals and 58.8% for female individuals), overall specificity (true negative cases) was 40% (50% for male individuals and 33.3% for female individuals), Positive Predictive Value (PPV) was 90.2, and the negative predictive value was 11.1.

Table (6): The results of the ROC curve analysis of the Alvarado score in the studied cases.

	AUC	SE	95% CI	Sensitivity	Specificity	Cutoff value
All cases	0.700	0.081	0.542-0.858	68.9%	40%	$\geq 7$
Males	0.804	0.132	0.545-0.999	75%	50%	$\geq 7$
Females	0.598	0.119	0.365-0.831	58.8%	33.3%	$\geq 7$

AUC : Area Under the Curve.  
SE : Standard Error.  
CI : Confidence Interval of AUC.

Out of 41 patients with Alvarado score more than seven, 37 patients were true positive for positive predictive value of 90% (90% of patients whom Alvarado score was  $>7$  truly had acute appendicitis).

Out of 9 patients with Alvarado score less than seven, one of them was true negative for negative predictive value of 11 %.

True positive 37	False positive 4
False negative 8	True negative 1

Two out of 50 patients had superficial surgical site infection on the post-operative follow-up (4%). We opened the wound and left it to heal by secondary intention, and it was completely healed in 10 days of daily dressing.

**Discussion**

Given the similarity of the symptoms of acute appendicitis with other conditions that are seen in medical emergencies, it is not uncommon for misconceptions and delays in the diagnosis of the condition, especially in its initial periods, which negatively affect the related morbidity and mortal-

ity. Based on the findings and experience of the surgeon, the decision to be taken should be decided as quickly as possible, and the Alvarado's Score is a good tool to guide the best option between hospital discharge, deepening of the diagnostic investigation or surgical approach [13].

Failure to make an early diagnosis, an inflamed appendix will eventually burst or perforate, thereby spilling infectious material into the abdominal cavity. This event can lead to peritonitis, a severe inflammation of the abdominal cavity's lining (the peritoneum) that can be fatal [14].

Among young male patients, the negative appendectomy rate is relatively low (5-22%), while for women of childbearing age, the figure may be as high as 30-50%. In young children, the diagnosis may be wrong in 30-46% of the patients. The difficulty in diagnosing acute appendicitis in old age is reflected by the high incidence of perforation, 60-90% in many reports, rather than by a high rate of negative appendectomy [15].

Decision making in cases of acute appendicitis may be a problematic experience in developing countries where the facilities for investigations lack, especially in rural and semi-rural areas, which is why Alvarado Score (AS) may be used as a guide in diagnosis and treatment of patients with acute appendicitis [16,17].

In this study was conducted on 50 patients complaining of lower abdominal pain with a provisional diagnosis of acute appendicitis. Aiming to find out the effectiveness of Alvarado Score in diagnosing Acute appendicitis by correlating it with the operative findings, and the pathological findings; to know the specificity and sensitivity of Alvarado Score as a diagnostic tool of Acute Appendicitis in both genders and all ages groups so we can apply it on all patients who are suspected of having acute appendicitis; and also to save the time and money.

In this study, Acute Appendicitis existed more frequently in males (60% of patients). The age of patients ranged from 9 to 62 years, with the mean age was about 28 years old.

These results are in line with Subotić et al., in their study, from 48 patients with AA 25 (52,09%) were males, and 23 (47,91%) were female. Furthermore, ages ranged from 16 years old to 70 years old, with a mean age was 27,5 years, and the majority of the patients (73,68%) were between 16-35 years. Previous studies in Kenya, Nigeria,

and Ethiopia also found a male dominance in acute appendicitis [18,19].

The male dominance in the current study is in disagreement with Khan et al., and Kanumba et al., who found female preponderance in Acute Appendicitis in their studies. Moreover, attributed the reason for the difference in sex distribution to the fact that female patients with right iliac fossa pain have a wide range of differential diagnoses. As a result, acute appendicitis may be over diagnosed in this gender group. In this case, the Alvarado score is less specific; hence, additional investigations may be required in female patients to confirm the diagnosis of acute appendicitis [20,21].

Another study showed the females of reproductive age are a difficult group to differentiate appendicitis from gynecologic pathologies, by comparison of sensitivity and specificity of Alvarado score determinants in men and women. It may be due to a high prevalence of these common general findings in women presenting with abdominal pain [22].

Acute appendicitis is rare in small children (i.e., 5 years of age), with the highest incidence found in young adults with most frequency among patients in their second through fourth decades of life (13-40 years). Male patients are most often encountered [23].

Parameters that make Alvarado score are migration of pain, anorexia, nausea or vomiting, right lower abdominal quadrant tenderness, rebound tenderness in the right iliac fossa (Bloumberg sign), elevated temperature, leukocytosis, shift to the left of neutrophils. If we use these variables together, the diagnostic accuracy is higher [19].

In this study, the Right Lower Quadrant tenderness (RLQ), and rebound tenderness were in all of the cases (100%), followed by; anorexia in (96%) of cases. The migration of pain to the right lower quadrant was present in (68%) of cases. Leukocytosis in (68%) and leukocyte left shift in (74%). Nausea and vomiting were in (66%) of cases, and finally, the least frequent symptom was the elevated temperature (37.3°C or 99.1°F), which was present in 62% of the studied cases. This is in line with the findings of Subotić et al., who diagnosed migratory pain in 62,50% of the patients.

Anorexia in of Subotić et al., study existed in 48 (84,21%) patients, with no statistically significant ( $p>0,05$ ) differences in the presence of anorexia in the patients with Acute Appendicitis compare with the patients without Acute Appendicitis,

and this is higher than what was diagnosed in our study.

Tenderness in the right iliac fossa was found in 91,23% of patients, which is lower than our current study, in which all patients had tenderness in the Right Lower Quadrant tenderness (RLQ) as well as rebound tenderness.

Leukocytosis was diagnosed in 68% (34/50) of the patients, and this is lower than of Subotić et al. in which 82,46% of the patients had leukocytosis in the interval between 10-20 X 1000/mm<sup>3</sup>.

The elevated temperature was a sign among 62% of the patients, which is similar to Subotić et al., study, in which elevated temperature was identified in 63% of the patients [19].

In John et al., the most frequent Alvarado Parameter detected was right lower quadrant tenderness (93%) followed by migration of the pain in about (72% of the patient), which was close to our study results (100%) and (68%) respectively.

In the same study, the least frequent Alvarado parameter detected was the elevated temperature (50%), which is in line with our study here (62%) [17].

The most frequent score of the patient in our study was 10 in 14 cases, followed by 9 and 8, then 7. Most of the studied cases were classified as high risk (41 cases out of 50), and as the intermediate-risk, we had 5 cases and only 4 cases classified as low risk by total Alvarado score.

The results were in line with the study of Subotić et al., in which patients had the mean value of the Alvarado score 9,25 points in this group. They stated that that data was expected because the patients from this group had all the symptoms, signs, and lab. Findings were scoring in the Alvarado score, and also the higher values of this score. the highest values of the Alvarado score (mean 9,33), because the most variables of the Alvarado score were present (they did not have to have migratory pain) [19].

The intermediate-risk group in Subotić et al., study were patients with a pre-operative diagnosis of "abdominal colic," and they were very suspected of having Acute Appendicitis. The patients from this group had an atypical clinical picture, so it is not easy to differentiate Acute Appendicitis from the other abdominal diseases (mesenteric adenitis, no organic pathologic conditions, gynecologic disorders) [19].

Also, our study was in line with John et al., as the most common Alvarado score value was 9 in 22 patients, 8 in 18 patients and 7 in 10 patients out of 58 patients (in total 50 patients of 58 or 87%) [17].

Kong et al., studied 1000 patients (54% male, median age 21yrs.). Forty percent had inflamed, nonperforated appendices, and 60% had perforated appendices. Alvarado scores were 1-4 in 20.9%, 5-6 in 35.7%, and 7-10 in 43.4%, indicating low, intermediate, and high clinical probability, respectively. If we excluded the patients with generalized peritonitis as we did in our study, then the results of 510 patients without generalized peritonitis, Alvarado scores were 1-4 in 5.5%, 5-6 in 18.1% and 7-10 in 76.4%, indicating low, intermediate and high clinical probability, respectively [12].

It should be taken into consideration that the pain localization in AA depends on the position of the appendix and, eventually, appendiceal perforation. Patients with AA and atypical position of the appendix do not have a clear clinical picture, which leads to a more difficult diagnosis and delays in surgical treatment. So, they have a higher rate of perforation [24].

These patients have lower values of the Alvarado score because they do not have two common signs, tenderness in right iliac fossa and Bloumberg sign. If those patients miss one more symptom (nausea or vomiting, anorexia, or migratory pain), they will have the Alvarado score six or less, so there is the likelihood of an uncertain diagnosis of AA until the appendiceal perforation occurs [20].

The overall sensitivity (true positive cases) for the Alvarado score at the cutoff value of  $\geq 7$  in our study was 68.9% (75% for male individuals and 58.8% for female individuals). Overall specificity (true negative cases) was 40% (50% for male individuals and 33.3% for female individuals), Positive Predictive Value (PPV) was 90.2, and the negative predictive value was 11.1 this was in line with Saidi & Chavda study which had overall sensitivity (proportion of group  $>7$  with positive histopathology) 80% [18].

Gupta et al., studied 50 patients, and the patients were categorized into three groups-men - 1, women -2, children - 3. For men (group 1), the sensitivity of Alvarado score was 96.29%, specificity was 66.66%, and the positive predictive value was 92.85%, while in women group (group 2), the sensitivity was 81.8%, specificity was 66%, and positive predictive value was 81.8%. For children

in group 3, the sensitivity, specificity, and positive predictive value were 100% [25].

In a study of 68 patients, Crnogorac et al., found a significant proportion (82.7%) of patients with Alvarado score seven or more. The score was found useful with sensitivity and specificity levels of 87% and 60% respectively being achieved while in our study, the specificity was 40% (50% for males and 30% for females) [26].

The similar rates of positive histology for both high and low-risk scores in our study indicate that the accuracy of a diagnosis of appendicitis is not improved by a combination of historical and physical examination findings. These findings appear to support the results by Izbicki et al. In their study, the male sex, white cell counts greater than 11000, history of fewer than 24 hours, rebound tenderness, a shift of pain from epigastrium and localized guarding were predictive retrospectively, but were characterized by low specificities and sensitivities when applied prospectively [18]. Combining the scores did not improve their predictive power. The authors concluded that accurate diagnosis of appendicitis depended mainly on the experience of the surgeon and not by the application of a scoring system that included the above variables [26]. Their attributed the limited utility of the clinical parameters to low specificities may be due to the protean nature of the presentation of appendicitis and a myriad of other diagnoses mimicking appendicitis. No single clinical variable can, therefore, guarantee the correct diagnosis [26,27].

Evaluation of studied cases according to the histopathological examination of the removed specimens revealed that; many patients with proven acute appendicitis were 45 (90%), and many patients with negative appendectomy were 5 cases (10%). In all, 22 cases were catarrhal appendicitis, 20 were suppurative appendicitis, and 3 were complicated appendicitis.

Complicated appendicitis was distributed as one case with a gangrenous appendix, one with retro-caecal impending rupture inflammation, and one case with perforated appendix (2%). The rate of the perforation in the current study is much lower than literature, with a reported general rate of perforations is about 25%, and it is based on all age groups including children, female during reproductive age and elderly patients, which have the rate of the perforation close to 50%. This result may be because children younger than 16 years were few in the current study, who were reported to have higher perforation rates.

This rate of post-operative histological confirmation of acute appendicitis in the current study is higher than. In which the rate of histological examination confirmed appendicitis was 66.9% [20].

The negative appendectomy rate in the current study was 10%, which is lower than Kanumba et al., who reported a 33.1% negative appendectomy rate. They attributed the high negative appendectomy rate in their study to appendectomies that were done to patients who presented with other conditions mimicking acute appendicitis. Moreover, the current negative appendectomy rate was lower than what was reported in previous literature, with a negative appendectomy rate of 20-40% that has been reported in the literature. However, many surgeons advocate early surgical intervention for the treatment of acute appendicitis to avoid perforation, accepting a negative appendectomy rate of about 15-20% [20,28].

This lower negative appendectomy rate is in favor of the effectiveness of the Alvarado score in the diagnosis of the AA cases, thus decreasing the negative appendectomy rate. Removing a normal appendix is an economic burden on both patients and health resources. Misdiagnosis and delay in surgery can lead to complications like perforation and, finally, peritonitis [28].

Previous literature also showed slightly higher negative appendectomy rate in the present study in females than in males (male: female ratio was 26.8%: 38.3%) in Kanumba et al., this is because misdiagnosis may have occurred in females of the reproductive age group where other pelvic diseases could make diagnosis difficult. In such cases, AS should be complemented with a diagnostic procedure like laparoscopy or imaging such as Ultrasound scan or CT scan to minimize the rate of negative appendectomy [20].

Khan documented a rate of 15.62% as a negative appendectomy rate in their study, which is higher than our study results. Operative findings and histopathological reports in their study showed that 84.4% of the patients had inflamed appendix; this was in agreement with our results. However, Khan reported a higher perforation rate and gangrenous appendicitis rate than our study, with 7.8% and 10.9% for perforated appendices and gangrenous appendices, respectively. With non-missing any case studies by Alvarado score [21].

Puttaraju & Keerthana's study had positive and negative appendectomy rates overall were 92.77% and 7.23%, respectively, which was comparable

to our study. Bhattacharjee et al., concluded that a high Alvarado score was found to be a dependable aid both in the pre-operative diagnosis of acute appendicitis and in the reduction of negative appendicectomies in men and children. However, the same was not true for women who had a high false-positive rate for acute appendicitis. In the Puttaraju study, positive predictive value was 92.77%, which was comparable to our study (90.2%) [29].

In this study shows that the application of the Alvarado scoring system in the diagnosis of acute appendicitis can provide a high degree of positive predictive value and, thus, diagnostic value. The positive predictive value shown by our study is comparable with the literature which reports 87.5%, 85.3% 87.4% in Singh et al., [30].

In this study also revealed that the Alvarado scoring system is more helpful in male patients by showing lower negative appendectomy rate and high positive predictive value for male patients as compared to females. In females, additional investigations may be required to confirm the diagnosis. Literature also supports this observation [31].

The lower overall sensitivity of the score in females is expected. Bhattacharjee et al., analyzed 110 patients, found a sensitivity of 94.1% in males and a lower value of 71.9% in females. Pre-menopausal females have several gynecological conditions with presentations similar to appendicitis. The common misdiagnoses include pelvic inflammatory disease, gastroenteritis, urinary tract infection, ruptured ovarian follicle, and ectopic pregnancy. For their group of women with normal appendices who underwent an operation, alternative diagnoses included pelvic inflammatory disease, ruptured follicular cysts, twisted ovarian cysts, and ruptured ectopic pregnancy [32].

### Conclusion:

From this study, we concluded that in our local setting, efficacy (sensitivity, specificity, and diagnostic odds ratio) of Alvarado Score, using a conventional cut off value of 7 for high-risk group, in the diagnosis of Acute Appendicitis is a good initial evaluation of patients with acute lower abdominal pain. Also, it is a cheap and quick tool to apply in Emergency Departments to rule our acute appendicitis.

However, it has low specificity for both males and females and also lower sensitivity for females than males, still can be used to guide us in the operative decision or to order more expensive imaging studies like CT scan, MRI, or even exploratory laparoscopy.

We recommend doing this study with higher numbers of cases and to be careful while using it in the female patient.

A new cut off value of 5 in a high-risk group is to be considered in future studies, and to compare between Alvarado score and other diagnostic scores in future studies.

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## تقييم مقياس الفارادو في تشخيص إلتهاب الزائدة الدودية الحاد

لا يزال إلتهاب الزائدة الدودية الحاد أكثر حالات الطوارئ الجراحية الباطنية شيوعاً في العالم المتقدم. يعد الفشل في إجراء تشخيص مبكر سبباً رئيسياً لإستمرار معدل المراضة والوفيات. قد يكون إتخاذ القرار في حالات إلتهاب الزائدة الدودية الحاد إشكالية في البلدان النامية حيث تفتقر المستشفيات إلى الأجهزة المتطورة اللازمة للتشخيص نظراً لتكلفتها الباهظة مثل الأشعة المقطعية والرنين المغناطيسي، خاصة في المناطق الريفية وشبه الريفية. يمكن إستخدام مقياس ألفارادو كأداة في التشخيص.

أجريت هذه الدراسة على ٥٠ مريضاً يشكون من آلام أسفل البطن مع تشخيص مؤقت لإلتهاب الزائدة الدودية الحاد، تم إختيارهم بشكل عشوائي، في قسم الطوارئ بمستشفى هاربر التذكاري بمدينة منوف بمحافظة المنوفية - مصر. تم تقييم المرضى قبل إجراء الجراحة بمقياس ألفارادو. تم إجراء الفحص النسيجي بعد العملية الجراحية للعينات التي تمت إزالتها.

أظهرت النتائج أن ٦٠٪ من المرضى من الذكور. كان متوسط العمر ٢٧.٥٤، تتراوح أعمارهم (٩-٦٢) سنة. ١٠٠٪ من الحالات كان لديها آلام في الربع السفلي الأيمن للبطن بالإضافة إلى إيلام إرتدادى تليها، فقدان الشهية في (٩٦٪) من الحالات. كانت هجرة الألم إلى الربع السفلي الأيمن موجودة في (٦٨٪) من الحالات. إرتفاع في عدد كريات الدم البيضاء في (٦٨٪) وإرتفاع نسبة كرات الدم البيضاء غير الناضجة أو المحببة (٧٤٪). كان الغثيان والقيء في (٦٦٪) من الحالات، وأخيراً، كانت الأعراض الأقل تكراراً هي إرتفاع درجة الحرارة (٣٧.٣ درجة مئوية أو ٩٩.١ درجة فهرنهايت)، والتي كانت موجودة في ٦٢٪ من الحالات المدروسة.

تم تصنيف غالبية الحالات التي تمت دراستها على أنها عالية المخاطر (٤١ حالة من أصل ٥٠)، وكمخاطر متوسطة، كان لدينا ٥ حالات و٤ حالات فقط تم تصنيفها على أنها منخفضة الخطورة من مجموعة درجات ألفارادو.

وفقاً لتقييم الحالات المدروسة بواسطة الفحص النسيجي للعينات التي تم إزالتها جراحياً: كان عدد المرضى الذين يعانون من إلتهاب الزائدة الدودية الحاد ٤٥ مريض (٩٠٪)، وعدد المرضى الذين ثبت عدم وجود إلتهاب في الزائدة الدودية ٥ حالات (١٠٪). في جميع الحالات التي ثبت وجود إلتهاب بها، كانت ٢٢ حالة إلتهاب الزائدة الدودية النزلى، و٢٠ حالة إلتهاب الزائدة الدودية القيحي، و٣ حالات إلتهاب الزائدة الدودية المعقدة. تم توزيع إلتهاب الزائدة الدودية المعقدة كحالة واحدة مع إلتهاب الزائدة الغرغرينى، واحدة مع إلتهاب بالزائدة الدودية على وشك الإنفجار، وحالة واحدة مع زائدة منفجرة.

كانت الحساسية الإجمالية لمقياس ألفارادو عند قيمة القطع ٧ هي ٦٨.٩٪ (٧٥٪ للذكور و٥٨.٨٪ للإناث)، وكانت الخصوصية أو النوعية الإجمالية ٤٠٪ (٥٠٪ للذكور و٣٣.٣٪ للإناث)، كانت القيمة التنبؤية الإيجابية (PPV) ٩٠.٢٪، والقيمة التنبؤية السلبية ١١.١.

من هذه الدراسة، إستنتجنا أنه في محيطنا المحلى، تعد الفعالية (الحساسية والنوعية ونسبة الأرجحية التشخيصية) من مقياس ألفارادو، بإستخدام قيمة قطع تقليدية تبلغ ٧ لتحديد مجموعة المرضى عالية الخطورة، في تشخيص إلتهاب الزائدة الدودية الحاد أمراً جيداً.

يمكن إستخدام هذا المقياس في التقييم الأولي للمرضى الذين يعانون من آلام أسفل البطن الحادة حيث إنه أداة رخيصة وسريعة للتطبيق في أقسام الطوارئ.

ومع ذلك، فإن لها خصوصية منخفضة لكل من الذكور والإناث وكذلك حساسية أقل للإناث من الذكور، لا يزال يمكن إستخدامها لتوجيهنا في القرار الجراحى أو لطلب دراسات تصوير أكثر تكلفة مثل التصوير المقطعى المحوسب أو التصوير بالرنين المغناطيسى أو حتى التنظير البطنى الإستكشافى.

نوصى بإجراء هذه الدراسة مع عدد أكبر من الحالات وأن نكون حذرين أثناء إستخدامها في المريضات.

يجب النظر في قيمة قطع جديدة تبلغ ٥ في الدراسات المستقبلية، والمقارنة بين مقياس ألفارادو والمقياسات التشخيصية الأخرى في الدراسات المستقبلية.