

The effect of appendix diameter on perforation in acute appendicitis cases

Akut apandisit olgularında apandiks çapının perforasyona etkisi

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SUMMARY




Objective: The aim of the study is to examine the association between appendix diameter and perforation and to show the significance of appendix diameter in acute appendicitis cases.

Method: The data of 286 cases who were older than 18 years of age and who were operated in a tertiary hospital between 2017 and 2018 with a diagnosis of acute appendicitis were examined retrospectively. The patients' ages, genders, pathology results, appendix diameter at abdominal tomography, white blood cell (WBC), and C-reactive protein (CRP) values were analyzed. The patients were grouped in three as perforated, non-perforated, and negative appendectomy group.

Results: Of the 286 patients operated with a diagnosis of AA, 166 (58%) were male, while 122 (42%) were the female and the average age of the patients was 37±16.79 years. The non-perforated group consisted of 194 patients, while the perforated group consisted of 56 patients, and negative appendectomy group consisted of 36 patients. Average appendix diameter of the patients was 8.84±3.29 mm, while the average WBC value was 13071±3726/mm³ and average CRP value was 3.44±5.15mg/L. When the patients' appendix diameters and CRP values were compared, a statistically significant difference was found between the groups (p<0.001). The average value of white blood cell was the lowest in negative appendectomy group, while it was the highest in the perforated group. There was a statistically significant difference between negative appendectomy group and the other two groups in terms of white blood cell (p<0.001). There was a positive correlation between the groups in terms of appendix diameter, white blood cell, and CRP (p<0.001).

Conclusions: Appendix diameter is important in the diagnosis of acute appendicitis and detection of perforated appendicitis. Appendix diameter is correlated with white blood cell and CRP.

Keywords: Acute appendicitis, perforation, appendix diameter, abdominal pain

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ÖZET

Amaç: Akut apandisit olgularında apandiks çapının önemini ve perforasyonla olan ilişkisini irdeleyip ortaya koymak amaçlandı.

Yöntem: Ordu Üniversitesi Tıp Fakültesi Eğitim Araştırma Hastanesinde akut apandisit tanısıyla 2017-2018 yılları arasında ameliyat edilen 18 yaşından büyük 286 hastanın verileri geriye dönük olarak incelendi. Hastaların yaş, cinsiyet, patoloji sonuçları, batin tomografisindeki apandiks çapı, kan beyaz küre ve C-reaktif protein (CRP) değerleri analiz edildi. Hastalar perfore, non perfore ve negatif apandektomi grubu olarak 3'e ayrıldı.

Bulgular: AA tanısı ile opere edilen 286 hastanın 166 (%58)'si erkek 122 (%42) 'si kadın olup yaş ortalamaları 37 ± 16.79 yıl idi. Non perfore grup 194, perfore grup 56 ve negatif apandektomi grubu ise 36 hastadan oluşmaktaydı. Hastaların apandiks çapı ortalaması 8.84 ± 3.29 mm, kan beyaz küre değeri ortalaması $13071\pm 3726/\text{mm}^3$ ve CRP değeri ortalaması $3.44\pm 5.15\text{mg/L}$ idi. Hasta gruplarının apandiks çapları ve CRP değerleri karşılaştırıldığında gruplar arası istatistiksel olarak anlamlı bir fark vardı ($p<0.001$). Beyaz kürenin ortalama değeri negatif apandektomi grubunda en düşük perfore grubunda ise en yüksekti. Negatif apandektomi grubu ile diğer iki grup arasında beyaz küre açısından istatistiksel olarak anlamlı bir fark vardı ($p<0.001$). Gruplar arasında apandiks çapı, beyaz küre ve CRP arasında pozitif korelasyon vardı ($p<0.001$).

Sonuç: Akut apandisit tanısında ve perfore apandisitlerin tespitinde apandiks çapı önemlidir. Apandiks çapı, beyaz küre ve CRP ile birlikte koreledir.

Anahtar sözcükler: Akut apandisit, apandiks çapı, karın ağrısı, perforasyon

INTRODUCTION

Acute appendicitis (AA) is the leading acute abdominal cause seen in patients who refer to emergency service with abdominal pain. With a delayed diagnosis of AA, appendix perforation and as a result of this, peritonitis, intraabdominal abscess, sepsis, and ileus can develop in patients.¹ In AA patients; perforation diagnosis is frequently made with intraoperative observation or postoperative histopathological examination.

For this reason, it is of critical importance for perforation diagnosis to be made timely and correctly in AA patients to prevent complications that will occur as a result of this.² Anamnesis, physical examination, increase in blood inflammatory parameters, radiological imaging and clinical experience have a significant place in the diagnosis. There are studies which show that inflammatory blood parameters, which are indicators of acute inflammation such as white blood cell count, C-reactive protein (CRP), procalcitonin, pentraxin-3 are associated with AA.^{3,4} Although there are disputes about which radiological imaging method to be used in the diagnosis of AA, it has been reported by a large number of studies that abdominal computed tomography is more reliable in the diagnosis of AA.⁵

In the present study, we aim to assess the significance of appendix diameter in AA cases and to examine its association with perforation and blood inflammatory parameters.

MATERIAL AND METHODS

The study was conducted after the approval of Ordu University Faculty of Medicine Clinical Researches Ethics Board (decision No.2019/89)

was taken. In the study, the data of patients older than 18 who referred to the emergency service of a tertiary hospital with a complaint of abdominal service and who were hospitalized with a pre-diagnosis of acute appendicitis between the dates 01.01.2017 and 31.12.2018 were examined retrospectively. All of the patients who had an abdominal computed tomography (CT) for AA diagnosis were included in the study. The patients who did not have CT, whose appendix diameters were not measured in CT and whose data were missing were not included in the study. The patients who were hospitalized with the pre-diagnosis of AA but who were not operated were excluded. Postoperative histopathological results of the patients included in the study were examined. According to histopathological results, the patients were grouped in three as perforated AA, non-perforated AA, and those whose post-operative surgical results were not compatible with AA (negative appendectomy). The patients' age, gender, WBC, and CRP values were recorded. Appendix diameters were recorded in mm. Perforated appendicitis, non-perforated appendicitis, and negative appendectomy patients' appendix diameters in abdominal CT were compared.

Statistical Analysis

A statistical package program was used for data analysis. Descriptive statistics of the assessment results were given in numbers and percentage for categorical variables and as average, standard deviation (SD), minimum (min), and maximum (max) for numerical variables. Kolmogorov Smirnov test was used for normality distribution. In the comparison of groups, ANOVA test was used to compare the groups in parameters that

were normally distributed, and the Kruskal-Wallis test was used to compare the groups in parameters that were not normally distributed. When the ANOVA test was found to be significant, Tukey test was used in comparisons of two if the groups were homogeneous, while Tamhane's test was used if they weren't. When the Kruskal-Wallis test was found to be significant, Bonferroni corrected Mann Whitney U test was used for comparisons of two. Correlation coefficients and statistical significance of the variables were calculated with the Pearson test for the variables which were normally distributed, and with Spearman test for the variables which were not normally distributed. Statistical significance level was accepted as $p < 0.05$.

RESULTS

In the study, the data of 296 patients who had a pre-diagnosis of AA in the emergency service between the dates 01.01.2017 and 31.12.2018 were analyzed. Since ten patients were discharged as a result of clinical follow-up without being operated, they were excluded from the study. Two hundred eighty-six patients were operated with a diagnosis of AA. 166 (58%) of the patients were male, while 122 (42%) were female. The average age of the patients was 37 ± 16.79 , with min:18, max:93. Average appendix diameter of the patients was 8.84 ± 3.29 mm, average WBC value

was $13071 \pm 3726/\text{mm}^3$, and average CRP value was 3.44 ± 5.15 mg/L. Table 1 shows the age, gender, and clinical data distribution of the patient groups.

Statistically, a significant difference was found in appendix diameter comparison of patient groups ($p < 0.001$). No statistically significant difference was found between WBC values of the non-perforated AA patient group and perforated AA patient group ($p = 0.088$). Statistically, a significant difference was found in the comparison of WBC values of negative appendectomy patient group with the other patient groups ($p < 0.001$). Statistically, a significant difference was found in CRP values comparison of patient groups ($p < 0.001$) (Table 2). Average appendix diameter of 158 non-perforated AA patients with a WBC value of $\geq 10000/\text{mm}^3$ was 8.71 ± 1.71 mm, while the average appendix diameter of 51 perforated AA patients with a WBC value of $\geq 10000/\text{mm}^3$ was 12.73 ± 2.73 mm. Average appendix diameter of 36 non-perforated AA patients with a WBC value of $< 10000/\text{mm}^3$ was 7.96 ± 1.06 mm, while the average appendix diameter of 5 perforated AA patients with a WBC value of $< 10000/\text{mm}^3$ was 12.60 ± 1.51 mm. When the correlation between appendix diameter and WBC and CRP was examined, low (r values 0.28 and 0.23, respectively) statistically significant positive correlation was found ($p < 0.001$ for both values).

Table 1: Age, gender, WBC, CRP and appendix diameter values of patient groups

	Non-perforated AA (n=194)	Perforated AA (n=56)	Negative appendectomy (n=36)
Sex, Male (%)	120 (61.9)	34 (60.7)	12 (33.3)
Female (%)	74 (38.1)	22 (39.3)	24 (66.7)
Age, mean \pm SD (min-max)	35.65 ± 15.16 (18-87)	42.96 ± 20.26 (18-93)	35.03 ± 17.69 (18-82)
WBC (cells/ mm^3)	13169 ± 3585	14322 ± 3788	10598 ± 3287
CRP (mg/L)	3.23 ± 4.91	5.21 ± 6.33	1.79 ± 3.39
Appendix diameter (mm)	8.58 ± 1.63	12.72 ± 2.64	4.21 ± 3.99

Table 2: Comparison of WBC, CRP and appendix diameter averages of patient groups

	Non-perforated AA ^a n=194 (mean±SD)	Perforated AA ^b n=56 (mean±SD)	Negative Appendectomy ^c n=36 (mean±SD)	p Value
WBC (cells/mm ³)	13169±3585	14322±3788	10598±3287	p<0.001 ^a p ^{a,b} =0.088 ^γ , p ^{a,c} <0.001 ^γ , p ^{b,c} <0.001 ^γ
CRP (mg/L)	3.23±4.91	5.21±6.33	1.79±3.39	p<0.001 ^β p ^{a,b} =0.021 ^δ , p ^{a,c} =0.004 ^δ , p ^{b,c} <0.001 ^δ
Appendix diameter (mm)	8.58±1.63	12.72±2.64	4.21±3.99	p<0.001 ^β p ^{a,b} <0.001 ^δ , p ^{a,c} <0.001 ^δ , p ^{b,c} <0.001 ^δ

^a: according to ANOVA test, ^β: according to the Kruskal Wallis test, ^γ: according to Post Hoc Tamhane's test, ^δ: according to Bonferroni-corrected Mann Whitney U-test

In ROC analysis conducted to measure the diagnostic value of appendix diameter in perforated appendicitis, the area under the curve was found as 0.91 (p<0.001, 95% confidence interval 0.87-0.95), (**Figure 1**). When the cut off value of appendix diameter was taken as 9.25 mm, its sensitivity for appendicitis diagnosis was found as 91%, and its specificity was found as 79%.

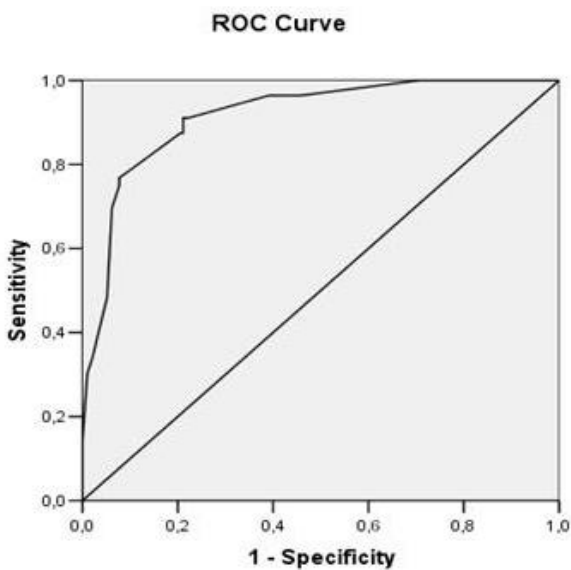


Figure 1: ROC analysis graph conducted to measure the diagnostic value of appendix diameter in perforated acute appendicitis patients.

DISCUSSION

Despite the advancements in the field of medicine, it is very difficult to make AA diagnosis even today. Delays in diagnosis and surgical intervention can cause AA perforation. In AA cases, one of the most important reasons for the increase in morbidity and mortality is developing perforation.² At the same time, it can be seen in literature that still in 10-20% of the patients operated with a pre-diagnosis of AA, pathological diagnosis is not AA.^{4,6,7} In the diagnosis of AA, in which negative appendectomy is so high, imaging techniques such as abdominal ultrasonography, abdominal CT, and abdominal magnetic resonance (MR) are important.⁸ In the diagnosis of AA, CT has been reported to have a sensitivity of 90-100%, a specificity of 91-99%, a positive predictive value of 92-98% and a negative predictive value of 95-100%. The use of CT has caused a decrease in negative appendectomy and perforated AA cases.⁹⁻¹¹ In our study, when CT was taken as the diagnostic imaging method in AA cases, 19.6% of the 286 patients were found to be perforated AA, while 12.6% were found to be negative appendectomy and these results were in parallel with the literature. In imaging techniques, one of the most important findings in making AA diagnosis is appendix diameter. The diameter of the normal appendix is 6 mm or less.^{12,13} In AA, when appendix diameter is over 6 mm, sensitivity has been reported as 93%, while

specificity has been reported as 92%.¹⁴ If the appendix diameter is 10 mm and over, the case can be accepted as AA. In a study by Webb et al., while all of the cases with an appendix diameter of 10 mm and over were found to be AA, in Benjamin et al.'s study, while only 1 of the patients 187 patients with an appendix diameter of over 10 mm was normal, the other 1986 were found to be AA.^{13,15} Of the CT findings, the presence of extra lumen gas, abscess or phlegmon, extra luminal appendicolith and focal defect in appendix wall can be indicators of AA perforation. The rate of perforation increases as the appendix diameter increases. In a study by Bixby et al., while the average diameter was found as 15.1 mm in the perforated appendix, it was found as 11mm in the non-perforated appendix.¹⁵ The results of our study are in parallel with the literature, and a significant association was found between diameter increase and perforation ($p < 0.001$). While the average appendix diameter was 8.58 ± 1.63 mm in our non-perforated cases, the average diameter was found as 12.72 ± 2.64 mm in perforated cases. When the cut-off values of appendix diameter were taken as 9.25 mm, sensitivity was found as 91%, and specificity was found as 79% for perforated appendicitis diagnosis. White blood cell and CRP are very valuable in the diagnosis of AA. When the literature is reviewed, sensitivity and specificity values of both in AA diagnosis are around 90%.^{17,18} In perforated AA cases, white blood cell and CRP values are higher when compared with non-perforated AA.¹⁹ In AA, the intensity of inflammatory response which occurs as a result of the spread of inflammation to the peritoneal cavity with perforation increases. In our study, both white blood cell and CRP values were found to be higher in perforated patients when compared with non-perforated patients. In our cases, white blood cell and CRP values were found to increase directly proportionally to appendix diameter. This brings to mind that perforated AA should be suspected in patients with high appendix diameter and WBC and CRP values. In patients who refer to the emergency service with right lower quadrant pain, anamnesis, physical examination, laboratory findings, and increase in appendix diameter in CT are important in AA diagnosis.

CONCLUSION

In AA diagnosis, appendix diameter is important. In perforated AA patients, white blood cell and WBC parameters increase directly proportionally to appendix diameter.

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