

# The Value of Ultrasonography, Leukocyte Count and Clinical Results in Diagnosis of Acute Appendicitis and the Duration of Stay of the Patients in Emergency Department

## Akut Apandisit Tanısında Ultrasonografi, Lökosit ve Klinik Sonuçların Değerliliği ve Hastaların Acil Serviste Kalış Süreleri

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### SUMMARY

#### Objectives

In this study, we aimed to compare the clinical data of patients diagnosed with acute appendicitis in our center with the literature.

#### Methods

The patients who were diagnosed with acute appendicitis between 01.10.2010 and 01.10.2011 in Emergency Department of İzmir Bozyaka Training and Research Hospital were included in this study. Patient demographics, dates and times of emergency department application, dates and times of hospitalization in the general surgery ward, duration of stay in the emergency department, leukocyte count and its relationship with age, the perforation rate, the relationship of perforation with age and leukocyte count, and the final diagnosis and ultrasound findings were assessed in this study.

#### Results

A total of 482 patients who were diagnosed with acute appendicitis [300 (62.2%) male, mean age 30.7±12.03; 182 (37.8%) female, mean age 31.17±13.22] were enrolled. The duration of stay in the emergency department was between 0-6 and 6-12 hours in 320 (66.4%) and 143 (29.7%) patients, respectively. The ultrasonography findings were consistent with acute appendicitis in 366 (75.9%) patients, and the mean leukocyte count of these patients was 13.141/mm<sup>3</sup>. 46 (9.5%) of the patients were diagnosed with perforated appendicitis. The ultrasonography findings were not consistent with acute appendicitis in 36 (7.5%) patients and the leukocyte counts were less than 11.000/mm<sup>3</sup> in these patients.

#### Conclusions

According to the present study results, acute appendicitis is commonly seen among the young adult male population. The coherence of ultrasonography findings with the diagnosis and its association with leukocytosis is significant and supportive. Additionally, the ultrasonography findings, leukocytosis, medical history and physical examination are important and essential factors for the diagnosis of acute appendicitis. A large number of patients with acute appendicitis were followed-up between 0-6 hours in the emergency department.

**Key words:** Acute appendicitis; emergency department; general surgery.

### ÖZET

#### Amaç

Bu çalışmada, akut apandisit tanılı hastalarımızla ilgili elde ettiğimiz verileri literatürle karşılaştırmayı amaçladık.

#### Gereç ve Yöntem

Çalışmamız İzmir Bozyaka Eğitim ve Araştırma Hastanesi Acil Tıp Kliniği'ne 01.10.2010-01.10.2011 tarihleri arasında başvuran ve akut apandisit tanısı almış olan hastaları kapsamaktadır. Çalışmamızda hastaların demografik özellikleri, acil servise başvuru tarih ve saatleri, genel cerrahi servisine yatış tarih ve saatleri, acil serviste kalış süreleri, lökosit değerleri ve yaş ile ilişkisi, perforasyon oranı ve perforasyonun yaş ve lökosit değerleri ile ilişkisi ve alınan tanı ile ultrasonografi bulguları incelendi.

#### Bulgular

Apandisit tanısı alan 482 hastanın 300'ü (%62.2) erkek, 182'si (%37.8) kadındı. Erkeklerin yaş ortalaması 30.7±12.03 iken kadınların yaş ortalaması 31.17±13.22 idi. Akut apandisit tanısı alan 482 hasta incelendiğinde; bunların 320'si (%66.4) acil serviste 0-6 saat kalırken, 143'ü (%29.7) 6-12 saat kalmıştır. Akut apandisit tanılı 482 hastanın 366'sında (%75.9) ultrasonografi bulguları akut apandisit lehineydi ve bunların da lökosit ortalaması 13.141/mm<sup>3</sup> idi. Akut apandisit tanısı alan 482 hastanın 46'sı (%9.5) perforasyonlu apandisit tanısı almıştır. Akut apandisit tanısı alan 482 hastanın lökosit ortalaması 13.044/mm<sup>3</sup> bulunmuştur. Akut apandisit tanılı 482 hastanın 36'sında (%7.5) hem ultrasonografi bulguları akut apandisit desteklememiştir ve hem de lökosit değerleri 11.000/mm<sup>3</sup> altında çıkmıştır.

#### Sonuç

Akut apandisit olgularının daha sıklıkla genç erişkin erkek popülasyonunda görüldüğü sonucuna ulaşılmıştır. Ultrasonografi bulgularının tanı ile uyumu ve lökosit birlikteliği akut apandisit için anlamlı ve destekleyici bulunmuştur. Lökosit seviyesi ve ultrasonografi bulgularının yanında; anamnez ve fizik muayenenin de önemli ve temel olduğu sonucuna varılmıştır. Akut apandisit tanılı hastaların büyük bir bölümü acil serviste 0-6 saat takip edilmiştir.

**Anahtar sözcükler:** Akut apandisit; acil servis; genel cerrahi.

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## Introduction

Acute appendicitis often presents with subtle symptoms and may be confused with other conditions. However, acute appendicitis is one of the most frequent causes of acute abdominal pain. Among all the emergent intra abdominal operations in the world, appendectomies are the most commonly performed.<sup>[1-4]</sup>

The sensitivity of the combination of diagnostic testing, physical examination, and imaging studies in diagnosing acute appendicitis is quite high.<sup>[5-7]</sup> Even though these diagnostic studies are noninvasive, their accuracy has been overestimated in several studies.<sup>[4,8]</sup> Therefore, performing a thorough history and physical examination remain very important in diagnosing acute appendicitis.<sup>[3,9]</sup> Currently, there are no diagnostic tools that when used in isolation would lead to a definitive diagnosis of acute appendicitis.<sup>[10,11]</sup> Research is ongoing so to better identify acute appendicitis with laboratory testing that is noninvasive, cost-effective and practical.

The duration of time from diagnosing acute appendicitis in the emergency department (ED) to the operating table has been reported often in the literature. Yet, the time taken to determine a diagnosis of acute appendicitis by an ED physician has not yet been published. In this study, our aim was to compare length of stay in the ED for patients with acute appendicitis, and we assessed these patients' demographic characteristics, clinical outcomes, abdominal ultrasonography results, and leukocyte counts.

## Materials and Methods

Our study included patients who presented to the İzmir Boz-yaka Training and Research Hospital Emergency Medicine Clinic between January 10, 2010 and January 10, 2011 that had histologically confirmed diagnoses of appendicitis. This was a retrospective chart review that was evaluated and approved by the educational board of the hospital (meeting No.: 343). Medical records for all patients that presented to the ED within the designated time frame were accessed. Data including patient demographics, date and time of ED presentation, ED length of stay, admission date and time to the general surgery service, leukocyte count, appendix perforation rate, and ultrasound (US) imaging were investi-

gated. Leukocyte count and appendix perforation rate and their relation with patient age were also analyzed.

US imaging results were saved in the hospital database and all images were obtained preoperatively. Various radiologists read the US images as they work shifts that switch daily. The Digi Prince DP-9900 ultrasonography device was utilized for imaging. Total blood count was performed with the LH780 device (Beckman Coulter). A leukocyte count over 11.000/mm<sup>3</sup> was defined as leukocytosis. The normal reference leukocyte count in our hospital laboratory ranged between 4.300-10.300/mm<sup>3</sup>.

## Statistical analysis

Data were recorded and analyzed with Microsoft Office Excel 2007 and SPSS version 15.0 (SPSS Inc, Chicago). Categorical data was described as the quantity "n" and percentages, whereas continuous data were expressed as the mean  $\pm$  one standard deviation with the range (minimum value-maximum value). Pearson's test and the chi-squared test were used to compare categorical data between groups, and the Kolmogorov-Smirnov test and Mann-Whitney U-test were used to compare groups of continuous variables that were not normally distributed.

## Results

Of the 482 patients that were diagnosed with acute appendicitis, 62.2% were male and the mean age of the entire study sample was 30.88 $\pm$ 12.48 years. The average age of the male patients was 30.7 $\pm$ 12.03 years, and the average age of the female patients was 31.17 $\pm$ 13.22 years. Most of the patients were between 20-29 years-old, and 38% of the study subjects fell within this age range.

The length of ED stay was 0-6 hours for 66.4% of the patients and the remaining 29.7% stayed in emergency department for 6-12 hours. The mean ED length of stay was 5.45 $\pm$ 3.46 hours. The average length of stay in the ED for patients with a perforated appendix was 5.58 $\pm$ 4.33 hours, whereas the mean length of stay for patients without a perforated appendix was 5.44 $\pm$ 3.36 hours (p=0.992, Table 1).

US examination results supported a diagnosis of acute appendicitis in 75.9% of patients. In 77.2% of patients, both

**Table 1.** The average length of ED stay of the patients according to the perforation status of appendix

Perforation	n	%	Mean $\pm$ SD (hour)	Min	Max	p
Yes	436	90.5	5.44 $\pm$ 3.36	0.22	22.28	0.992
No	46	9.54	5.58 $\pm$ 4.33	0.36	28.83	
Total	482	100	5.45 $\pm$ 3.46	0.22	28.83	

**Table 2.** The distribution of patients diagnosed as acute appendicitis according to the leukocytosis and US imaging suggesting

US	Leukocytosis				Total		X <sup>2</sup>	p
	>11.000		<11.000					
	n	%	n	%	n	%		
US (–)	80	22.8	36	27.5	116	24.1	1.148	0.284
US (+)	271	77.2	95	72.5	366	75.9		
Total	351	72.8	131	27.2	482	100.0		

**Table 3.** Age, gender and leukocyte count of the patients according to the perforation status of appendix

	Perforated	Not perforated	Total	p
Gender				
Male, n (%)	35 (11.7)	265 (88.3)	300 (62.2)	0.042
Female, n (%)	11 (6.0)	171 (94.0)	182 (37.8)	
Age				
Mean±Standard deviation	37.2±17.24	30.21±11.7	30.88±12.48	0.014
Minimum-Maximum	16-80	14-75	14-80	
Leukocytosis				
Mean±Standard deviation	15.147.83±3.619.56	12.822.71±3.811.09	13.044.61±3.850.81	0.001
Minimum-Maximum	9.400-28.000	4.100-27.100	4.100-28.000	

leukocytosis and suggestive US findings supported a diagnosis of acute appendicitis, but 72.5% of patients did not have leukocytosis but still demonstrated US results suggesting this diagnosis. There was no significant difference in the number of patients that demonstrated leukocytosis versus those that did not with US imaging suggesting acute appendicitis ( $X^2=1.148$ ,  $p=0.284$ , Table 2). For 27.2% of the patients, they had leukocyte levels below 11,000/mm<sup>3</sup>, and the mean age of this group was 30.79±13.18 years. Of these patients, 42.7% were between 20-29 years-old.

Out of all the patients in our study, 9.5% were diagnosed with perforated appendicitis and their mean age was 37.2±17.24 years. The average age of patients that did not sustain an appendix perforation was 30.21±11.7 years, which differed significantly from the mean age of patients with appendix perforations ( $p=0.014$ ). On average, the entire patient population had leukocyte levels of 13.044±3.850/mm<sup>3</sup>. For patients that did not sustain a perforation, the mean leukocyte level was 12.822±3.811/mm<sup>3</sup>, and the average level for patients with an appendix perforation was significantly higher at 15.147±3.619/mm<sup>3</sup> ( $p=0.001$ , Table 3).

## Discussion

Körner et al.<sup>[12]</sup> demonstrated that appendicitis is diagnosed more often between the 2nd and 4th decades of life, and we obtained similar results in this study. There were more males than females in our study population, which suggests that a diagnosis of acute appendicitis should be considered especially in young adult male patients presenting with abdominal pain.

Approximately one third of our patients remained in the ED for 6 or more hours. However there is no literature regarding the recommended time to diagnose patients that present to the ED with abdominal pain. When considering the high patient turnover rate in the ED, it is imperative that the source of the abdominal pain is identified and treated as rapidly as possible. Our study suggests that diagnosing ED patients with acute appendicitis within a 6-hour time frame is reasonable.

Dikicier et al.<sup>[13]</sup> emphasized that leukocytosis is relevant in diagnosing acute appendicitis. Our study also supported that patients with appendicitis frequently have concurrent

leukocytosis, which aids in making the correct diagnosis. A thorough physical examination in addition to the presence of leukocytosis are important diagnostic indicators of acute appendicitis in the literature.<sup>[14]</sup>

The rate of appendix perforation in our study was less than what other studies have previously reported.<sup>[15]</sup> A study conducted by Ezer et al.<sup>[16]</sup> revealed that the mean age of patients was higher for those with perforated appendicitis when compared to patients without a perforation. They also identified that males sustained appendix perforations more commonly than females, which was also observed in our study.

Leukocyte levels were significantly higher in patients with perforated appendicitis when compared to patients without perforated appendicitis. This finding was comparable to other reports in the literature.<sup>[2,9,17]</sup> These data suggest that higher than expected leukocytes levels may indicate an appendix perforation and confirmatory imaging techniques should be used in these patients.

We also compared ED length of stay for patients with and without appendix perforations. For patients with perforated appendicitis, it was anticipated that the length of stay would be shorter, but we determined that the duration of time spent in the ED did not significantly differ with patients without a perforation. Possible reasons for this are patients are being diagnosed with perforations relatively late during their ED stay and due to delays in physician consultation.

In this study, we investigated the correlation between leukocyte levels, US examination findings, and length of ED stay. US imaging supported the diagnosis of acute appendicitis in the majority of the patients, and leukocytosis was also observed in the majority of these patients as well. These data suggest that leukocytosis and US findings together are more meaningful in making a definitive diagnosis. However, patients with acute appendicitis may present without leukocytosis or US imaging that suggests this diagnosis. Hence, we strongly recommend that a thorough history and physical examination are performed so to further reinforce diagnostic decision-making.<sup>[14]</sup>

### Study limitations

A standard method to read US imaging was not used in this study as multiple radiologists are employed by the hospital and work in shifts. Moreover, we could not statistically compare the physical examination findings for patients with acute appendicitis as the physical examination records for ED patients could not be retrieved.

### Conclusion

We identified that acute appendicitis often occurs in young adult male patients. US imaging that suggest appendicitis

concurrent with leukocytosis are most indicative of a diagnosis of acute appendicitis. Leukocyte levels were significantly higher in patients with perforated appendicitis. One out of every ten acute appendicitis patients exhibited normal leukocytes levels and US findings. In conclusion, US imaging, leukocyte levels, history, and physical examination must all be performed so to diagnose acute appendicitis most effectively.

### Conflict of Interest

The authors declare that there is no potential conflicts of interest.

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