



Prediagnostic Clinical Evaluations and Double Contrast Computed Tomography in Suspected Acute Appendicitis

Akut Apandisitte Klinik Değerlendirme ve Çift Kontrastlı Bilgisayarlı Tomografi ile Ön Tanı

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Cite this article as: Aydın Y, Kuday AD, Tunalıgil V, Abuşka D, Yazıcıoğlu M, et al. Prediagnostic Clinical Evaluations and Double Contrast Computed Tomography in Suspected Acute Appendicitis. Bosphorus Med J 2023;10(4):223–230.

Received: 02.05.2023

Revision: 05.06.2023

Accepted: 06.06.2023

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ABSTRACT

Objectives: The aim of this study is to reveal the diagnostic value of abdominal computed tomography (CT) in patients with suspected acute appendicitis according to their histopathological diagnosis and who were operated on after double contrast abdominal CT.

Methods: The data of patients who were admitted to Bakirkoy Dr. Sadi Konuk Research and Training Hospital Emergency Medicine Clinic between March 01, 2009, and March 01, 2011, due to abdominal pain and were operated on with a clinical diagnosis of the acute appendicitis have been reviewed. The case group consisted of 111 patients who underwent preoperative double-contrast abdominal CT scans; the control group consisted of 50 randomly selected patients who were operated on without abdominal CT scans.

Results: In this study, 57.1% of patients were male, 42.9% of patients were female, and the mean age of patients was 38.90±16.38 years. There was no significant difference between the groups in terms of gender, age, symptoms, body temperature, abdominal physical examination, white blood cells, complete urinalysis results, or Alvarado score ($p>0.05$). The diagnostic difference between ultrasonography (USG) and CT was found to be statistically significant in patients who were histopathologically diagnosed with appendicitis compared to those who did not. While the sensitivity of USG was 35.71%, specificity 85.71%, positive predictive value (PPV) 90%, and negative predictive value (NPV) 27.02%, the sensitivity of CT was 60.46%, specificity 92%, PPV 92.85%, and NPV 40.35% was found in the diagnosis of acute appendicitis.

Conclusion: CT is one of the essential methods that can be used in the diagnosis of acute appendicitis in the emergency department and it can reduce unnecessary laparotomies. Acute appendicitis can be diagnosed by clinical examination and USG in the emergency department, but the value of CT was higher in patients who could not be diagnosed with acute appendicitis by USG.

Keywords: Abdominal; acute appendicitis; Alvarado score; CT; emergency department; EMS; IV contrast.

ÖZET

Amaç: Bu çalışmanın amacı, histopatolojik tanıya göre akut apandisit ön tanısı olan ve çift kontrastlı abdominal bilgisayarlı tomografi (BT) sonrası opere edilen hastalarda abdominal BT'nin tanısal değerini ortaya koymaktır.

Yöntem: Bakırköy Dr. Sadi Konuk Eğitim ve Araştırma Hastanesinde, 01 Mart 2009-01 Mart 2011 tarihleri arasında, acil tıp polikliniğine karın ağrısı şikayetiyle başvuran ve klinik olarak akut apandisit tanısı ile ameliyat edilen hastaların verileri gözden geçirildi. Olgu grubu, ameliyat öncesi çift kontrastlı karın BT taraması yapılan 111 hastadan oluşuyordu; kontrol grubu ise abdominal BT taraması yapılmadan opere edilen rastgele seçilmiş 50 hastadan oluşuyordu.

Bulgular: Bu çalışmada hastaların %57,1'i erkek, %42,9'u kadın ve hastaların yaş ortalaması 38,90±16,38 yıl idi. Gruplar arasında cinsiyet, yaş, semptomlar, vücut ısısı, abdominal fizik muayene, beyaz küre, tam idrar tahlili sonuçları ve Alvarado skoru açısından anlamlı fark yoktu ($p>0,05$). Histopatolojik olarak apandisit tanısı alan hastalarda, almayanlara göre ultrasonografi (USG) ve BT arasındaki tanı farkı istatistiksel olarak anlamlı bulundu. Akut apandisit tanısında USG'nin duyarlılığı %35,71, özgüllüğü %85,71, pozitif prediktif değeri (PPV) %90 ve negatif prediktif de-

ğeri (NPV) %27,02 iken, BT'nin duyarlılığı %60,46, özgüllüğü %92, PPV değeri %92,85 ve NPV değeri %40,35 bulundu.

Sonuç: BT, acil serviste akut apandisit tanısında kullanılabilecek temel yöntemlerden biridir ve gereksiz laparotomiye azaltabilir. Acil serviste klinik muayene ve USG ile akut apandisit tanısı konulabilmektedir, ancak USG ile akut apandisit tanısı konulamayan hastalarda BT değeri daha yüksek bulunmuştur.

Anahtar sözcükler: Acil tıp kliniği; ASH, abdominal; akut apandisit; Alvarado skoru; bilgisayarlı tomografi; intravenöz kontrast.

Acute appendicitis, which was defined as “tiflitis” or “peritiflitis” at the beginning of the 16th century, is an acute inflammation of the appendix vermiformis and one of the most common acute surgical abdominal emergencies.^[1] Appendicitis typically results from obstruction of the appendix vermiformis lumen due to causes such as fecalith, lymphatic tissue gallstones, tumors, and parasites.^[2] Continuation of mucus secretion in the closed lumen after appendiceal obstruction causes increased intraluminal pressure and luminal distension. This situation stimulates the visceral afferent spinal nerves to T8–T10 levels and causes epigastric and periumbilical pain. Abdominal pain is the primary symptom of acute appendicitis. Classically, the pain is located around the navel or in the epigastric region; it is usually severe and stable. This light and unlocalized visceral pain lasts for 4–6 h.

The increased intraluminal pressure as a result of the obstruction exceeds the capillary perfusion pressure and causes venous distention, arterial congestion, and tissue ischemia. When the epithelial mucosal barrier becomes inadequate, the proliferation of luminal bacteria and invasion of the appendix wall cause transmural inflammation. Ongoing tissue ischemia causes appendiceal infarction and perforation. Inflammation may extend to the parietal peritoneum and adjacent structures, including the terminal ileum, cecum, and pelvic organs. Patients feel that the pain shifts to the right lower quadrant during this period. This somatic pain is continuous and sharper than the previous visceral pain. It was first suggested by Reginald Fitz in 1886 that the disease is inflammation of the appendix, and the treatment is to remove the appendix.^[3]

Surgery can be performed immediately without the need for scanning methods if the diagnosis can be clarified with the patient's history, physical examination, and laboratory results.^[4] However, one-third of patients with appendicitis are in an atypical clinic, the findings are mixed, and a conclusion can be reached with radiological evaluation.^[5] As the definitive diagnosis of appendicitis is difficult and to avoid delay in surgical intervention, 30% of patients who underwent appendectomy have a normal appendix.^[6] The rate of misdiagnosis is higher in women than in men (women: 17.9%, men: 12%), and the rate of negative appendectomy in women of reproductive age is 23%.^[7] Appendectomy is not a completely benign process, and it has a risk of complications. Therefore, unnecessary appendectomies will be reduced in patients who were

suspected of appendicitis but with a normal appendix by the increase in the diagnostic reliability of the imaging method. Unnecessary surgeries, perforation rates, and hospital stay rates are tried to be reduced by using imaging methods such as CT and ultrasonography (USG) in the diagnosis of patients without acute appendicitis.^[8]

In many studies, computed tomography (CT) is seen as an adequate imaging method in the diagnosis of appendicitis, but the search for the optimal CT technique continues. In recent years, especially high values of non-contrast and contrast (IV and oral contrast) abdominal CT have been reported in various publications in terms of sensitivity and specificity.^[9-13] Although the issue of which technique is optimal is controversial, most studies have shown that CT is highly reliable in the diagnosis of acute appendicitis. Therefore, the primary aim of this study is to reveal the diagnostic value of abdominal CT in patients with a prediagnosis of acute appendicitis according to histopathological diagnosis and who were operated on after double contrast abdominal CT.

Methods

This research is a case–control type study that retrospectively analyzed patients who were admitted with the complaint of abdominal pain, followed up with clinical suspicion of acute appendicitis, and operated between March 2009 and 2011. Ethics committee approval dated 07.25.2011 and numbered 2011/9-08 was obtained from the Bakirkoy Dr. Sadi Konuk Research and Training Hospital Ethics Committee for the research. The research was conducted according to the principles of the Declaration of Helsinki.

Out of a total of 1072 adult patients examined, 161 patients were included in the study. The patients operated with the diagnosis of acute appendicitis and were performed preoperatively on an IV and an oral contrast CT of the abdomen, constituting the case group (Group 1: 111 cases; 69%). The patients who were operated on directly without abdominal CT before the operation constituted the control group (Group 2: 50 cases taken randomly; 31%). The data of the patients were accessed from the Emergency Medicine Clinic, Hospital Information Center, Radiology Clinic Report, and

Pathology Laboratory Results archives. The Alvarado Score was used to predict the likelihood of appendicitis diagnosis (Fig. 1). Gender, age, symptoms, body temperature, abdominal physical examination findings, WBC value, complete urinalysis results, USG and CT results, histopathological diagnoses, histopathological findings, and Alvarado measurements were obtained from the medical records of the selected study group. At the time of the study, Siemens SOMATOM Emotion 16 CT and Siemens SOMATOM Sensation 40 CT were used in the hospital.

Statistical Analysis

The data obtained as a result of the research were analyzed with the SPSS 15.0 package program. The normal distribution of the data was evaluated with the Kolmogorov-Smirnov test. Continuous variables were expressed as mean±standard deviation, and categorical variables were expressed with frequency and percentage in statistical analysis. For categorical variables, Chi-square and Fisher's exact tests were used to compare frequencies between groups. For comparing continuous variables, Student's t-test was used to examine mean differences between two groups, and a one-way ANOVA was used to examine mean differences between more than two groups. In cases of statistically significant results between several groups, Tukey's post hoc subgroup analyses were calculated. In addition, we estimated the sensitivity, specificity, and positive and negative predictive values of CT and USG. The level of significance was set at $p < 0.05$.

The Alvarado Score	
Characteristic	Points
Right lower quadrant tenderness	2
Elevated temperature	1
Rebound tenderness	1
Anorexia	1
Nausea or vomiting	1
Migration of pain to right lower quadrant	1
Leukocytosis (>10.000 WBC)	2
Left shift (>75% neutrophils)	1
Total	10
Recommendations	
Score < 5	Appendicitis unlikely
Score 5 or 6	Appendicitis possible
Score 7 or 8	Appendicitis likely
Score 9 or 10	Appendicitis high likely

Figure 1. The Alvarado score clinical scoring system used in the diagnosis of appendicitis.

Results

111 people aged 18–84 years (mean: 38.90 ± 16.38 years) were included in the case group, and 50 people were included in the control group, and a total of 161 people participated in the study. Of the case group, 61 (55%) were male and 50 (45%) were female; 31 (62%) of the control group were male and 19 (38%) were female. The primary complaint in all patients was abdominal pain. This situation was followed by anorexia, nausea+vomiting (52.8%), nausea+vomiting (25.5%), no additional complaints (13%), only anorexia (8.1%), and only fever (0.6%), respectively. The measured axillary body temperature was normal ($< 37.3^\circ\text{C}$) in 131 (81.4%) patients and high ($\geq 37.3^\circ\text{C}$) in 30 (18.6%) patients. As a result of abdominal physical examination, only tenderness in the right lower quadrant was found in 14 patients (8.7%); tenderness and rebound in the right lower quadrant were found in 79 patients (49.1%); and tenderness, defense, and rebound in the right lower quadrant were found in 67 patients (41.6%). The abdomen was relaxed and normal in only one patient. White blood cells (WBC) were below 10,000 in 24 patients (14.9%) and above in 137 (85.1%) patients. While the complete urinalysis results were normal in 97 patients (60.2%), hematuria was observed in 42 patients (26.1%), leukocyturia was observed in 11 patients (6.8%), and both leukocyturia and hematuria were observed in 11 patients (6.8%).

All 161 patients included in the study were evaluated by USG. While the appendix could not be visualized on USG in 111 (68.9%) patients, the findings were found to be consistent with acute appendicitis in 50 (31.1%) patients. Whole abdomen CT with IV+oral contrast in addition to USG was performed only in the case group among the 161 patients included in the study. The appendix could not be visualized by CT in 57 (51.4%) of the 111 patients in the case group, but the findings were found to be compatible with acute appendicitis in 54 (48.6%) of the patients. The histopathological diagnosis of 35 (21.7%) patients was compatible with a normal appendix, and 126 (78.3%) patients had acute appendicitis. 90 of 126 histopathological findings consistent with acute appendicitis were acute appendicitis + periappendicitis, 28 were phlegmenous appendicitis, 1 was gangrenous appendicitis, and 7 were consistent with perforated appendicitis. According to the Alvarado Score, none of the patients who were operated on with a preliminary diagnosis of acute appendicitis had a score below five (unlikely appendicitis). 20 (12.4%) of 161 patients scored possible appendicitis^[5,6] of acute appendicitis, 98 (60.8%) scored likely appendicitis^[7,8] and 43 (26.7%) scored compatible high likely acute appendicitis (Table 1).^[9,10]

Table 1. Comparison of the variables of the case and control group

	Case (n=111)	Control (n=50)	Total	p
Gender, n (%)				
Male	61 (55)	31 (62)	92	>0.05
Female	50 (45)	19 (38)	69	
Age, mean±SD	41.94±16.81	32.16±13.20	38.90±16.38	>0.05
Symptoms, n (%)				
Anorexia	7 (6.3)	6 (12.0)	13 (8.1)	>0.05
Fever	1 (0.9)	-	1 (0.6)	
Nausea+Vomiting	22 (19.8)	19 (38.0)	41 (25.5)	
Anorexia, Nausea+Vomiting	62 (55.9)	23 (46.0)	85 (52.8)	
None	19 (17.1)	2 (4.0)	21 (13.0)	
Body Temperature, n (%)				
Normal	95 (85.6)	36 (72)	131 (81.4)	>0.05
≥37.3 C	16 (14.4)	14 (28)	30 (18.6)	
Abdominal Physical Examination, n (%)				
No Sensitivity	1 (0.9)	-	1 (0.6)	>0.05
Right lower quadrant tenderness	13 (11.7)	1 (2.0)	14 (8.7)	
Right lower quadrant tenderness + rebound	55 (49.5)	24 (48.0)	79 (49.1)	
Right lower quadrant tenderness + rebound + defense	42 (37.8)	25 (50.0)	67 (41.6)	
White Blood Cell, n (%)				
WBC <10000	15 (13.5)	9 (18.0)	24 (14.9)	>0.05
WBC ≥10000	96 (86.5)	41 (82.0)	137 (85.1)	
Complete Urinalysis, n (%)				
Normal	65 (58.6)	32 (64.0)	97 (60.2)	>0.05
Hematuria	28 (25.2)	14 (28.0)	42 (26.1)	
Leukocyturia	10 (9.0)	1 (2.0)	11 (6.8)	
Hematuria + Leukocyturia	8 (7.2)	3 (6.0)	11 (6.8)	
USG Findings, n (%)				
Normal	90 (81.1)	21 (42.0)	111 (68.9)	*0.002
Acute appendicitis	21 (18.9)	29 (58.0)	50 (31.1)	
CT Findings, n (%)				
Normal	57 (51.4)	-	54 (48.6)	
Acute Appendicitis	54 (48.6)		57 (51.4)	
Histopathological Diagnosis, n (%)				
Normal	25 (22.5)	10 (40)	35 (21.7)	>0.05
Acute Appendicitis	86 (77.5)	40 (80)	126 (78.3)	
Histopathological Findings, n (%)				
Normal	25 (22.5)	10 (20.0)	35 (21.7)	> 0.05
Acute Appendicitis + Periappendicitis	64 (57.7)	26 (52)	90 (55.9)	
Phlegmenous appendicitis	14 (12.6)	14 (28)	28 (17.4)	
Gangrenous appendicitis	1 (0.9)	-	1 (0.6)	
Perforated appendicitis	7 (6.3)	-	7 (4.3)	
Alvarado Score, n (%)				
Appendicitis Unlikely (<5)	-	-	-	> 0.05
Appendicitis Probably (5–6)	14 (12.6)	6 (12.0)	20 (12.4)	
Appendicitis Likely (7–8)	67 (60.4)	31 (62.0)	98 (60.9)	
Appendicitis High Likely (9–10)	30 (27.0)	13 (26.0)	43 (26.7)	

There was no significant difference found when the patients' gender, age, symptoms, body temperature, abdominal physical examination, WBC value, complete urinalysis results, and Alvarado scores were compared with their histopathological diagnoses of the patients ($p>0.05$). However, a significant difference was found according to CT and USG results ($p<0.05$) (Table 2). The USG findings of 35.7% (45) of the patients who were diagnosed with acute appendicitis histopathologically and 15% (5) of patients who were non-diagnosed with acute appendicitis histopathologically in favor of acute appen-

Table 2. Comparison of variables according to histopathological findings

	Histopathological Diagnosis		Total	p
	Normal (n=35)	Acute Appendicitis (n=126)		
Gender, n (%)				
Male	16 (45.7)	76 (60.3)	92 (57.2)	>0.05
Female	19 (54.3)	50 (39.7)	69 (42.8)	
Age, mean±SD	41.94±16.81	32.16±13.20	38.90±16.38	
Symptoms, n (%)				
Anorexia	2 (15.4)	11 (84.6)	13 (8.0)	>0.05
Fever	-	1 (100)	1 (0.7)	
Nausea+Vomiting	7 (17.1)	34 (82.9)	41 (25.5)	
Anorexia, Nausea+Vomiting	21 (24.7)	64 (75.3)	85 (52.8)	
None	5 (23.8)	16 (76.2)	21 (13.0)	
Body Temperature, n (%)				
Normal	29 (81)	102 (82.9)	131 (100)	>0.05
≥37.3 C	6 (19)	24 (17.1)	30 (100)	
Abdominal Physical Examination, n (%)				
No Sensitivity	0	1 (0.8)	1 (0.6)	>0.05
Right lower quadrant tenderness	2 (5.7)	12 (9.5)	14 (8.7)	
Right lower quadrant tenderness + rebound	20 (57.1)	59 (46.8)	79 (49.1)	
Right lower quadrant tenderness + rebound + defense	13 (37.1)	54 (42.9)	67 (41.6)	
White Blood Cell, n (%)				
WBC <10000	28 (80.0)	109 (86.5)	137 (14.9)	>0.05
WBC ≥10000	7 (20.0)	17 (13.5)	24 (85.1)	
Complete Urinalysis, n (%)				
Normal	23 (23.7)	74 (76.3)	97 (60.2)	>0.05
Hematuria	9 (21.4)	33 (78.6)	42 (26.1)	
Leukocyturia	1 (9.1)	10 (90.9)	11 (6.8)	
Hematuria + Leukocyturia	2 (18.2)	9 (81.8)	11 (6.8)	
USG Findings, n (%)				
Normal	30 (85)	81 (64.3)	111 (68.9)	*0.015
Acute appendicitis	5 (15)	45 (35.7)	50 (31.1)	
CT Findings, n (%)				
Normal	23 (92)	34 (39.5)	57 (51.4)	**0.000
Acute Appendicitis	2 (8)	52 (60.5)	56 (48.6)	
Alvarado Score, n (%)				
Appendicitis Unlikely (<5)	-	-	-	>0.05
Appendicitis Probably (5-6)	8 (22.9)	12 (9.5)	20 (12.4)	
Appendicitis Likely (7-8)	20 (57.1)	78 (61.9)	98 (60.9)	
Appendicitis High Likely (9-10)	7 (20)	36 (28.6)	43 (26.7)	

*P<0.05; **P<0.001.

ditis. The difference between USG diagnoses of patients with and without diagnosed acute appendicitis histopathologically was found to be statistically significant ($p=0.015$, $p<0.05$). While the value of USG in patients with and without histopathological diagnosis of acute appendicitis was not found to be significant in the case group, it was found to be significantly different in the control group ($p=0.002$, $p<0.05$). The sensitivity of USG in the diagnosis of acute appendicitis was 35.71%, the specificity was 85.71%, the positive predictive value (PPV) was 90%, and the negative predictive value (NPV) was 27.02% (Table 3).

The diagnostic difference of CT was found to be statistically significant ($p=0.000$, $p<0.05$) between patients with and without histopathological diagnosis of acute appendicitis when the CT results were compared according to the histopathological diagnosis. The sensitivity of CT in the diagnosis of acute appendicitis was 60.46%, the specificity was 92%, the PPV was 92.85%, and the NPV was 40.35%. In the comparison of USG and CT applied to the patients in the case group, 19% ($n=21$) of 111 patients were diagnosed with acute appendicitis on USG and 48.6% ($n=54$) were diagnosed with acute appendicitis on CT. While both USG and CT evaluated 41.4% ($n=46$) of patients as normal, they evaluated 9% of patients ($n=10$) as having acute appendicitis. 44 patients (39.6%) who were evaluated as normal by USG were diagnosed with acute appendicitis by CT.

Discussion

In this study, there was no significant difference in terms of gender, age, symptoms, body temperature, abdominal physical examination, WBC value, complete urinalysis results, or

Alvarado scores between patients who were included in the study and were diagnosed with and without histopathologically acute appendicitis ($p>0.05$). However, the diagnostic difference between USG and CT was found to be statistically significant ($p=0.015$, $p=0.000$, respectively) between patients with and without histopathologically diagnosed of acute appendicitis.

When the similar studies of Wagner et al.,^[14] Stengel et al.,^[15] Toorenvliet et al.,^[16] Aren et al.,^[17] Mahato et al.,^[18] Mavili et al.,^[19] Ergün et al.,^[20] Yükksekaya et al.,^[21] Yıldırım et al.,^[22] Khan et al.^[23] and Phophrom et al.^[24] were examined and compared with this study; the sensitivity of nausea+vomiting was consistent, but the specificity was lower and inconsistent; the sensitivity of anorexia was consistent, but the specificity was lower and inconsistent with the literature; the sensitivity of the right lower quadrant sensitivity was found higher and consistent, but the specificity was found to be 0%; the sensitivity of fever was found lower and inconsistent, but the specificity was found consistent; the sensitivity and specificity of right lower quadrant rebound tenderness were found consistent; the sensitivity and PPV of leukocytosis were found consistent with the literature, but the specificity and NPV were found to be lower and inconsistent; and finally, the sensitivity and NPV of USG were found lower and inconsistent, but the specificity and PPV were found higher and consistent with the literature.

In the study of Yükksekaya et al.,^[21] the sensitivity of spiral CT without contrast in the diagnosis of acute appendicitis was 93%, the specificity was 92%, the accuracy was 95%, the PPV was 89%, and the NPV was 95%.^[6] In a study of 52 patients by Mavili et al.,^[19] the sensitivity of CT was

Table 3. Diagnostic values of diagnostic methods

Diagnostic Methods	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
High Fever	19.04	82.85	80.00	22.10
WBC	86.50	20.00	79.56	41.17
Anorexia	59.52	34.28	23.46	19.04
Nausea+Vomiting	77.77	20.00	77.77	20.00
Tenderness in the right lower quadrant	99.20	0	78.12	0
Rebound in the right lower quadrant	89.68	5.70	89.68	13.13
USG	35.71	85.71	90.00	27.02
USG in case	77.90	92.00	90.47	25.55
USG in control	35.00	70.00	10.34	33.33
CT	60.46	92.00	92.85	40.35

*PPV: Positive predictive value; NPV: Negative predictive value.

93.1%, the specificity was 86.9%, PPD was 90%, and NPV was 90.1%. Sensitivity of CT in the diagnosis of acute appendicitis in this study was 60.46%; specificity of 92%; PPD was 92.85%; NPD was 40.35%. When the research findings are compared with the literature, the sensitivity of CT was lower, specificity was consistent, PPD was high, and NPD was lower and inconsistent.

The patients were divided into three groups according to their Alvarado scores (score 1–4, score 5–7, and score 8–10) and examined whether their histopathological diagnosis was compatible with acute appendicitis in the study conducted by Yildirim et al.^[22] There was no difference between the CT scans of the patients in terms of PPD, but it was emphasized that CT should be performed even in patients with low scores. In the studies of Ikhan et al.^[23] and Mahato et al.,^[18] it was emphasized that a high Alvarado score is important and can be used in the diagnosis of appendicitis. Consistent with the literature, the increase in Alvarado Score (score: 5–6, score: 7–8, score: 9–10) was found to be proportional to the increase in the diagnosis of acute appendicitis (respectively, 60%, 79.6%, and 83.7%).

Although the research findings are not fully compatible with the literature, it was shown that the use of the Alvarado score in the diagnosis of appendicitis may reduce unnecessary laparotomies as a result of our research. In addition, it has been found that appendicitis can be diagnosed with clinical examination and USG, but the diagnostic value of CT is higher than USG and clinical examination.

Limitations of the Study

The most important limitation of the study is that it was conducted retrospectively. The second limitation of the study is that examination and evaluation could not be performed by the same doctors in the same clinic since the study period covered a period of approximately 1 year. Since different radiologists may interpret the same case differently and affect the outcome of the study, it is recommended to provide strong evidence by standardizing the inclusion and diagnostic criteria in future studies.

Conclusion

Despite all clinical and diagnostic methods, negative appendectomy continues to be performed in patients who underwent emergency appendectomy. Although CT is a valid diagnostic tool for patients with suspected acute appendicitis,

its appropriate use remains unclear. Unnecessary surgeries, perforation rates, and length of stay in the hospital should be reduced in patients without acute appendicitis by using assistive imaging tests (such as US or CT) in the diagnosis. As supported in the literature, it was shown in our study that CT had high sensitivity and specificity values and was highly reliable in the diagnosis of acute appendicitis.

Disclosures

Acknowledgements: This original research article is based on the first author's (Aydin Y) 2011 dissertation in Emergency Medicine, at the TR MoH Bakirkoy Dr. Sadi Konuk Research and Training Hospital, advised by the senior author (Ozucelik DN) of this article.

The authors appreciate the participants' collaboration in this scientific research and acknowledge Executive Administrator Burak Kaan Sular, who went beyond the call of duty to support the conduct of the study. We hereby express our gratitude for emergency teams' commitment to saving lives, anywhere in the world.

Ethics Committee Approval: Ethics committee approval dated 07.25.2011 and numbered 2011/9-08 was obtained from the Bakirkoy Dr. Sadi Konuk Research and Training Hospital Ethics Committee for the research. The research was conducted according to the principles of the Declaration of Helsinki.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – Y.A., D.N.Ö.; Design – Y.A., V.T., D.N.Ö.; Supervision – Y.A., V.T., D.N.Ö.; Materials – Y.A., A.D.K.; Data collection &/or processing – Y.A., D.A., M.Y.; Analysis and/or interpretation – Y.A., A.D.K., V.T., D.N.Ö.; Literature search – Y.A., A.D.K., V.T., D.A.; Writing – Y.A., A.D.K., V.T.; Critical review – Y.A., V.T., D.N.Ö.

References

- Barie PS. Non-operative management of appendicitis: Evolution, not revolution. *Surg Infect Larchmt* 2021;22:991–1003.
- Tran N, Emuakhagbon VS, Baker BT, Huerta S. Re-assessing the role of the fecalith in acute appendicitis in adults: Case report, case series and literature review. *J Surg Case Rep* 2021;2021:rjaa543.
- Zhang PH, Wei JJ, Lian TT, Jiang Y, Zhuang ZH. Effect of endoscopic appendix intubation and irrigation on acute uncomplicated appendicitis. *World J Surg* 2021;45:3313–9.
- Takada T, Inokuchi R, Kim H, Sasaki S, Terada K, Yokota H, et al. Is "pain before vomiting" useful?: Diagnostic performance of the classic patient history item in acute appendicitis. *Am J Emerg Med* 2021;41:84–9.
- Baidya N, Rodrigues G, Rao A, Khan S. Evaluation of Alvarado score in acute appendicitis: A prospective study. *Internet J of Surg* 2006;9:1–4.
- Luksaite-Lukste R, Kliokyte R, Samuilis A, Jasiunas E, Luksta M, Strupas K, et al. Conditional CT strategy - an effective tool to

- reduce negative appendectomy rate and the overuse of the CT. *J Clin Med* 2021;10:2456.
7. Çomçalı B, Kocaoz S, Altun Özdemir B, Canlıkarakaya F, Korukluoğlu B. What is the effectiveness of the Tzanakis scoring system modified by the Delta Neutrophil Index in the diagnosis of acute appendicitis in pregnant women? *Eur J Obstet Gynecol Reprod Biol* 2021;264:219–23.
 8. Podda M, Pisanu A, Sartelli M, Coccolini F, Damaskos D, Augustin G, et al. Diagnosis of acute appendicitis based on clinical scores: Is it a myth or reality? *Acta Biomed* 2021;92:e2021231.
 9. Rud B, Vejborg TS, Rappoport ED, Reitsma JB, Wille-Jørgensen P. Computed tomography for diagnosis of acute appendicitis in adults. *Cochrane Database Syst Rev* 2019;2019:CD009977.
 10. Eurboonyanun K, Rungwiriyanich P, Chamadol N, Promsorn J, Eurboonyanun C, Srimunta P. Accuracy of nonenhanced CT vs contrast-enhanced CT for diagnosis of acute appendicitis in adults. *Curr Probl Diagn Radiol* 2021;50:315–20.
 11. Yazıcı P, Öz A, Kartal K, Battal M, Kabul Gürbulak E, Akgün İE, et al. Emergency computed tomography for the diagnosis of acute appendicitis: How effectively we use it? *Ulus Travma Acil Cerrahi Derg* 2018;24:311–5.
 12. Moris D, Paulson EK, Pappas TN. Diagnosis and management of acute appendicitis in adults: A review. *JAMA* 2021;326:2299–311.
 13. Fu J, Zhou X, Chen L, Lu S. Abdominal ultrasound and its diagnostic accuracy in diagnosing acute appendicitis: A meta-analysis. *Front Surg* 2021;8:707160.
 14. Wagner JM, McKinney WP, Carpenter JL. Does this patient have appendicitis? *JAMA* 1996;276:1589–94.
 15. Stengel JW, Webb EM, Poder L, Yeh BM, Smith-Bindman R, Coakley FV. Acute appendicitis: Clinical outcome in patients with an initial false-positive CT diagnosis. *Radiology* 2010;256:119–26.
 16. Toorenvliet BR, Wiersma F, Bakker RF, Merkus JW, Breslau PJ, Hamming JF. Routine ultrasound and limited computed tomography for the diagnosis of acute appendicitis. *World J Surg* 2010;34:2278–85.
 17. Aren A, Gökçe Ah, Gökçe Fs, Özakay K. Correlation of acute appendicitis with age, gender and leukocyte. *İstanbul Tıp Derg [Article in Turkish]* 2009;10:126–9.
 18. Mahato IP, Bhandari R, Rajbhandari R, Kumari S, Yadav AK. Sensitivity and specificity of clinical features used in alvarado scoring system. *Health Renaiss* 2011;9:12–14.
 19. Mavili E, Kahrıman G, Şenol S, Durak AC. Correlation of unenhanced helical CT and ultrasonography for the diagnosis of acute appendicitis. *Tıp Araştırmaları Derg [Article in Turkish]* 2005;3:1–7.
 20. Ergün E, Bilaloğlu P, Koşar U, Ünlübay D, Temel S. Akut apandisit tanısında opaksız spiral BT incelemenin yeri, US ve cerrahi sonuçları ile korelasyonu. *Tanısal Girişimsel Radyol [Article in Turkish]* 2002;8:231–6.
 21. Yüksekaya R, Akgül E, İnal M. Akut apandisit tanısında kontrastsız spiral BT'nin Yeri. *Tanısal ve Girişimsel Radyol [Article in Turkish]* 2004;10:131–9.
 22. Yildirim E, Karagülle E, Kirbaş I, Türk E, Hasdoğan B, Tekşam M, et al. Alvarado scores and pain onset in relation to multislice CT findings in acute appendicitis. *Diagn Interv Radiol* 2008;14:14–8.
 23. Khan I, ur Rehman A. Application of alvarado scoring system in diagnosis of acute appendicitis. *J Ayub Med Coll Abbottabad* 2005;17:41–4.
 24. Phophrom J, Trivej T. The modified Alvarado score versus the Alvarado score for the diagnosis of acute appendicitis. *Thai J of Surg* 2005;26:69–72.