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Original Investigation

The comparison of the effectiveness of tomography and Alvarado scoring system in patients who underwent surgery with the diagnosis of appendicitis

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ABSTRACT

Objective: The aim of this study is to compare the effectiveness of computed tomography and Alvarado scoring system in the diagnosis of acute appendicitis in patients who underwent appendectomy with the preliminary diagnosis of acute appendicitis.

Material and Methods: One hundred and one patients who underwent appendectomy with the diagnosis of acute appendicitis between January and December 2011 were included in the study. Alvarado scores were calculated, and abdominal tomography scans were obtained for each patient before surgery. Patients with Alvarado score ≥7 were considered to have appendicitis while patients with a score <7 were considered not to have appendicitis. Patients were classified into two groups based on the presence of appendicitis findings on abdominal tomography. Histopathological examination of the appendices was performed following appendectomy. All patients were classified into groups according to pathology results, Alvarado score and tomography findings. The effectiveness of Alvarado score and tomography were compared using the McNemar test.

Results: Sixty patients (59.4%) were male and 41 (40.6%) were female, with a mean age of 32 years (5-85 years). The rate of negative appendectomy was 3.9%. In 78 patients (77.3%) the Alvarado score was ≥7, while 23 patients (22.7%) had Alvarado scores <7. The presence of appendicitis was determined by histopathology in 22 out of 23 patients whose Alvarado score was <7. Tomography indicated appendicitis in 97 patients (95.9%) whereas four patients (4.1%) exhibited no signs of appendicitis by tomography. However, histopathological evaluation indicated the presence of appendicitis in those four patients as well.

Conclusion: The study results imply that tomography is a more effective means of diagnosing acute appendicitis as compared to the Alvarado scoring system.

Keywords: Appendicitis, Alvarado score, tomography

INTRODUCTION

Acute appendicitis (AA) is one of the most common causes of surgical abdominal pain. It can be confused with other diseases due to atypical complaints or variations in complaints by age and sex. If appendicitis cannot be correctly diagnosed, then either an unnecessary appendectomy is performed or complications such as perforation develop due to delay in diagnosis. Therefore, timely diagnosis of AA is imperative.

The Alvarado scoring system is a practical evaluation method used to diagnose acute appendicitis by scoring patient's complaints and symptoms. It was first proposed in 1986 by Alvarado (1). Alvarado score of 1-4 points is considered as no risk of appendicitis, patients with a score of 5-6 require either observation or additional work-up, while patients with a score higher than 7 are considered as AA (2-5). The data used for Alvarado scoring are shown in Table 1. Acute appendicitis can be correctly diagnosed in 70% of patients by using Alvarado scoring alone (6). Despite Alvarado scoring, imaging methods such as ultrasound (US) and computed tomography (CT) are utilized to avoid an unnecessary appendectomy and diagnose AA before perforation.

The previously proposed disadvantages of CT such as its being expensive, not being available everywhere, and the use of contrast medium (7) have gradually decreased, and today CT is more commonly used in the diagnosis of appendicitis. Computed tomography and Alvarado score are complementary to each other, not alternatives. However, publications comparing the efficacy of these two methods in the diagnosis of appendicitis are limited in number. In our study, we aimed to compare the diagnostic efficacy of CT and Alvarado scoring in patients who were operated with a preliminary diagnosis of appendicitis.

MATERIAL AND METHODS

This study was planned prospectively. One hundred-one patients who underwent surgery for acute appendicitis between January-December 2011 and underwent an abdominal CT were enrolled in the study. Fatih University Faculty of Medicine Hospital Ethics Committee approved the study. Patients who did not undergo surgery, and those who were diagnosed with appendicitis without a CT were excluded.

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Table 1. Alvarado score components

Findings	Score
Shift of the abdominal pain to the right lower quadrant	1
Loss of apetite	1
Nausea and vomiting	1
Right lower quadrant tenderness	2
Rebound tenderness	1
Fever (>37.3 ºC)	1
Leukocyte count (≥10.000)	2
Neutrophil ratio (>75%)	1
Total	10

The complaints of patients along with physical examination and laboratory results were recorded. Alvarado score was calculated based on values presented in Table 1. All study patients were scanned with multi-slice CT for abdominal imaging. An appendiceal lumen larger than 7 mm, presence of an appendicolith, fluid accumulation in the appendix region, presence of inflammation at the meso-appendix were considered as significant signs of AA on CT. All patients were operated with the presumptive diagnosis of AA. Four patients were operated due to clinical suspicion although there were no signs of appendicitis on CT. Other findings and pathologies beside appendicitis were also recorded. The appendix was examined histopathologically after surgery.

All patients were divided into groups after histopathologic examination according to their Alvarado score and CT findings (Table 2).

Statistical Analysis

In our study, the cut-off value for appendicitis was accepted as an Alvarado score of 7, as mentioned in previous publications (8-10). Patients with an Alvarado score ≥7 were considered to have AA, while AA was ruled out in those with an Alvarado score <7.

Computed tomography findings and Alvarado scores were compared by using the McNemar test (Table 3), p <0.05 was considered as statistically significant.

RESULTS

The study enrolled 101 patients. 60 patients (59.4%) were male and 41 (40.6%) were female, with a mean age of 32 years (5-85). Four patients who underwent surgery with a preliminary diagnosis of AA and had an appendectomy did not have histological appendicitis. Two of these patients had epiploic appendicitis and the other two patients had normal appendix vermiformis. Based on this, our negative appendectomy rate was determined as 3.9% (4/101).

Appendicitis was detected in 97 patients according to histopathology results. The Alvarado score of 75 of the 97 patients (77.3%) with appendicitis was ≥7, and was <7 in 22 (22.7%). In 93 of these 97 patients (95.9%), appendicitis findings were observed on CT, while 4 patients (4.1%) showed no signs of appendicitis. Within the four patients without appendicitis on histopathologic diagnosis, three had an Alvarado score ≥7 and one <7. However, all four patients had appendicitis findings on CT (Table 2).

Table 2. Patient distribution according to pathology, tomography and Alvarado results

		Alvarado <7	Alvarado ≥7	Total
Appendicitis (+)	Appendicitis finding on CT (+)	21 (20.7%)	72 (71.2%)	93 (92%)
	Appendicitis finding on CT (-)	1 (1%)	3 (2.9%)	4 (3.9%)
Appendicitis (-)	Appendicitis finding on CT (+)	1 (1%)	3 (2.9%)	4 (3.9%)
	Appendicitis finding on CT (-)	0	0	0
	Total	23 (22.7%)	78 (77.3%)	101 (100%)

CT: Computed Tomography

Table 3. Correlation of Alvarado score and tomography results according to McNemar test

	CT findings: Those with appendicitis findings on CT n, %	Those without appendicitis findings on CT n, %	Total n, %	p
Alvarado score ≥7	72 (74.2)	3 (3.1)	75 (77.3)	
Alvarado score <7	21 (21.6)	1 (1.0)	22 (22.7)	[a]0.001**
Total	93 (95.9)	4 (4.1)	97 (100)	

[a]Mc Nemar, **p<0.01. BT: bilgisayarlı tomografi; CT: Computed tomography

In patients with histopathologically proven appendicitis, there was a statistically significant discordance among patients with Alvarado score ≥7 and those with appendicitis findings on CT (p<0.01).

In our study, the positive predictive value of Alvarado score in the diagnosis of AA was determined as positive predictive value (PPV) = 0.9615, the negative predictive value (NPV) = 0.043, sensitivity as 0.7732, and specificity as 0.25. These values could not be calculated for tomography since there was no patient in whom the appendix could not be visualized or the appendix could not be detected on pathology.

For patients with no signs of appendicitis on histopathology, there was no significant difference in terms of diagnosis failure between patients with an Alvarado score ≥7 and those with appendicitis findings on CT (p<0.05).

DISCUSSION

Acute appendicitis can often be diagnosed by a simple examination and laboratory tests, but confirming the diagnosis can be difficult if the signs and symptoms are atypical. Studies (11, 12) report the negative appendectomy rate as 16.5-22.8%, and perforated appendectomy rate as 15-23%. Thus, the timely and

accurate diagnosis of AA is important. In our study, a negative appendectomy was performed in four patients and our rate of negative appendectomy was determined as 3.9% (4/101). This low rate can be attributed to the inclusion criteria of the study that enrolled only patients with CT, but it is also an indicator of the effectiveness of CT in the diagnosis of appendicitis.

Alvarado scoring is a method to assess the risk of AA in a particular patient. In a study by Inan et al (6), the sensitivity of the Alvarado score was reported as 70.4% and specificity as 71.4%, while Jalil et al. (13) reported these rates as 66% and 81%, respectively. In our study, 75 out of 78 patients with an Alvarado score ≥7 (96.1%) were pathologically identified to have appendicitis. Appendicitis was pathologically detected in 22 out of 23 patients with an Alvarado score <7 (95.6%). According to these results, an Alvarado score of ≥7 is quite an effective method for the diagnosis of AA, but a score <7 is not a reliable method to rule out appendicitis.

Despite implementation of the Alvarado scoring system that was based on clinical and laboratory results, negative appendectomy and perforated appendicitis have been reported. In a study using only the Alvarado score (14), the negative appendectomy rate was reported as 15.6% and the perforated appendectomy rate as 7.8%. The more frequent occurrence of atypical clinical symptoms especially in women, in children and the elderly makes it difficult to correctly diagnose AA. Imaging techniques are required more in such circumstances (11). Ultrasonography and CT are reported to decrease the negative appendectomy rate especially in women (15). As its availability, faster imaging opportunity, and diagnostic accuracy rate increased CT has been used more frequently in the diagnosis of AA.

Ultrasound has some advantages in the diagnosis of AA. It is a quick, cheap, and more available method with no radiation risk, but its success depends on the experience of the physician. In a meta-analysis, the sensitivity of sonography in the diagnosis of appendicitis was reported as 86% and the specificity as 81% (16), with different results reported in the literature. The false negative rate of US in the diagnosis of AA was determined as 14.7% in a study (6) stating that it should not be used as a stand-alone diagnostic test.

Computed tomography is superior to other imaging modalities in the diagnosis of appendicitis. It was found to be successful particularly in ruling out AA (17). The negative appendectomy rate declined after the introduction of computerized tomography (16, 18). The sensitivity of CT was reported as 86% (19), and the specificity as 66%. The sensitivity and specificity of CT in patients with an Alvarado score higher than 7 is 90.4% and 95%, respectively (3). In a meta-analysis (8), the negative appendectomy rate with only clinical evaluation was 16.7%, while this rate decreased to 8.7% in patients with CT.

In our study, appendicitis findings were observed on CT in 97 patients (95.9%), in 93 of these patients (95.8%) the pathologic diagnosis was appendicitis, while appendicitis was not detected in 4 (4.1%) patients by pathologic evaluation. Two of these patients had inflammation of the epiploic appendix that was mistaken for acute appendicitis on CT. The other two patients are those without appendicitis findings on CT but were determined to have AA based on histopathologic findings.

In all other 4 patients without signs of appendicitis on CT, appendicitis was identified pathologically. According to these results, CT is an effective method for diagnosing appendicitis. However, patients with clinical suspicion of appendicitis in whom CT findings of appendicitis are not detected should be evaluated cautiously.

In our study, the number of patients accepted as having AA according to the Alvarado score was 78 (77.2%). If the diagnosis was made only with the Alvarado score, 3 patients with a score of 1-4 would not be diagnosed as AA, and 20 patients with a score of 5-6 score would require further investigations with imaging methods or observation. But the number of patients who were diagnosed with AA by CT was 97 (95.9%). Following CT scan, patients were diagnosed without any further evaluation and were directly operated. Accordingly, we observed the significant superiority of CT in comparison to the Alvarado score in the diagnosis of AA.

If we evaluate error in AA diagnosis, three patients with an Alvarado score of 1-4 were histologically diagnosed with AA. But in CT, only four (4.1%) patients did not show any signs of appendicitis. According to these results, the failure rate of both methods in discriminating patients without AA were found to be similar.

As known, the Alvarado score that is based on clinical evaluation and laboratory measurements and CT are not alternatives to each other. In almost all patients, the values that the Alvarado score is based on are already being evaluated. However, because CT is now an easily accessible imaging method, with a shorter imaging time, and a fair cost with high diagnostic accuracy rate in AA, it is an analysis method that is being preferred quite more.

Our study was limited to "patients who were operated with the diagnosis of appendicitis", and not "all patients with suspected appendicitis" were included. So, there are some limitations of our study. Data on patients who had CT for suspicion of AA, patients who were operated with the diagnosis of appendicitis without CT, and of patients who were followed-up with suspicion of appendicitis but did not undergo surgery were not included in the study. Comparison of the Alvarado score and CT findings in all patients with suspected AA may yield different results, and more reliable conclusions could be made regarding the diagnostic power of these two methods in appendicitis.

CONCLUSION

According to the results of this study, CT is more effective in the diagnosis of AA than the Alvarado score. Therefore, in addition to classic clinical evaluation and laboratory data, CT can reduce the rate of negative laparotomy or laparoscopy in patients with suspected appendicitis by providing more accurate and faster diagnosis of AA.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Fatih University School of Medicine.

Informed Consent: Additional informed consent was not taken because the diagnosis process and the intervention were routine for appendicitis.

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