

# EVALUATION OF THE MODIFIED ALVARADO SCORE IN ACUTE APPENDICITIS AMONG IRANIAN PATIENTS

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**Abstract-** Various scoring systems have been devised to aid diagnosis of acute appendicitis. The main objective of this study was finding the accuracy of modified Alvarado score in prediction of acute appendicitis. The registries of cases with appendectomy, who had been admitted to a referral medical center in the capital of Iran from February 2000 to March 2004, were studied. Sensitivity and specificity of modified Alvarado scoring and clinical diagnostic system used in our center were calculated. ROC curve analysis demonstrated increasing chance of acute appendicitis by increasing of the modified Alvarado score ( $P = 0.001$ ), but it was neither sensitive nor specific (sensitivity, 55%; specificity, 59%). Diagnosis based on surgeons' decision was more sensitive than Alvarado scoring (sensitivity 93-95% in different age groups). Diagnosis of acute appendicitis based on surgeons' decision is more helpful than modified Alvarado score.

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**Key words:** Acute appendicitis, modified Alvarado score, Iranian patients

## INTRODUCTION

Acute appendicitis may simulate many other acute abdominal illnesses. The diagnosis in patients with equivocal signs can be difficult. Many patients with suspected appendicitis are admitted for observation. Therefore, the exact diagnosis is important for the proper management (1, 2).

Various scoring systems have been devised to aid diagnosis (3-11). The Alvarado score was described in 1986. Classic Alvarado score included shift to left of neutrophil maturation (score 1) yielding a total score of 10 (5, 11). However, Kalan *et al.* omitted

this parameter which was not routinely available in many laboratories and produced a modified score (10).

In this study, modified Alvarado scoring system was evaluated regarding its usefulness in the early diagnosis of acute appendicitis among different age groups of Iranian patients.

## MATERIALS AND METHODS

In this study the registries of cases with appendectomy, who had been admitted to Loghman-Hakim Hospital, a referral medical center in the capital of Iran, have been studied. All appendectomies were performed from February 2000 to March 2004. The review board and ethical committee of our institution approved the trial. We obtained informed consent from all participants.

All of the patients were operated according to the decision of surgeons, based on patients' history,

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physical exam, and paraclinical investigation (cell blood count). Often, at least two positive factors were necessary for decision of appendectomy.

During the study period, 101 cases were observed due to findings suspicious for acute appendicitis, but discharged because of relieving of symptoms or diagnosis of other diseases mimicking picture of acute appendicitis. Data of these patients were not registered but number of them was used in calculating specificity of different diagnostic approaches, including modified Alvarado score.

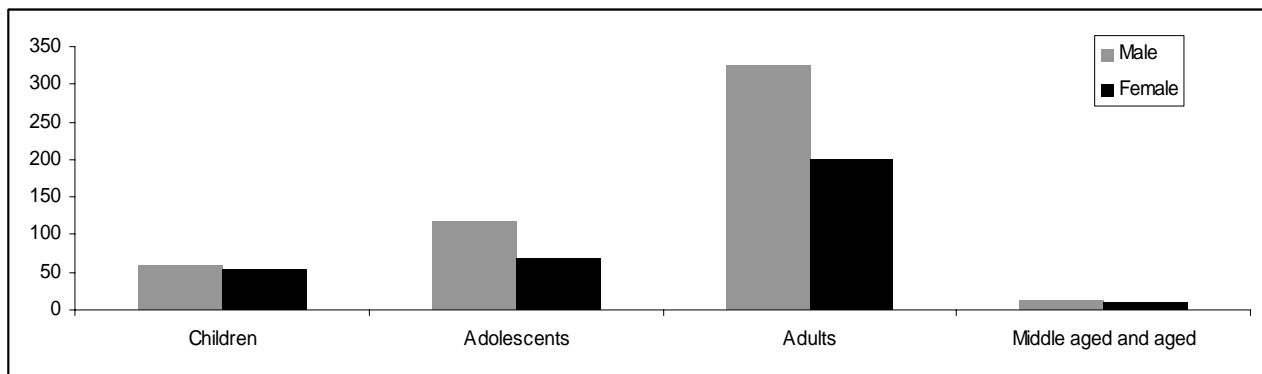
Patients were divided into four age groups: 1) children, 1 month to 12 years of age, 2) adolescents, 13 to 18 years of age, 3) adults, 19 to 54 years of age, and 4) middle aged and aged with more than 55 years of age.

The main objective of this study was finding the accuracy of modified Alvarado scoring in prediction of acute appendicitis. The modified Alvarado score was defined as Table 1. Patients with a score of 7 or above were categorized as group A and patients with a score of six or below as group B. The definite diagnosis of acute appendicitis was based on postoperative pathologic study.

Data were analyzed by SPSS for windows version 11.5 (New Jersey, USA). Sensitivity and specificity of modified Alvarado scoring and clinical diagnostic system used in our center were calculated.

**RESULTS**

A total of 849 patients were included in this study. Most of the patients were in adult age group (Fig. 1).



**Fig. 1.** Distribution of sex among different age groups.

**Table 1.** The modified Alvarado score (10, 12)

	Score
<b>Symptoms</b>	
Migratory right iliac fossa pain	1
Anorexia	1
Nausea/vomiting	1
<b>Signs</b>	
Tenderness right lower quadrant	2
Rebound tenderness right iliac fossa	1
Pyrexia greater than or equal to 37.5°	1
<b>Investigation</b>	
Leucocytosis	2
<b>Total score</b>	9

The surgical operation was decided when at least 2 positive factors in history (shifting pain), physical examination (localized tenderness, rebound, or guarding), and positive paraclinical evaluation were present (Table 2). The overall frequency of negative appendectomy was equal to 9.1 percent. By including cases that had not been operated upon, the specificity of clinically used diagnostic system may arise maximally to 64 percent.

The frequencies of symptoms, signs and paraclinical findings in accordance to Alvarado scoring are shown in Table 3. ROC curve analysis (Fig. 2) demonstrated increasing of the chance of acute appendicitis by increasing of the modified Alvarado's score ( $P = 0.001$ ), but it was neither sensitive nor specific (sensitivity, 55 percent; specificity, 59 percent; and by including non-operated patients specificity maximally equal to 63 percent).

Table 4 reveals the diagnostic value of modified Alvarado score among different age groups.

**Table 2.** Causes of operation among the study patients\*

	Children		Adolescents		Adults		Middle aged and aged	
	Acute app (n = 100)	Neg app (n = 11)	Acute app (n = 173)	Neg app (n = 16)	Acute app (n = 479)	Neg app (n = 47)	Acute app (n = 20)	Neg app (n = 3)
Positive Hx and Ph-Ex	14	1	16	3	52	7	5	-
Positive Hx and Paraclinic	-	-	0	1	3	1	-	-
Positive Ph-Ex and Paraclinic	34	5	51	4	146	12	8	1
Positive Hx, Ph Ex and Paraclinic	45	4	95	4	251	18	6	1
Total	93	10	162	12	452	38	19	2
Sensitivity	93%		94%		94%		95%	
Specificity	47%		57%		55%		60%	

Abbreviations: acute app, acute appendicitis; Neg app, negative appendectomy; Hx, history; Ph-Ex: physical examination.

\*Data are given as number.

**Table 3.** The frequency of medical findings in different age groups\*

	Children	Adolescents	Adults	Middle aged and aged	P value†
<b>Symptoms</b>					
Migratory right iliac fossa	64 (57.7%)	119(63%)	332(63.1%)	12(52.2%)	NS
Pain/Anorexia	32 (28.8%)	55(29.1%)	176(33.5%)	9(39.1%)	NS
Nausea/vomiting	75 (67.6%)	140(74.1%)	425(80.8%)	18(78.3%)	NS
<b>Signs</b>					
Pyrexia greater than or equal to 37.5°	79 (71.2%)	95(50.3%)	275(52.3%)	7(30.4%)	.0001
Rebound tenderness right iliac fossa	95 (85.6%)	163(86.2%)	444(84.4%)	19(82.6%)	NS
Tenderness right lower quadrant	111 (100%)	189(100%)	520(98.95%)	23(100%)	NS
<b>Investigation</b>					
Leukocytosis	88 (79.3%)	157(83.1%)	434(82.5%)	16(69.6%)	NS

Abbreviations: NS, Not significant.

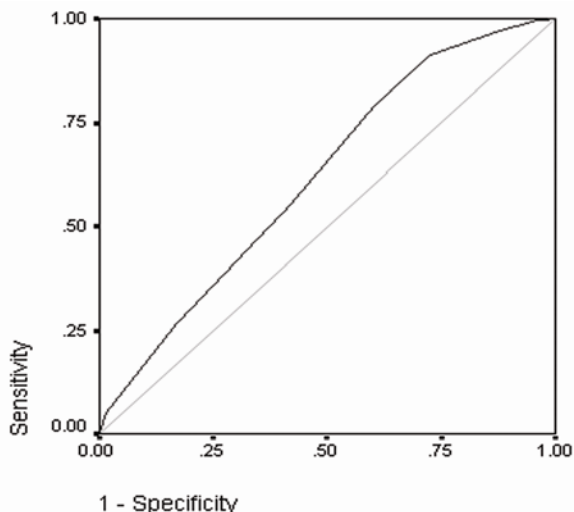
\*Data are given as number (percent).

†Chi-square.

**Table 4.** The diagnostic value of modified Alvarado's score\*

	Children	Adolescents	Adults	Middle aged and aged
<b>Group A</b>				
Appendicitis	73	124	352	19
Normal	6	14	42	3
<b>Group B</b>				
Appendicitis	27	49	126	1
Normal	5	2	6	-
Sensitivity	57%	61%	53%	40%
Specificity	55%	63%	55%	100%

\* Data are given as number.



**Fig. 2.** ROC curve indicating accuracy of modified Alvarado’s scoring.

## DISCUSSION

The goal of the clinical decision process in patients who have acute abdominal pain is to make a correct diagnosis in the fastest and cheapest way. The proper diagnosis of patients with suspicious acute appendicitis is based on separation of patients with high likelihood of acute appendicitis that operation is warranted for them and those who may be safely observed or discharged. The application of the current clinical scoring system for the diagnosis of acute appendicitis could be of help (10, 13).

Many scoring systems have been developed for preoperative diagnosis of acute appendicitis. Among these, the most famous ones are Alvarado score and its modified form (10, 11). The question is why such scorings have been developed? The creators decided to make the fastest and cheapest way of diagnosis. In other words, they decided to decrease negative appendectomy rates, beside more accurate preoperative diagnosis of positive cases.

The variant of Alvarado score (10), named modified Alvarado score, is based on 3 different categories including: factors related to patients’ history, physical examination, and blood leukocyte count (Table 1). According to the previous studies, 80 percent of acute appendicitis cases may present with migratory pain. It may range from 61 to 92

percent for nausea and vomiting, and 74 to 78 percent for loss of appetite. Positive physical findings excluding pyrexia can be seen in up to 96 percent of cases (15).

The percentage of negative appendectomy ranges from 8 to 33 percent in different studies. According to pathologic reports, 91 percent of our patients definitely had acute appendicitis. Therefore, the negative appendectomy rate was about 9 percent, which was in concordance with previous studies (12-14).

In our patients factors related to positive history (shifting pain, anorexia, and nausea-vomiting) were prominently less than previous studies. Other studies from Iran revealed that these factors are not as diagnostic as physical findings. The cause of this difference with other regions is unknown. Maybe our patients do not give an accurate history. Among the adult patients, 80 to 85 percent of cases may have leukocytosis (16). But the literatures do not agree on the prevalence of leukocytosis in pediatric and elderly.

Although the above factors can be seen in acute appendicitis, the wide range of their positiveness in different studies can predict that accumulation of them in a single parametric score might not be able to predict the presence or absence of acute appendicitis.

The modified Alvarado score was neither sensitive nor specific in our cases. Some studies revealed that this scoring system is useful for preoperative diagnosis of acute appendicitis (1, 10). But some others do not agree with this scoring as a reliable predictive system (12). The sensitivity and specificity of this scoring are reported 53-90 percent and 57-80 percent, respectively (1, 10, 12). Accordingly, many studies decided to design other scoring systems among suspected patients.

In our cases, factors such as anorexia and nausea/vomiting were not commonly present. So, giving scores to such factors may decrease the total score of modified Alvarado scoring. On the other hand, many patients could be missed or operated negatively. As reported previously (13), lower frequency of symptoms in our cases may be the result of inability of patients to define the symptoms. Most of the times, relatives had to be asked for

assistance. This is a common problem faced by physicians working in developing countries with low socioeconomic status.

We traditionally diagnose cases of acute appendicitis according to patients' symptoms (medical history), physical findings, and paraclinical evaluation including cell blood counts. As shown this system was highly sensitive in our cases. It has been estimated that the accuracy of the clinical diagnosis of acute appendicitis is between 76 and 92% (17-19).

In conclusion, the diagnosis of acute appendicitis based on surgeons' decision is more helpful than modified Alvarado score. Although if we insist on using a scoring system, regional modification is recommended.

### Conflict of interests

The authors declare that they have no competing interests.

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