

THE ROLE OF THE ALVARADO SCORING SYSTEM AND ULTRASONOGRAPHY IN THE DIAGNOSIS OF ACUTE APPENDICITIS

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ABSTRACT:

Purpose: To determine the role and predictive value of the Alvarado scoring system and ultrasonography in the diagnosis of acute appendicitis (AA).

Materials and Methods: This study is a retrospective review of all patients who underwent appendectomy for presumed AA in our clinic in 2008. The clinical diagnosis was established preoperatively based on clinical history, physical examination, laboratory tests, and radiologic findings. The patients' Alvarado scores and ultrasonography findings were obtained from their medical records.

Results: In 2008, 581 patients underwent appendectomy for presumed AA. Of these, 184 patients with both preoperative ultrasound and Alvarado scores were evaluated. There were 95 male and 89 female patients with a median age of 24 years (range, 14-78). While 171 patients (93%) had AA, 13 patients (7%) did not. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of the Alvarado score were 56%, 69%, 96%, 89%, and 56%, respectively. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of ultrasonography were 52%, 38%, 92%, 94%, and 51%, respectively. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of both the Alvarado score and ultrasonography were 58%, 51%, 94%, 89%, and 58%, respectively.

Conclusion: The Alvarado scoring system, based on symptoms, clinical signs and laboratory findings, and/or imaging studies, especially ultrasonography, is helpful for diagnosing AA.

Key words: Acute Appendicitis, Alvarado Scoring System, Diagnosis

AKUT APANDİSİT TANISINDA ALVARADO SKOR SİSTEMİ VE ULTRASONOGRAFİNİN ROLÜ

ÖZ:

Amaç: Alvarado skor sistemi ve ultrasonografinin akut apandisit (AA) tanısında rolü ve prediktif değerinin saptanması.

Gereç ve Yöntem : Kliniğimizde 2008 yılı içinde AA ön tanısı ile ameliyat edilmiş hastalar retrospektif olarak değerlendirildi. Klinik tanı öykü, fizik muayene, laboratuvar ve radyolojik bulgular ile yapıldı. Alvarado skorları ve ultrasonografi bulguları hastaların dosyalarından elde edildi.

Bulgular: 2008 yılı içinde, kliniğimizde 581 hasta AA ön tanısı ile ameliyat edildi. Dosyasından hem Alvarado skoru hem de ultrasonografi bilgilerine ulaşılabilen 184 hasta retrospektif olarak incelendi. Hastaların 95'i erkek, 89'u kadın olup, ortalama yaş 24 yıl idi (aralık 14-78 yıl). 171 hastada (%93) patolojik olarak AA tanısı konulurken, 13 hastada (%7) AA saptanmadı. Alvarado skorunun duyarlılık, özgüllük, pozitif tanımlama oranı, negatif tanımlama oranı ve doğruluk oranı sırasıyla, %56, %69, %96, %89, ve %56; Ultrasonografinin duyarlılık, özgüllük, pozitif tanımlama oranı, negatif tanımlama oranı ve doğruluk oranı sırasıyla %52, %38, %92, %94, ve %51; hem Alvarado skorunun hem de ultrasonografinin duyarlılık, özgüllük, pozitif tanımlama oranı, negatif tanımlama oranı ve doğruluk oranı sırasıyla %58, %51, %94, %89 and %58 idi.

Sonuç: Semptom, klinik ve laboratuvar bulgularına dayanan Alvarado skor sistemi ile ultrasonografi AA tanısında yardımcıdır.

Anahtar Kelimeler Akut Apandisit, Alvarado Skoru, Tanı

INTRODUCTION

Acute appendicitis (AA) is a common and urgent surgical illness with significant morbidity, which increases with diagnostic delay. Despite technological advances, the diagnosis of appendicitis is still based primarily on the patient's history and the physical examination. No single sign, symptom, or diagnostic test accurately confirms the diagnosis of AA. In order to minimize the negative appendectomy rate without increasing the incidence of perforation, patients with suspected AA are evaluated carefully.^{1,2} Different scoring systems such as Alvarado, Ohmann, and Eskelinen are used to minimize both the negative appendectomy and perforation rates.³⁻⁷

Alvarado reported a practical diagnostic score that may help in patients with suspected AA. It is based on symptoms, clinical signs, and laboratory findings.³ Some studies show that this simple clinical score can correctly classify the majority of patients with suspected appendicitis.^{3,7-15}

The aim of the present study was to determine the role and predictive value of the Alvarado scoring system and ultrasonography in AA.

PATIENTS AND METHODS

We retrospectively reviewed the general surgery medical data of 581 patients in whom appendectomy had been performed by an experienced surgeon for suspected AA in 2008. The clinical diagnosis was established based on clinical history, physical examination, laboratory tests including complete blood count, and radiologic findings, and histopathologic features were reviewed retrospectively. Laboratory tests were carried out on blood samples obtained from the patients on admission to the hospital. The leukocyte and neutrophil counts were measured by an automated hematology analyzer.

The Alvarado scoring system (Table 1) was used to diagnose AA. The patients were divided into two groups according to cumulative score: those with a cumulative score of 7 and less (Group 1) and 8 and more (Group 2). The diagnostic criteria for AA on ultrasonography were identification of an echogenic mass in the right iliac fossa and/or a non-compressible aperistaltic, tubular, laminated structure measuring at least 6 mm in anteroposterior diameter. The final diagnosis of AA was based on the histopathologic examination of the appendix.²

The study protocol was approved by the head of the department of general surgery and the Ethics Committee of Selçuk University, Meram Faculty of Medicine, and was conducted according to the Declaration of Helsinki Good Clinical Practice Guidelines. Informed consent was not required.

Table 1. The Alvarado scoring system

	SCORE
Relocation of pain	1
Vomiting	1
Pain in RIF	2
Anorexia	1
Rebound tenderness or muscular defense	
None	0
Positive	1
Body temperature	
≤ 37.4 °C	0
>37.4 °C	1
Proportion polymorphonuclear leukocytes	
≤ 74%	0
>75%	1
Leukocyte count	
≤ 10.0x10 ⁹ /L	0
>10.0–14.9x10 ⁹ /L	2

RESULTS

The patients with both preoperative ultrasound and Alvarado scores (n: 184) were enrolled in this study. There were 95 male and 89 female patients with a median age of 24 years (range, 14-78). Of these, 171 patients (93%) had AA and 13 patients (7%) did not (3.2% in male patients and 11.2% in female patients) (Table 2).

Of the patients with AA, 92 were male and 79 were female, with a median age of 24 years (range, 14-78). Pathological stages of AA were catarrhal (n: 5, 3%), simple (n: 96, 56%), suppurative (n: 23, 13.5%), gangrenous (n: 11, 6.4%), perforated (n: 13, 7.6%), and phlegmonous (n: 23, 13.5%). Of the patients without AA, 3 were male and 10 were female, with a median age of 21 years (range, 15-47). The diagnoses of the patients with negative laparotomy were normal appendix vermiformis (n: 9, 69%), lymphoid hyperplasia (n: 3, 23%), and appendiceal neuroma (n: 1, 8%). The proportion of females in the patients without AA was higher than the proportion in those with AA. The leukocyte count, and leukocytosis and neutrophilia rates of the patients with AA were higher than those of patients without AA (Table 2).

Table 2. Demographic and clinical features of the groups

	Acute appendicitis (n: 171)	Negative laparotomy (n:13)	P
Median age (range, years)	24 (14-78)	21 (15-47)	NS
Age group			
≤30 years	119 (70%)	9 (69%)	NS
31-50 years	39 (23%)	4 (31%)	
≥51 years	13 (7%)	0	
Gender			
Male	92 (54%)	3 (23%)	0.043
Female	79 (46%)	10 (77%)	
Symptoms			
Pain	171 (100%)	13 (100%)	NS
Nausea	37 (22%)	3 (23%)	
Vomiting	28 (16%)	3 (23%)	
Duration of symptoms (hours)			
≤24 hours	117 (68%)	8 (61%)	NS
24-48 hours	34 (20%)	2 (16%)	
>48 hours	20 (12%)	3 (23%)	
Signs			
Tenderness	171 (100%)	13 (100%)	NS
Rebound	152 (89%)	10 (77%)	
Defense	152 (89%)	10 (77%)	
Leukocyte count (/mm ³)	15828.65±12381.83	11192.31±4603.70	0.007
Leukocytosis rate (%)	88%	8 (61%)	0.019
Neutrophilia rate (%)	53%	23%	0.045
Ultrasonography			
Normal	82(48%)	5 (39%)	NS
Positive	89(52%)	8 (61%)	
Alvarado score			
≤7	76 (44%)	9 (69%)	NS
>7	95 (56%)	4 (31%)	

The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of the Alvarado score were 56%, 69%, 96%, 89%, and 56%, respectively. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of ultrasonography

were 52%, 38%, 92%, 94%, and 51%, respectively. The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of both the Alvarado score and ultrasonography were 58%, 51%, 94%, 89%, and 58%, respectively (Table 3).

Table 3. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of leukocytosis, neutrophilia, Alvarado score, and ultrasonography

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	DV (%)
Leukocytosis	88%	38%	95%	80%	85%
Neutrophilia	53%	77%	97%	89%	55%
Ultrasonography	52%	38%	92%	94%	51%
Alvarado score	56%	69%	96%	89%	56%
Alvarado score+ultrasonography	58%	51%	94%	89%	58%

PPV: Positive predictive value; NPV, negative predictive value; and DV, diagnostic value

DISCUSSION

Acute appendicitis is a common and urgent surgical disease, overlapping with other clinical syndromes. The main symptom of appendicitis is abdominal pain. The pain is diffuse and poorly localized at first, that is, not confined to one spot. Poorly localized pain is typical whenever a problem is confined to the small intestine or colon, including the appendix. The pain is so difficult to pinpoint when asked to point to the area of the pain that most people indicate the location of the pain with a circular motion of their hand around the central part of their abdomen. A second, common, early symptom of appendicitis is loss of appetite, which may progress to nausea and even vomiting. No single sign, symptom, or diagnostic test accurately confirms the diagnosis of appendiceal inflammation in all cases.^{1,2} In our study, the negative laparotomy rate was 7% (3.2% in male patients and 11.2% in female patients). The major symptoms of the patients with AA were abdominal pain, nausea, and vomiting, and the major physical examination findings were tenderness and rebound.

AA has significant morbidity and complications increasing with diagnostic delay. The most frequent complication of appendicitis is perforation. The risk of perforation is at least 17%. The major reason for appendiceal perforation is delay in diagnosis and treatment.⁹ Perforation of the appendix can lead to a periappendiceal abscess (a collection of infected pus) or diffuse peritonitis (infection of the entire lining of the abdomen and the pelvis). The less common complications of AA are ileus and sepsis, a feared complication of AA. The perforation rate in our study was 7.6%. We think that the low negative laparotomy and perforation rates are due to the diagnosis having been made by experienced surgeons.

The diagnosis of appendicitis begins with a thorough history and physical examination. Patients often have an elevated temperature, and there usually will be moderate to severe tenderness in the right lower abdomen. If inflammation has spread to the peritoneum, there is frequently rebound tenderness.

No single sign, symptom, or diagnostic test accurately confirms the diagnosis of AA. To minimize the negative appendectomy rate without increasing the incidence of perforation, different scoring systems including the Alvarado, Ohmann, and Eskelinen scoring systems are used.³⁻⁷

Alvarado reported a practical diagnostic score that may help in patients with suspected AA. It is based on symptoms, clinical signs, and laboratory findings.³ In a study on 57 patients with a diagnosis of suspected AA, Alvarado scoring system's specificity (positive predictive value) was 92.59% in males and 76.67% in females. Moreover, the negative appendectomy rate was 7.41% in males and 23.33% in females. They commented that with the application of the Alvarado scoring system postoperative morbidity and mortality could decrease.¹⁰ In another study, by Althoubaity,¹¹ the accuracy rate of appendicitis with the Alvarado scoring system, ultrasonography, and computed tomography was 67.7%, 7.9%, and 66.7%, respectively. A positive correlation was found between advanced cases and the Alvarado scale in this study. The positive predictive value of the Alvarado scoring system in males is higher than it is in females.^{10,12}

In this study, the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of the Alvarado score were 56%, 69%, 96%, 89%, and 56%, respectively.

In the study by Pruekprasert et al.,¹³ compared with the surgeon's clinical diagnosis (sensitivity 96% and specificity 67%), the diagnosis based on an Alvarado score of ≥ 7 had a lower sensitivity (79%) and that based on CRP of > 10 mg/l a much lower sensitivity (62%) and lower specificity (56%). The overall accuracy of these three diagnostic modalities was 90%, 72%, and 61%, respectively.

The sensitivity and specificity of ultrasonography were 94.7% and 88.9%, respectively. In our study, the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of ultrasonography were 52%, 38%, 92%, 94%, and 51%, respectively.

The diagnostic performance of the Alvarado score was variable according to patient age and sex, and the overall sensitivity of the Alvarado score was too low (72.8%) for determining immediate surgical intervention in the study by Sun et al.¹⁴ They concluded that clinical assessment using the Alvarado score should be supplemented with computed tomography examination for accurate diagnosis of AA in all patients with suspected AA. In another study, the sensitivity of Alvarado scores 3 or lower for not having AA was 96.2%, and the specificity was 67%. The sensitivity of Alvarado scores 7 or higher for AA was 77%, and the specificity was 100%. The sensitivity of equivocal Alvarado scores, defined as scores of 4 to 6, for AA was 35.6%, and the specificity was 94%. The sensitivity and specificity of CT scans in patients with equivocal Alvarado scores remained high, at 90.4% and 95%, respectively.¹⁵

The sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic value of both the Alvarado score and ultrasonography in our study were 58%, 51%, 94%, 89% and 58%, respectively.

In conclusion, despite technological advances, the diagnosis of appendicitis is still based primarily on the patient's history and the physical examination. Low negative laparotomy and perforation rates are achieved by the diagnosis performed by experienced surgeons. The Alvarado scoring system, based on symptoms, clinical signs and laboratory findings, and/or imaging studies, especially ultrasonography, are helpful for diagnosing AA.

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