Original Article

Does Alvarado Score Reduce the Need for Ultrasonography in the Diagnosis of Acute Appendicitis?

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Abstract

Aims: We aimed to evaluate the correlation between Alvarado scoring and ultrasonographic findings in the diagnosis of acute appendicitis and its role in reduction of the rate of negative appendectomy. **Methods:** A total of 2772 patients operated between January 2010 and September 2016 with the presumed diagnosis of acute appendicitis were retrospectively evaluated. Patients with appendicitis detected in histopathologic examination were assessed as Group 1, and those with no appendicitis detected were assessed as Group 2. **Results:** The rate of negative appendectomy was 5.3%. Alvarado score was ≥7 in 2226 and <7 in 399 patients in Group 1. Alvarado score was ≥7 in 92 and < 7 in 55 patients in Group 2 ($P < 0.0001$). Among the patients with acute appendicitis identified in histopathologic examination, USG revealed acute appendicitis in 1804 and no acute appendicitis in 422 of the patients with an Alvarado score >7. Among the patients without acute appendicitis in histopathologic examination, USG revealed acute appendicitis in 74 and no acute appendicitis in 18 of the patients with an Alvarado score >7, while acute appendicitis was detected in USG in 29 and was not detected in 26 of the patients with an Alvarado score <7. **Conclusion:** While possibility of correct diagnosis is high in patients with an Alvarado score ≥7, the diagnosis should not be ruled out in patients with a low Alvarado score. Instead of using alone, the use of Alvarado scoring and ultrasonography together could reduce the rate of negative appendectomy and increase specificity.

Keywords: *Alvarado score, appendicitis, ultrasonography*

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Introduction

Acute appendicitis is one of the most common emergency conditions requiring surgery. Clinical and physical examination findings of the patient are important for the diagnosis. Besides, blood tests such as CRP and procalcitonin, scoring systems, ultrasonography and radiologic examinations including computed tomography (CT), and magnetic resonance imaging (MRI) are used in the diagnosis.[1] Clinical symptoms and findings, major complaints, elevated white blood count (WBC) counts and levels of c-reactive protein paves the road for different scoring systems. The Alvarado score is one of the most common clinical scoring system used in the diagnosis of acute appendicitis. The high diagnostic value of this scoring system has been confirmed in a number of studies all around the world. This scoring system is accepted as non-invasive, safe, simple, reliable, and repeatable diagnostic method. Delays in diagnosis and treatment increase the rates of morbidity and mortality.[2] The rate of negative appendectomy is seen by 8-30%.[3,4] The objective of this study was to evaluate the correlation between Alvarado scoring and ultrasonographic findings in the diagnosis of acute appendicitis and its role in reduction of the rate of negative appendectomy.

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Methods

Patients operated between January 2010 and September 2016 with the presumed diagnosis of acute appendicitis were retrospectively evaluated. The patients' data were accessed via hospital recording system (Health Information System 5). Physical examination findings were recorded. Blood samples were collected for full blood count and biochemical analysis and ultrasonography was performed. Alvarado score was calculated according to physical examination and laboratory outcomes. Pregnant patients, those aged under 18, patients who rejected to participate in the study, and those with malignancy detected in histopathologic examination were excluded from the study.

In ultrasonographic examination, a peristaltic wall thickness exceeding 6 mm which showed no compression, detection of appendicolitis, 'target sign' view, and the conditions with blind end creating per appendicular fatty tissue echogenicity were considered as acute appendicitis. An appendix having no these signs with a wall thickness under 6 mm detected in ultrasonography was assessed as normal.

Patients' histopathologic examinations were evaluated. Patients with no inflammation finding identified in the histopathologic examination were accepted as negative appendicitis. Patients with appendicitis detected in histopathologic examination were assessed as Group 1, and those with no appendicitis detected according to operational findings or the patients with no appendicitis detected in histopathologic examination were assessed as Group 2. All patients were preoperatively administered intravenous single dose 2nd generation cephalosporin. Alvarado scores, leukocyte values, neutrophil counts and ultrasonographic findings were compared between the groups.

SPSS (Statistical Package for Social Sciences) 22.0 software was used for statistical analyses. Descriptive statistical methods such as mean, standard deviation, frequency and median were used in evaluation of study data. Sensitivity, specificity, positive and negative predictive values were found. Mann Whitney U test and Chi-square test were used in comparison of the data. Significance was set at $P < 0.05$.

Results

A total of 2772 patients undergone appendectomy with the presumed diagnosis of acute appendicitis were included in the study. Of the patients, 1794 (64.7%) were males and 978 (35.3%) were females. The mean age was found as 30.8 ± 10,2 (range 18-88) years. No findings in favour of appendicitis were found in histopathologic examination of 147 patients who underwent appendectomy with the presumed diagnosis of acute appendicitis. The rate of negative appendectomy was 5.3%. The mean Alvarado score was calculated as 7.5 ± 1.8. Patient distribution by the parameters in the Alvarado scoring is given in Table 1. The mean Alvarado score was found to be 7.5 in the group with acute appendicitis detected in the histopathologic examination and 7.5 in the negative appendectomy group. No statistically significant difference was found between the groups ($P > 0.05$).

The Alvarado score was ≥7 in 2226 (84.8%) and <7 in 399 (15.2%) patients in Group 1. Alvarado score was ≥7 in 92 (62.6%) and <7 in 55 (37.4%) patients in Group 2. There was a statistically significant difference between the 2 groups ($P < 0.0001$) [Table 2]. The sensitivity of the Alvarado scoring in diagnosis of acute appendicitis was found as 84%, specificity as 37%, positive predictive value as 0.80 and negative predictive value as 0.37.

When evaluating according to ultrasonographic outcomes; ultrasonographic examination revealed evidence of acute appendicitis in 2015 (80.2%) patients, while appendix could not be seen or was normal in 520 (19.8%) patients in Group 1. Whereas in Group 2, ultrasonographic examination revealed evidence

Table 1: Distribution of patients according to Alvarado scoring parameters

	n	Percentage
Displacing pain	2534	91.4
Tenderness in the right lower quadrant	2297	82.8
Rebound	2107	76.0
Anorexia	2178	78.5
Nausea/Vomiting	1702	61.4
Fever	2102	75.8
Leukocytosis	2290	82.6

Table 2: Alvarado score of groups

	Alvarado score ≥7 *n* (%)	Alvarado score <7 *n* (%)	*p
Group 1	2226 (84.8%)	399 (15.2%)	*p*<0,0001**
Group 2	92 (62.6%)	55 (37.4%)	

* Chi-sqare testi, ** $P<0,05$ statistically significance

Table 3: Results of ultrasonography

	Ultrasonography revealed acute appendicitis *n* (%)	Ultrasonografi revealed no appendicitis/normally *n* (%)	*p
Group 1	2105 (80.2%)	520 (19.8%)	*p*=0.003**
Group 2	103 (70%)	44 (30%)	

* Ki-kare testi, ** $P<0,05$ istatistiksel anlamlı

Table 4: Comparison of groups according to alvarado scores and ultrasonography results

	Ultrasonography revealed acute appendicitis (*n*)		Ultrasonografi revealed no appendicitis/normally (*n*)	
	Alvarado score ≥7	Alvarado score <7	Alvarado score ≥7	Alvarado score <7
Group 1	1804	301	422	98
Group 2	74	29	18	26

of acute appendicitis in 103 (70%) patients, while appendix could not be seen or was normal in 44 (30%) patients. There was a statistically significant difference between the groups (P = 0.003). The sensitivity of the ultrasonography in diagnosis of acute appendicitis was found as 80%, specificity as 29%, positive predictive value as 0.95 and negative predictive value as 0.07 [Table 3].

Among the patients with acute appendicitis identified in histopathologic examination, USG revealed acute appendicitis in 1804 (81%) and no acute appendicitis in 422 (19%) of the patients with an Alvarado score >7. Whereas acute appendicitis was detected with USG examination in 301 (75%) patients, no acute appendicitis was detected in 98 (25%) patients with an Alvarado score <7. Among the patients without acute appendicitis in histopathologic examination, USG revealed acute appendicitis in 74 (80%) and no acute appendicitis in 18 (20%) of the patients with an Alvarado score >7, while acute appendicitis was detected in USG in 29 (53%) and was not detected in 26 (47%) of the patients with an Alvarado score <7 [Table 4].

Discussion

Acute appendicitis is a frequently encountered disease requiring emergency surgery. The most common clinical symptoms are abdominal pain, nausea and vomiting. Abdominal pain usually begins in the epigastric region and displaces to the right lower quadrant. The most common findings in physical examination are defence and rebound. In the present study, displacing pain was found in 91.4%, tenderness in the right lower quadrant in 82.8%, loss of appetite in 78.5%, and nausea/vomiting in 61.4% of the patients. In general, laboratory investigation reveals leukocytosis between 10.000 and 18.000. In this study, leukocytosis was found in 82.6% of the patients.

When patients are evaluated with clinical findings and laboratory investigations, negative laparotomy is observed by 10-25% and complicated appendicitis by 10-20%.[4,5] Therefore, it is important to make a correct and timely diagnosis. The rates of negative appendectomy should be reduced in order to decrease morbidity from laparotomy. Besides, one should not be delayed to prevent encountering with complicated appendicitis. Laboratory investigations increasing with inflammation, ultrasonography and radiologic examinations such as CT and MRI are used for this reason.[6]

Alvarado scoring is made according to the symptoms, physical examination and laboratory outcomes.[7] In this study, the sensitivity of the Alvarado scoring in the diagnosis of acute appendicitis was found as 84%, specificity as 37%, positive predictive value as 80%, and negative predictive value as 37%. Ultrasonography is an inexpensive, non-invasive, rapid investigation that is resulted quickly. However, it is a disadvantage that this method is dependent on the person who performs it. Ultrasonography has a sensitivity of 50-95% and a specificity of 75-100% in the diagnosis of acute appendicitis.[8] In a meta-analysis, sensitivity of ultrasonography in the diagnosis of acute appendicitis was reported as 86% and specificity as 81%.[9] In the present study, sensitivity of USG was found as 80%, specificity as 29%, positive predictive value as 95% and negative predictive value as 7%. According to these results, ultrasonography has a high diagnostic rate when it is compatible with appendicitis. However, when appendicitis is not detected with ultrasonography, the diagnosis of acute appendicitis should not be ruled out and the patients should not be discharged.

In this study, among the patients with acute appendicitis detected in the histopathologic examination, Alvarado score was ≥7 in 1804 (86%) and <7 in 301 (14%) of the patients with acute appendicitis identified with ultrasonography, while Alvarado score was ≥7 in 422 (81%) and <7 in 98 (19%) of the patients without acute appendicitis or normal appendix found with ultrasonography. If the patients would be operated based on the Alvarado score alone, correct diagnosis could not be made in 301 (11%) patients and ultrasonography had no contribution in 422 (16%) patients.

Conclusion

While the possibility of correct diagnosis is high in patients with an Alvarado score ≥7, the diagnosis should not be ruled out in patients with a low Alvarado score. However, the rate of diagnosis is high when ultrasonographic examination is compatible with acute diagnosis, which is likely to rule out the diagnosis of acute appendicitis when acute diagnosis is not detected. Instead of using alone, the use of Alvarado scoring

and ultrasonography together could reduce the rate of negative appendectomy and increase specificity.

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Conflicts of interest

There are no conflicts of interest.

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