

## Efficiency of Alvarado Score in Diagnosis of Acute Appendicitis

### Akut Apandisit Tanısında Alvarado Skorunun Etkinliği

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#### Abstract

**Aim:** Acute appendicitis is the most common cause of abdominal pain resulting in surgery. This study aims to investigate the efficiency of Alvarado Score (AS) in diagnosis of acute appendicitis.

**Materials and Method:** The files of 185 patients operated due to acute appendicitis between January 2013 and February 2015 were retrospectively examined. The Alvarado Scores of the patients were calculated. The patients were divided into 2 groups as <7 and ≥7 according to their Alvarado Scores and their pathology results were compared.

**Results:** Of the 185 patients included in the study, 44.8% (n: 83) were females and 55.2% (n: 102) were males. The average age was 27.12 (10-80) years. In terms of distribution, 63.8% (n: 118) of the patients had an Alvarado score of ≥7 and 36.2% (n: 67) had a score of <7. In the study, 16.7% (n: 31) of the patients had normal pathology results and the pathology of 83.2% (n: 154) patients operated with the pre-diagnosis of acute appendicitis were acute appendicitis patients. We also obtained the following results: specificity of Alvarado score: 90.3%; sensitivity: 74.6%; positive predictive value: 97.4%; negative predictive value: 18.1%; and accuracy ratio: 77.2%.

**Conclusion:** Alvarado Scoring is an affordable and effective method that is easy to use in the diagnosis of acute appendicitis.

**Keywords:** Acute Appendicitis; Alvarado Score; Abdominal Pain.

#### Öz

**Amaç:** Akut apandisit cerrahi ile sonuçlanan karın ağrısının en sık nedenidir. Bu çalışmanın amacı akut apandisit tanısında Alvarado skorunun (AS) etkinliğini araştırmak.

**Gereçler ve Yöntemler:** Ocak 2013-Şubat 2015 tarihleri arasında akut apandisit nedeniyle opere edilen 185 hastanın dosyaları geriye dönük olarak incelendi. Hastaların Alvarado Skor'u hesaplandı. Alvarado Skoru'na göre hastalar <7, ≥7 olarak 2 gruba ayrıldı ve patoloji sonuçları ile karşılaştırıldı.

**Bulgular:** Çalışmaya alınan 185 hastanın %44.8 (n: 83)'ü kadın, %55.2 (n: 102)'si erkekti. Ortalama yaş 27.12 (10-80) yıl idi. Alvarado skoru <7 olan %36.2 (n: 67) ve ≥7 olan %63.8 (n: 118) hasta mevcuttu. Çalışmada %16.7 (n: 31) hastanın patoloji sonucu normal ve akut apandisit tanısıyla opere edilen %83.2 (n: 154) hastanın patoloji sonucu akut apandisitti. Alvarado skorunun spesifitesi %90.3, sensivitesi %74.6, pozitif prediktif değeri %97.4, negatif prediktif değeri %18.1 ve doğruluk oranı %77.2 olarak hesaplandı.

**Sonuç:** Akut apandisit tanısında Alvarado Skorlaması, kullanım kolaylığı olan, ucuz ve etkin bir yöntemdir.

**Anahtar Kelimeler:** Akut Apandisit; Alvarado Skoru; Karın Ağrısı.

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## INTRODUCTION

Acute appendicitis is one of the most frequent reasons for emergency abdominal surgery. Even though it has a high rate of incidence, there are no effective methods for diagnosing acute appendicitis. The negative laparotomy rates are high for patients undergoing surgery with the pre-diagnosis of acute appendicitis in spite of pre-operative physical examination and studies. Ultrasonography (USG), tomography (CT), magnetic resonance (MRI), laparoscopy and scoring methods may be used for diagnosing acute appendicitis in suspected patients in order to reduce negative laparotomy ratios (1). The Alvarado scoring (AS) system is also one of the applicable scoring systems. The Alvarado score is calculated on the basis of patient anamnesis, examination findings and laboratory results. The migration of abdominal pain, lack of appetite, nausea/vomiting, rebound, fever, leukocytosis and neutrophilia (left shift) are evaluated and calculated on a scale of 10 points (Table 1) (2). While those who get a score in the range of 7-10 points with the Alvarado scoring system are recommended to undergo surgery, those who get a score in the range of 5-6 points are recommended to be evaluated with an additional method (3).

In this study, we aimed to investigate the effectiveness of AS system for the diagnosis of acute appendicitis.

**Table 1.** Alvarado score table

| Clinical Sign     | Points |
|-------------------|--------|
| Migration of pain | 1      |
| Nausea/Vomiting   | 1      |
| Lack of appetite  | 1      |
| Defense           | 2      |
| Rebound           | 1      |
| High Fever        | 1      |
| Leukocytosis      | 2      |
| Neutrophilia      | 1      |

## MATERIALS and METHODS

The files of 185 patients who were operated between January 2013 and February 2015 due to acute appendicitis were retrospectively examined and their AS values were calculated. The patients were divided into two groups as  $<7$  and  $\geq 7$  on the basis of their Alvarado scores. In scoring, leukocyte  $>10.000/\text{mm}^3$ , neutrophil percentage  $>75\%$  and fever  $>37.5^\circ\text{C}$  were considered positive. The groups were calculated based on their pathology results. The sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy test (test validity) of the Alvarado score for the diagnosis of acute appendicitis in general, in women and men were separately calculated ( $\text{Sensitivity} = (\text{RP} / (\text{RP} + \text{FN})) * 100 = \%$ ,  $\text{Specificity} = (\text{RN} / (\text{FP} + \text{RN})) * 100 = \%$ ,  $\text{positive predictive value} = (\text{RP} / (\text{RP} + \text{FP})) * 100 = \%$ ,  $\text{negative predictive value} = (\text{RN} / (\text{FN} + \text{RP})) * 100 = \%$ ,  $\text{diagnostic accuracy test (test validity)} = ((\text{RP} + \text{RN}) / (\text{RP} + \text{RN} + \text{FP} + \text{FN})) * 100 = \%$ ). The data collected were calculated using SPSS 15 for Windows, SPSS Inc., Chicago, Illinois, USA.

## RESULTS

Among the patients included in the study, 83 (44.8%) were females and 102 (55.2%) were males. Their average age was 27.12 (10-80) years. There were 67 (36.2%) patients with  $\text{AS} < 7$  and 118 (63.8%) with  $\text{AS} \geq 7$ . There were 34 (50.7%) women and 33 (49.3%) men with  $\text{AS} < 7$ ; 49 (41.5%) women and 69 (58.5%) men with  $\text{AS} \geq 7$  (Table 2).

**Table 2.** Distribution of patients according to Alvarado scores

| Alvarado Score |       | Acute Appendicitis | Negative Appendectomy | Total (n) |
|----------------|-------|--------------------|-----------------------|-----------|
| $< 7$          | Women | 18                 | 16                    | 34        |
|                | Men   | 21                 | 12                    | 33        |
|                | Total | 39                 | 28                    | 67        |
| $\geq 7$       | Women | 47                 | 2                     | 49        |
|                | Men   | 68                 | 1                     | 69        |
|                | Total | 115                | 3                     | 118       |

In our study, the pathology of 154 (83.2%) patients operated with the pre-diagnosis of acute appendicitis were acute appendicitis patients. Among these patients, 65 (35.1%) were women and 89 (48.1%) were men. Of these patients, the Alvarado score of 39 people (18 women, 21 men) was  $< 7$  while 115 (47 women, 68 men) of them were in the group with an Alvarado score of  $\geq 7$ . The pathology results of the remaining 31 (16.8%) patients were normal. Among these patients, 18 (9%) were women while 13 (7%) were men. The Alvarado score of 28 (16 women, 12 men) was  $< 7$  while 3 (2 women, 1 man) of them had an Alvarado score of  $\geq 7$ . AS specificity was calculated as 90.3%, sensitivity as 74.6%, positive predictive value as 97.4%, negative predictive value as 18.1% and accuracy ratio as 77.2%. In our study, the sensitivity for women was found to be 72.3% and specificity 89.4% while the sensitivity for men was found to be 77.1% and specificity 92.3% (Table 3). The frequency at which the AS parameters of patients were identified is provided in the Table 4.

**Table 3.** Alvarado score rates for the diagnosis of acute appendicitis

| Statistical Results       | General | Women | Men  |
|---------------------------|---------|-------|------|
| Sensitivity               | 74.6    | 72.3  | 77.1 |
| Specificity               | 90.3    | 89.4  | 92.3 |
| Positive predictive value | 97.4    | 95.9  | 98.6 |
| Negative predictive value | 18.1    | 26.1  | 13.0 |
| Diagnostic accuracy test  | 77.2    | 76.1  | 79.0 |

**Table 4.** Distribution of patients on the basis of parameters

| Parameter                         | Number of patients (% , n) |
|-----------------------------------|----------------------------|
| Migration of pain                 | 60.0 (111)                 |
| Lack of appetite                  | 80.5 (149)                 |
| Nausea/vomiting                   | 65.9 (122)                 |
| Defense                           | 87.0 (161)                 |
| Rebound                           | 83.7 (155)                 |
| Fever ( $37.5^\circ\text{C}$ )    | 30.2 (56)                  |
| Leukocytosis $>10000/\text{mm}^3$ | 67.0 (124)                 |
| Neutrophil percentage ( $>75\%$ ) | 42.7 (79)                  |

## DISCUSSIONS

Even though acute appendicitis is the disease that has the highest rate of incidence and requires emergency surgery, it is not always possible to make a timely and accurate diagnosis. Obtaining the patient history carefully and conducting a detailed physical examination are the most important tools in diagnosis. Acute appendicitis can be diagnosed at a great extent on the basis of clinical findings and physical examination. Given that AS is essentially based on clinical and physical examination, it offers an effective method for diagnosing acute appendicitis.

The most frequent sign of acute appendicitis is abdominal pain. It initially develops in the epigastric-periumbilical site and it migrates 1-12 hours later to become localized in the lower right quadrant of the abdomen. Another sign that is encountered in almost every patient is lack of appetite, which is generally the first sign. Nausea and vomiting are seen in 95% of the patients. The most important finding in physical examination is defense and rebound in the abdomen. The body temperature rarely exceeds 38°C. The body temperature is normal in 25-50% of the patients. The white blood cell count is generally between 10.000 and 18.000. Left shift in the neutrophil count is another laboratory finding (4). In our study, lack of appetite was identified in 149 (80.5%) patients, defense in 161 (87.0%), rebound in 155 (83.7%) and leukocytosis in 124 (67.0%) patients (Table 4).

Acute appendicitis is confused with several diseases - primarily gynecological diseases- in spite of laboratory findings, imaging studies and physical examination. This situation has increased negative appendectomy rates. The rate of negative appendectomy identified in the literature changes between 11% and 19.4% (5,6). In our study, this was 16.8% (n: 31). Out of these patients, 9% (n: 18) were women, 7% (n: 13) were men. The AS of 28 patients was <7 (16 women, 12 men) while the Alvarado score of 3 patients was  $\geq 7$  (2 women, 1 man).

The difficulties in the diagnosis of acute appendicitis and prolonged duration before the operation increase the appendicitis perforation rate. This rate changes between 3.7% and 20% (5, 7). In our study, perforation was identified in 14% (n:26) of the cases. Of these cases, 7.5% (n: 14) were men and 6.4% (n: 12) were women. There were three cases with AS <7 and 23 cases with AS  $\geq 7$ .

The combined use of multiple parameters for the diagnosis of acute appendicitis may provide better aid in the early and accurate diagnosis of the disease. In this way, perforation and negative appendectomy rates may

be reduced. For this purpose, the Alvarado scoring can be used where the assessment is made on the basis of most frequent symptoms, physical examination findings and laboratory results for the diagnosis of acute appendicitis. Several studies have been conducted to assess the usability and reliability of this scoring since it was defined by Alvarado. These studies reported its sensitivity as 54-96.2% and specificity as 54-74.39% (8,9). In our study, specificity was calculated as 90.3%, sensitivity as 74.6%, positive predictive value as 97.4%, negative predictive value as 18.1% and diagnosis accuracy test as 77.2%. The sensitivity was found to be 72.3% while specificity and sensitivity in women was 89.4% and 77.1%, respectively; specificity in men was 92.3%. In this study, the difference between female and male sex probably originates from the possibility that pelvic-gynecological diseases may lead to acute appendicitis findings in women.

In conclusion, Alvarado Scoring is a combination of physical examination, patient complaints and laboratory findings. We consider this scoring system to be a sensitive method for taking a decision to operate patients with the pre-diagnosis of acute appendicitis.

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