



# The role of computerized tomography in the diagnosis of acute appendicitis in patients with negative ultrasonography findings and a low Alvarado score

Ultrasonografi bulgusu negatif ve Alvarado skoru düşük akut apandisit şüpheli olgularda bilgisayarlı tomografinin tanıdaki rolü

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## BACKGROUND

We aimed to identify the role of computerized tomography (CT) in the differential diagnosis of acute appendicitis in patients with a low Alvarado score and negative ultrasonography findings.

## METHODS

Fifty-two cases who underwent appendectomy (December 2004-September 2008) were included. All patients had an Alvarado score of 4-6 together with negative ultrasonography findings; preoperative abdominal CT examination results were available in all patients. CT results were compared with intraoperative and pathological findings.

## RESULTS

The mean age of the cases was 31±4 years (range 11 to 71 years). The mean Alvarado score was 4.9. CT results were in favor of acute appendicitis in 34 of 52 cases. Of these 34 patients, acute appendicitis was confirmed by pathological findings in 31, whereas acute appendicitis could not be confirmed in the remaining three cases (8.2%). In 15 of 18 cases without CT findings of appendicitis, intraoperative and pathological findings were also in agreement; however, the remaining three cases had acute appendicitis. Based on the results of the recent studies, sensitivity and specificity of CT in the diagnosis of acute appendicitis were 91.2% and 83.3%, respectively.

## CONCLUSION

To avoid unnecessary appendectomies in suspected acute appendicitis cases with a low Alvarado score and negative ultrasonography findings, CT may be used as a complementary diagnostic tool.

**Key Words:** Acute appendicitis; Alvarado score; appendectomy; computerized tomography; ultrasonography.

## AMAÇ

Klinik muayenede Alvarado skoru düşük, ultrasonografi (US) bulgusu negatif olan, akut apandisit (AA) şüpheli olgularda bilgisayarlı tomografinin (BT) tanıya katkısını irdelemektir.

## GEREÇ VE YÖNTEM

Aralık 2004-Eylül 2008 tarihleri arasında AA ön tanısı ile incelen ve Alvarado skoru düşük olan hastalar çalışmaya alındı. Bu hastalarda önce US incelemesi yapıldı. US bulguları negatif olanların karın BT'si çekildi. BT çekilen ve ameliyat edilen 52 olguda, ameliyat ve patoloji sonuçları ile BT bulguları karşılaştırıldı.

## BULGULAR

Olguların yaş ortalaması 31±4 yıl (dağılım, 11-71) idi. Alvarado skor ortalaması 4,9 (dağılım, 4-6) idi. BT değerlendirme sonuçları; 52 hastanın 34'ü (%65,4) AA olarak değerlendirilirken 18'inde (%34) AA yönünden patoloji bulunmadı. AA olarak değerlendirilen 34 hastanın 31'inde (%91,2) ameliyat ve patoloji bulgularına göre AA saptandı, 3 olguda ise (%8,2) saptanmadı. BT'de AA olarak değerlendirilmeyen 18 olgunun 15'inde (%83,3) ameliyat ve patoloji bulgularında AA saptanmazken, 3 olguda ise saptandı. Bu çalışmada AA tanısında BT'nin duyarlılığı %91,2, özgüllüğü %83,3 olarak bulundu.

## SONUÇ

Alvarado skoru düşük, US bulguları negatif akut apandisit şüpheli olgularda gereksiz apendektomiden kaçınmak için yardımcı tanı yöntemi olarak BT'den yararlanılabilir.

**Anahtar Sözcükler:** Alvarado skoru; apendektomi; akut apandisit, bilgisayarlı tomografi; ultrasonografi.

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Acute appendicitis is one of the most common abdominal emergencies.<sup>[1,2]</sup> Its progression to perforation is associated with high morbidity and mortality rates.<sup>[2]</sup> Appendix vermiformis can be detected in 15-30% of the cases undergoing surgery for acute appendicitis.<sup>[2-5]</sup> There has been a continuous search for complementary diagnostic methods to limit the number of “unnecessary” appendectomies without delaying the diagnostic and therapeutic process and without increasing perforation rates. Thus, use of imaging modalities such as ultrasonography (US) and computerized tomography (CT) has helped to decrease the rates of perforation, morbidity and mortality, in addition to shortening the length of hospital stay.<sup>[1,6]</sup>

The Alvarado scoring system is used for the diagnosis of acute appendicitis, and it is based mainly on patient history, clinical examination and simple blood tests.<sup>[2,7,8]</sup> In his original paper, Alvarado<sup>[9]</sup> recommends surgery for patients with a score equal to or greater than 7, and follow-up for patients with a score of 5 and 6. This scoring system may also be used to differentiate between patients who require imaging studies vs. those who do not.

In the present study, abdominal CT was performed in cases suspected of acute appendicitis with an Alvarado score of 4-6 in addition to negative ultrasonography findings. In patients undergoing appendectomy, the correlation between CT findings and pathological results was evaluated.

## MATERIALS AND METHODS

Suspected cases of acute appendicitis with an Alvarado score of 4-6 were recruited for this study between December 2004 and September 2008. Initial assessment included abdominal US. The following were regarded as the signs of acute appendicitis: an appendix diameter greater than or equal to 6 mm, peri-appendicular fat tissue inflammation and pericecal fluid and/or abscess formation.<sup>[1,6,10]</sup> US was considered negative when the above-mentioned signs were absent or the appendix could not be visualized. Patients with clinical suspicion of acute appendicitis despite negative US findings underwent an abdominal CT examination. A diagnosis of acute appendicitis was made if the following were present: peri-appendicular inflammation, dilated appendix (6 mm), abscess formation, or presence of appendicolith.<sup>[1,11,12]</sup> No contrast medium was used during the CT examination (GE HiS-

peed Dual), and 5-mm thick slices were obtained to scan the abdomen and pelvis. In patients undergoing appendectomy, intraoperative findings, pathological results and CT findings were compared. The definitive diagnosis of acute appendicitis was based on pathology. US examinations were performed by two separate radiologists, and the CT images were interpreted by one radiologist.

## RESULTS

Between December 2004 and September 2008, a total of 297 patients underwent appendectomy in Kars State Hospital. Of these, 174 were also examined by US, with a negative result in 71. Among them, 52 had an Alvarado score of 4-6, and underwent appendectomy after an abdominal CT examination was performed. The mean age was 31.4 years (11-71); the female/male ratio was 30/22; and the average Alvarado score was 4.9 (4-9). Of the 34 patients with a CT examination positive for acute appendicitis, the diagnosis was also confirmed pathologically in 31 but was not confirmed in three cases, corresponding to true- and false-positive rates of 91.2% and 8.2%, respectively.

A total of 18 patients with negative CT findings underwent appendectomy due to clinical suspicion of acute appendicitis, and in three of these, pathology was also positive, with a false-negative rate of 16.7% (Table 1). In the remaining 15 patients (8 female, 7 male), appendix vermiformis was confirmed pathologically, with a true-negative rate of 83.7%. Ovarian cyst rupture was observed in two of the female patients and salpingitis in one, and mesenteric lymphadenitis was noted in two male patients (Table 2).

Thus, in our series, the sensitivity and specificity of abdominal CT in the diagnosis of acute appendicitis were 91.2% and 83.3%, respectively.

## DISCUSSION

Physical examination and patient history have been the mainstays of diagnosis in acute appendicitis for many years. As such, the accuracy of diagnosis was mainly dependent on the experience of the surgeon. A negative appendectomy rate of 15-30% has been documented in patients undergoing surgery for appendicitis.<sup>[2,13-15]</sup> Consequently, many complementary laboratory tests and scoring systems have been advocated to limit the number of “unnecessary” appendectomies. On the other hand, the use of these methods should

**Table 1.** CT findings, pathological results and the distribution of Alvarado scores

	Operated	Pathology positive	Pathology negative
CT (+)	34	31	3
CT (-)	18	3	15
Alvarado score	4.96 (4-6)	5.18 (4-6)	4.8 (4-6)

**Table 2.** The analysis of patients with negative CT findings diagnosed as appendix vermiformis in pathologic examination

Gender	Age	Number of patients	Alvarado score	Pathologic findings including appendix vermiformis
Female	23.1 (10-40)	8	4.8 (4-6)	Rupture of ovarian cyst (2) Salpingitis (1)
Male	28.2 (11-45)	7	5.1 (4-6)	Mesenteric lymphadenitis (2)
Total	25.6 (10-45)	15	4.9 (4-6)	(5)

not lead to delayed diagnoses and increased perforation rates.<sup>[16]</sup> Postoperative complications occur in 3% of the patients following simple appendectomy, while this figure may reach up to 47% in perforated appendicitis.<sup>[7]</sup> Thus, several complementary diagnostic methods such as US, CT, magnetic resonance imaging (MRI), laparoscopy, and scoring systems (e.g. Alvarado) have been used to increase the diagnostic accuracy<sup>[2]</sup> in this condition.

The Alvarado score is a 10-point clinical scoring system based on leukocyte count, symptoms and clinical findings.<sup>[2,7,17]</sup> Alvarado himself recommends surgery for all patients with a score equal to or greater than 7.<sup>[9]</sup> In the study by Chan et al.,<sup>[18]</sup> acute appendicitis was documented in 100%, 68% and 5% of cases with an Alvarado score of 9-10, 7-8, and  $\leq 6$ , respectively. Several prospective studies have concluded that the decision for surgery should not be based on Alvarado score.<sup>[19-21]</sup> However, the usefulness of Alvarado score is improved when used in conjunction with imaging modalities such as US and CT.<sup>[2,22]</sup>

While some authors advocate routine use of US in the diagnosis of acute appendicitis, others recommend selective use of this method.<sup>[2,23,24]</sup> Ultrasound is a convenient, non-invasive and inexpensive imaging technique,<sup>[1]</sup> with a sensitivity of 81-88% and specificity of 78-84%.<sup>[25]</sup> Some authors have recommended the use of Alvarado score in conjunction with US. For example, a 75% reduction in false-negative rate was reported by Stephan et al.<sup>[26]</sup> Other diagnostic methods such as CT have been proposed in equivocal cases due to high false-negative rates with US.<sup>[27]</sup> In our study, a CT examination was performed in equivocal cases with negative US findings.

In the diagnosis of acute appendicitis, CT offers higher sensitivity and specificity rates compared to US.<sup>[1,23]</sup> The reported diagnostic accuracy of CT ranges between 93-98%.<sup>[1]</sup>

However, discussions on the situations in which to use CT remain controversial. Because one-third of patients with acute appendicitis have atypical clinical signs, symptoms and laboratory findings, CT is suggested for these patients in many clinics.<sup>[13,28]</sup> Yildirim et al.<sup>[22]</sup> also suggested routine CT in patients which

Alvarado scores of 4 and below, although clinical suspicion is low. The cost and the radiation are generally assumed as the limiting factors.<sup>[23]</sup>

In this study, patients with a lower Alvarado score (4-6) were initially examined by US. A CT examination was performed in patients with clinical suspicion of acute appendicitis but without positive US findings. In these subjects, CT was 91.2% sensitive and 83.3% specific.

In conclusion, US examination in combination with clinical assessment may not provide adequate diagnostic accuracy in patients with suspected acute appendicitis. Therefore, an additional CT examination may be required in equivocal cases of acute appendicitis in order to avoid unnecessary appendectomies and higher morbidity and mortality rates associated with delayed diagnosis.

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