ORIGINAL ARTICLE

Computed tomography and clinical outcomes in the diagnosis of acute appendicitis: Significance of periappendiceal fat tissue

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ABSTRACT

BACKGROUND: This study aimed to elucidate the diagnostic significance of changes in periappendiceal fat density observed on computed tomography (CT) in patients with acute appendicitis (AA).

METHODS: Patients who underwent surgery with a diagnosis of AA based on CT findings from January 1, 2020 to December 31, 2020 were included in the study. Patients were divided into three grades. In Grade 1, the periappendiceal tissue appears hypoechoic, indicative of normal tissue. In Grade 2, the periappendiceal tissue is slightly hyperechoic but confined to the periappendiceal area. In Grade 3, dense hyperechoic areas are present not only in the periappendiceal tissue but also extend into surrounding organs and deeper tissues. The groups were compared in terms of clinical, laboratory, and pathological outcomes.

RESULTS: A total of 195 patients-131 males and 64 females-were included in the study. A correlation was identified between grade and several factors: appendix diameter, appendix wall thickness, incidence of lymphadenopathy, and duration of symptoms onset ($p<0.001$). Conditions such as appendicolitis, free air, and intra-abdominal abscesses were more frequently observed in Grade 3 patients compared to Grade 1 and Grade 2 patients ($p=0.002$, $p<0.001$). Both operative time and length of hospital stay were highest in Grade 3 patients ($p<0.001$). The rate of patients found to have a normal appendix upon pathological examination was significantly higher in Grade 1 than in Grade 2 ($p=0.03$).

CONCLUSION: In cases where the diagnosis is uncertain, the hyperechogenicity in periappendiceal tissue observed on CT strengthens the diagnosis of AA. Additionally, cases of AA become increasingly complex as echogenicity in periappendiceal tissue increases.

Keywords: Acute appendicitis; computed tomography; periappendiceal area; hyperechogenicity.

INTRODUCTION

Acute appendicitis (AA) is the most commonly encountered pathology in general surgical emergencies worldwide and is the leading cause of complaints related to acute-onset abdominal pain. Patients typically present to the emergency department with symptoms such as abdominal pain, nausea, vomiting, and loss of appetite. Imaging modalities, such as ultrasonography (USG), computed tomography (CT), and magnetic resonance imaging (MRI), are used in the diagnosis.

Due to its potential to mimic other emerging pathologies such

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as nephrolithiasis, ovarian cyst rupture, familial Mediterranean fever, and pelvic inflammatory disease (PID), AA can occasionally be overlooked or misdiagnosed. In patients undergoing surgery with a preliminary diagnosis of AA, the rate of negative appendectomy is approximately 20%.[1,2] Numerous studies have been conducted to investigate the impact of imaging modalities on the rate of negative appendectomy. Computed tomography has been reported to be effective in making the diagnosis and identifying complicated cases.[1] Studies have shown that CT was superior to USG in making a diagnosis, demonstrating complicated cases, and revealing pathologies of other organs for differential diagnosis.[2-4] Another study reported that CT reduced the rate of negative appendectomy.[5]

Some authors have advocated the use of USG during the initial phase because it is faster and easier to perform,[6,7] and it is the preferred initial imaging method, especially in women of reproductive age and children.[8] Occasionally, MRI can also be used for suspected AA in pregnant women. However, the reliability of all these imaging modalities is affected by many factors, including the experience of the interpreting specialist, patient body mass index (BMI), and patient compliance.[9]

The ultrasonographic diagnostic criteria for AA include the visualization of an aperistaltic, non-compressible, bluntly terminating tubular structure with a diameter of ≥6 mm in the right iliac fossa. Additionally, findings such as hyperechoic mesoappendix or pericecal fat tissue, the presence of fluid collection in the periappendiceal or pelvic region, aperistaltic bowel loops, and lymphadenopathy are other ultrasound indicators suggestive of AA.[10] Computed tomography findings indicative of AA include the presence of an enlarged appendix greater than 6 mm in diameter, thickening of the appendix wall, and fatty tissue changes around the appendix. Other CT findings of AA include thickening in the adjacent intestinal wall, cecal apical thickening, cecal bar or arrowhead sign, increased density and changes in the adjacent adipose tissue, presence of an abscess, and lymphadenopathy.[11] Among these findings, the two most important diagnostic criteria are changes in the periappendicular tissue and the diameter of the appendix.[11,12] The diagnostic accuracy of hyperechoic periappendiceal fat echogenicity for AA has been reported to be 73%, with a sensitivity and specificity of 98% each. The echogenicity of fat tissue in these regions is essential not only for diagnosing AA but also for identifying intra-abdominal inflammatory conditions such as diverticular disease, epiploic appendicitis, and omental infarction.[12,13] Increased echogenicity in periappendiceal tissue is particularly more common in complicated cases.[9,14]

Lee et al. found inflammatory changes in USG in 89% of patients with AA and classified periappendiceal tissue into three categories based on these inflammatory changes: In Grade 1, the periappendiceal tissue is hypoechoic, indicating normal; in Grade 2, the periappendiceal tissue is hyperechoic, yet the underlying muscle and vascular structures can be visualized; in Grade 3, the periappendiceal tissue is hyperechoic, and the underlying muscle and vascular structures cannot be visualized.[12] In another study using this classification, Walid et al. also emphasized the importance of periappendiceal tissue in diagnosing AA using USG.[10]

Many studies in the literature take a holistic approach to evaluating the findings from imaging methods for diagnosing AA. Apart from a few studies, the clinical significance of periappendiceal fat echogenicity alone has not been emphasized in sonographic evaluations. Thus, the extent to which this finding alone is crucial in diagnosing AA, independent of other findings, remains unclear. In previous studies examining periappendiceal tissue with USG, it was reported that hyperechoic fat tissue serves as a useful indicator for diagnosing AA. The most significant limitations of these studies include the small number of cases and the inability to fully compare the obtained findings with pathological and clinical outcomes. Additionally, apart from USG studies, no research has investigated the significance of periappendiceal tissue in diagnosing AA using CT and its correlation with clinical and pathological outcomes. Therefore, the aim of this study was to evaluate the diagnostic significance of changes in periappendiceal fat echogenicity on CT in diagnosing AA and to demonstrate the relationship between these findings and clinical and pathological outcomes.

MATERIALS AND METHODS

Trial Design

This retrospective study was conducted at the Department of General Surgery of Konya City Hospital. Before commencing the study, approval was obtained from the Scientific Research Ethics Committee of the Health Sciences University (Approval Date: April 7, 2023; Protocol Number: 23-194), and written informed consent was obtained from the participants after providing detailed information. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki.

Participants and Eligibility Criteria

Patients admitted to the hospital for general surgery diagnosed with AA between January 1, 2020 and December 31, 2020, and those who underwent surgery were included in the study.

Inclusion criteria:

- Patients who were 18 years or older,
- Patients diagnosed with AA by CT,
- Patients who underwent surgery due to AA.

Exclusion criteria:

- Patients under 18 years of age,
- Patients who underwent surgery for reasons other than AA,
- Patients diagnosed with AA using diagnostic methods other than CT,

- Patients with incomplete data in hospital records.

The clinical and laboratory data of the included patients were documented by reviewing their medical records. The recorded information included demographic characteristics such as age and gender, laboratory values including leukocyte count (WBC) and C-reactive protein (CRP), comorbidities, presenting complaints, durations between the onset of symptoms, hospital admission, and surgery, CT findings (appendix diameter, appendix wall thickness, periappendiceal fat tissue changes, presence of appendicolith, free fluid, free air, abscess, and lymphadenopathy), surgical methods employed, intraoperative findings, American Society of Anesthesiologists (ASA) score, anesthesia methods, operative time, postoperative complications, mortality status, duration of hospital stay, duration of intensive care stay, and final pathology results. Patients lacking these data were excluded from the study.

The condition of periappendiceal tissue, based on a classification previously established by Lee et al., was categorized into three stages using CT findings: In Grade 1, periappendiceal tissue is hypoechoic, indicating normal. In Grade 2, periappendiceal tissue is slightly hyperechoic but confined to the periappendiceal area. In Grade 3, dense hyperechoic areas are present in the periappendiceal tissue, extending into surrounding organs and deep tissues.[12] Computed tomography scans were reviewed by the same radiologist, with consultation sought from other radiologists as necessary. This approach minimized differences in interpretation between radiologists.

These groups, classified based on CT findings, were compared in terms of clinical and laboratory data, including WBC count, CRP levels, comorbidities, presenting complaints, surgical data, postoperative complications, mortality, duration of hospital stay, duration of intensive care stay, and final pathology results.

Statistical Analysis

Kolmogorov-Smirnov and Shapiro-Wilk normality tests were initially conducted. If normality could not be achieved in any of the groups, non-parametric methods were employed. For categorical variables, Chi-square and Fisher's exact tests were used to analyze relationships or differences among groups. Analysis of variance was conducted for multiple group comparisons. Bonferroni and Tamhane-T2 tests were performed depending on whether the variances were homogeneous or not, respectively. In these cases, a p value of 0.017 (0.05/3) was considered significant. Comparative results among groups and other demographic characteristics were presented as the ratio of qualitative variables. Quantitative variables were expressed as means (standard deviation). The Statistical Package for the Social Sciences (SPSS), version 22.0 (SPSS Inc., Chicago, IL, USA), was used for analysis and a p value of less than 0.05 was accepted as statistically significant in all analyses.

RESULTS

A total of 195 patients, 131 males (67.2%) and 64 females (32.8%), were included in the study. The mean age was 35.9 years (±15.02). Twenty-two patients (11.3%) had comorbidities, including diabetes, hypertension, chronic renal failure, and coronary artery disease.

All patients presented with abdominal pain. Additionally, 122 patients (62.6%) presented with nausea and vomiting, 57 (29.2%) with loss of appetite, and seven (3.6%) with constipation. The mean duration of complaints was 32.9 hours (±49). Results of the physical examination upon admission were normal for 11 patients (5.6%). One hundred fourteen patients (58.5%) had defense-rebound tenderness in the right lower quadrant, 55 patients (28.2%) had tenderness in the right lower quadrant, 12 patients (6.2%) had diffuse abdominal tenderness, and three patients had signs of an acute abdomen (1.5%) (Table 1).

The mean WBC count upon admission was 14.3×103/mL (±4.2), and the mean CRP value was 45.6 mg/L (±71.3). Computed tomography results revealed that the mean appendix diameter was 11.5 mm (±2.9), and appendix wall thickness was 2.8 mm (±1.02). Appendicoliths were detected in 60 patients (30.8%), free fluid in 70 (35.9%), free air in 20 (10.3%), abscess in 18 (9.2%), and lymphadenopathy in 177 (90.8%). The echogenicity of periappendiceal fat tissue increased in all patients at a rate of 95.9%. According to the classification of periappendiceal fat tissue on CT, eight patients were Grade 1 (4.1%), 134 patients were Grade 2 (68.7%), and 53 patients were Grade 3 (27.2%).

Of the surgeries, 141 were performed laparoscopically (72.3%), and 54 (27.7%) were conducted as open surgeries. A total of 38 patients were in ASA 1-E (19.5%), 142 in ASA 2-E (72.8%), and 15 in ASA 3-E (7.7%) risk classification. Moreover, 42 patients underwent surgery under spinal anesthesia (21.5%), whereas 153 patients (78.5%) underwent surgery under general anesthesia (Table 1). The mean operative time was 86.2 minutes (±26.4), and the mean duration of hospitalization was 2.2 days (± 2.5).

No mortality was observed. Postoperative complications developed in 15 patients (7.7%). These complications included ileus in four patients, intra-abdominal abscess in four patients, bleeding in three patients, surgical site infection in two patients, sinus bradycardia in one patient, and small intestine perforation in one patient. According to the Clavien-Dindo classification, one complication was classified as Grade 1 (0.5%), eight as Grade 2 (4.1%), two as Grade 3A (1%), three as Grade 3B (1.5%), and one as Grade 4A (0.5%).

Upon examination of pathology results, 155 patients were diagnosed with phlegmonous appendicitis (79.5%), 18 with gangrenous appendicitis (9.2%), 14 with lymphoid hyperplasia (7.2%), three with mucinous neoplasm (1.5%), three with a normal appendix (1.5%), and two with fibrous obliteration (1%).

Table 1. Demographic and clinical data of patients

Age (years)	35.9 (±15.02)
Gender (Male/Female)	131 (67.2%)/64 (32.8%)
Comorbidity	22 (11.3%)
Presenting Complaints	
Abdominal pain	195 (100%)
Nausea and vomiting	122 (62.6%)
Loss of appetite	57 (29.2%)
Constipation	7 (3.6%)
Duration of Complaints (hours)	32.9 (±49)
Physical Examination Findings	
Normal	11 (5.6%)
Defense-rebound tenderness in the right lower quadrant	114 (58.5%)
Tenderness in the right lower quadrant	55 (28.2%)
Widespread sensitization	12 (6.2%)
Acute abdominal symptoms	3 (1.5%)
Surgical Technique	
Laparoscopy	141 (72.3%)
Open surgery	54 (27.7%)
ASA Classification	
ASA 1-E	38 (19.5%)
ASA 2-E	142 (72.8%)
ASA 3-E	15 (7.7%)
Anesthesia Technique	
Spinal anesthesia	42 (21.5%)
General anesthesia	153 (78.5%)

Data are presented as mean ± standard deviation, median and frequency.

According to the classification of the periappendiceal area on CT, the diameter of the appendix was 6.4 mm (±1.8) in Grade 1 patients, 10.9 mm (±2.5) in Grade 2, and 13.8 mm (±2.3) in Grade 3 patients (p<0.001). The appendix wall thickness was 1.7 mm (±0.4) in Grade 1, 2.5 mm (±0.7) in Grade 2, and 3.7 mm (±1.1) in Grade 3 patients (p<0.001). Appendicolith was observed in 49.05% of Grade 3 patients and 24.6% of Grade 2 patients (p=0.002), compared to only 12.5% in Grade 1 patients. Free fluid was not observed in Grade 1 patients, compared to 20.1% of Grade 2 patients and 81.1% of Grade 3 patients (p<0.001). Free air was not observed in Grade 1 and Grade 2 patients, while it was present in 37.7% of Grade 3 patients (p<0.001). An abscess was not observed in Grade 1 and Grade 2 patients, whereas it occurred in 34% of Grade 3 patients (p<0.001). Lymphadenopathy was observed in 50% of Grade 1, 89.5% of Grade 2, and 100% of Grade 3 patients (p<0.001) (Table 2).

No significant difference was observed among the groups in terms of admission WBC count and CRP values (p=0.2, p=1). There was no significant difference between the groups in terms of postoperative complications and Clavien-Dindo classification (p=0.06, p=0.07) (Table 3). Complications in Grade 1 patients were medically treated. Almost all complications in Grade 2 patients were treated medically, with surgical treatment administered to only one patient (0.8%). In the Grade 3 group, 90.6% of patients received medical treatment, 5.7% received interventional treatment, and 3.7% underwent surgical treatment (p=0.03) (Table 3).

The mean operative time was 75.5 minutes (±10.2) for Grade 1 patients, 83.7 minutes (±24.7) for Grade 2 patients, and 94.04 minutes (±30.4) for Grade 3 patients. There was a significant difference between Grade 2 and Grade 3 patients (p=0.03). The duration of symptoms was 22.6 hours (±12.1) for Grade 1, 23.02 hours (±23.8) for Grade 2, and 59.4 hours (±80.6) for Grade 3 patients (p<0.001). There was no significant difference among the groups in terms of the number of patients in intensive care and the duration of intensive care stay (p=0.18). The total length of hospital stay was 1.5 days

Table 2. Comparison of computed tomography, laboratory, and clinical data between groups

Parameters	Grade 1	Grade 2	Grade 3	p value
Appendix diameter (mm)	6.4 (±1.8)	10.9 (±2.5)	13.8 (±2.3)	0.001>
Appendix wall thickness (mm)	1.7 (±0.4)	2.5 (±0.7)	3.7 (±1.1)	0.001>
Appendicolith	1 (12.5%)	33 (24.6%)[a]	26 (49.05%)[a]	0.002
Free fluid	0 (0%)	27 (20.1%)	43 (81.1%)	0.001>
Free air	0 (0%)[a]	0 (0%)[b]	20 (37.7%)[a,b]	0.001>
Abscess	0 (% 0)[a]	0 (%0)[b]	18 (34%)[a,b]	0.001>
Lymphadenopathy	4 (50%)	120 (89.5%)	53 (100%)	0.001>
WBC (10^3/mL)	11.7 (±2.8)	14.4 (±4.3)	14.2 (±4.1)	0.2
CRP (mg/L)	17.5 (±16.9)	22.9 (±35.9)	107.04 (±101.6)	1
Duration of complaints (hours)	22.6 (±12.1)	23.02 (±23.8)	59.4 (±80.6)	0.001>
Operative time (minutes)	75.5 (±10.2)	83.7 (±24.7)[a]	94.04 (±30.4)[a]	0.03
Intensive care hospitalization	0 (0%)	3 (2.2%)	4 (7.5%)	0.18
Duration of intensive care unit hospitalization (days)	0	0.03 (±0.2)	0.19 (±1)	0.18
Total length of hospital stay (days)	1.5 (±0.75)[a]	1.5 (±1)[b]	4.2 (±3.9)[a,b]	0.001>

Data are presented as mean ± standard deviation and frequency. The same superscripts (a, b) denote a subset of categories that are statistically significantly different from each other at the p=0.05 level.

Table 3. Comparison of groups in terms of complications

Parameters	Grade 1	Grade 2	Grade 3	p value
Clavien-Dindo Classification				0.07
0	8	129	43	
1	0	1	0	
2	0	3	5	
3A	0	0	2	
3B	0	1	2	
4A	0	0	1	
Postoperative Complications				0.06
None	8	129	43	
Sinus bradycardia	0	1	0	
Intra-abdominal abscess	0	0	4	
Bleeding	0	2	1	
Small intestine injury	0	0	1	
Ileus	0	1	3	
Wound site infection	0	1	1	
Re-intervention				0.03
None	8 (100%)	133 (99.2%)[a]	48 (90.6%)[a]	
Interventional	0	0[a]	3 (5.7%)[a]	
Surgery	0	1 (0.8%)[a]	2 (3.7%)[a]	

Data are presented as mean ± standard deviation and frequency. The same superscripts (a, b) denote a subset of categories that are statistically significantly different from each other at the p=0.05 level.

(±0.75) for Grade 1, 1.5 days (±1) for Grade 2, and 4.2 days (±3.9) for Grade 3 patients (p<0.001) (Table 2).

Upon examining the pathology results, lymphoid hyperplasia was most frequently observed in Grade 1 patients (62.5%), whereas phlegmonous appendicitis was more common in

Table 4. Comparison of groups in terms of pathology results

Parameters	Grade 1	Grade 2	Grade 3	p value
Phlegmonous Appendicitis	2 (25%)[a,b]	111 (82.8%)[a]	42 (79.2%)[b]	0.001>
Lymphoid Hyperplasia	5 (62.5%)[a,b]	7 (5.2%)[a]	2 (3.8%)[b]	0.001>
Gangrenous Appendicitis	0	10 (7.5%)	8 (15.1%)	0.17
Fibrous Obliteration	0	2 (1.5%)	0	0.63
Mucinous Neoplasia	0	2 (1.5%)	1 (1.9%)	0.92
Normal Appendix	1 (12.5%)	2 (1.5%)	0	0.03

Data are presented as mean ± standard deviation and frequency. The same superscripts (a, b) denote a subset of categories that are statistically significantly different from each other at the p=0.05 level.

Grade 2 and Grade 3 patients (82.8-79.2%). The incidence of phlegmonous appendicitis was significantly higher in Grade 2 and Grade 3 patients compared to Grade 1 patients (p<0.001). Lymphoid hyperplasia was significantly more common in Grade 1 patients compared to Grade 2 and Grade 3 patients (p<0.001). The rate of a normal appendix was significantly higher in Grade 1 patients compared to Grade 2 patients (p=0.03) (Table 4).

DISCUSSION

Acute appendicitis is the most commonly encountered pathology among general surgical emergencies. Acute appendicitis most commonly occurs in the second and third decades of life. In this study, the mean age was 35.9 years (±15.02). The lifetime prevalence of AA is 8.6%. It is more commonly observed in males, with a male-to-female ratio of 1.4/1 (15,16). In this study, 67.2% of the patients were male and 32.8% were female, which was consistent with the literature.

Abdominal pain is the most common symptom and is present in almost all cases of AA. Additionally, loss of appetite and nausea often accompany these symptoms. Rarely, diarrhea and bowel irregularities are observed.[17,18] In this study, all patients presented with abdominal pain, 122 patients (62.6%) presented with nausea and vomiting, 57 (29.2%) with loss of appetite, and seven (3.6%) with constipation. The most common FM finding in patients is tenderness in the right lower quadrant and defense-rebound tenderness,[19] consistent with the findings of this study in 86.7% patients.

In previous studies, the mean WBC count was reported to be between 14.5 and 17.9×103/mL and the mean CRP value was reported to be between 31 and 99 mg/L in cases of AA.[20,21] In the present study, the mean WBC count was determined to be 14.3×103/mL (±4.2) and the mean CRP value was 45.6 mg/L (±71.3). No significant difference was found between the groups in terms of WBC and CRP values.

The overall complication rates following appendectomy have been reported to range from 8.2% to 31.4%, with wound infection rates between 3.3% and 10.3%, and intra-abdominal abscess rates at 9.4% (22). In this study, postoperative complications developed in 15 patients (7.7%), which is close to the reported complication rates. There was no significant difference between the groups in terms of postoperative complications and Clavien-Dindo classification. However, more interventional and surgical methods were applied for treating complications that developed in Grade 3 patients compared to other groups.

According to the pathological results of a previous study, 88.6% of the specimens were consistent with AA, and 10.6% showed normal appendix tissue.[23] In another study, 93% of the specimens were reported as AA. In this study, phlegmonous appendicitis was detected in 74.6% of the cases, gangrenous appendicitis in 12.6%, and lymphoid hyperplasia in 5.3%.[24] Yilmaz et al. also reported their pathology results with phlegmonous appendicitis, normal appendix, gangrenous appendicitis, and fibrous appendicitis detected in 51.9%, 16.9%, 22.8%, and 3.8% of the cases, respectively.[22] Consistent with the literature, phlegmonous appendicitis was most commonly detected in this study (79.5%), followed by gangrenous appendicitis (9.2%), lymphoid hyperplasia (7.2%), mucinous neoplasia (1.5%), normal appendix (1.5%), and fibrous obliteration (1%).

Ultrasonography, CT, and MRI are commonly used imaging modalities in the diagnosis of AA. Ultrasonography is the most commonly preferred initial imaging method.[6,7] However, in cases where USG cannot establish a diagnosis, CT is more effective for differential diagnosis compared to other pathologies.[2-4] An appendix diameter greater than 6 mm is the most crucial parameter favoring appendicitis across all imaging methods. There are very few studies addressing the significance of the fatty tissue surrounding the appendix in diagnosing appendicitis. Periappendiceal fatty tissue, consisting of omental and mesenteric structures, acts as a barrier in cases of inflammation. The transformation of this normally hypoechoic tissue into a hyperechoic state is a crucial finding in diagnosing AA. The spread of inflammation from the appendix to the omentum and adjacent mesenteric fat tissue is the main cause of this change.[9]

In some studies, changes in the periappendiceal tissue were reported in 13-54% of non-perforated appendicitis patients and 31-64% of perforated appendicitis patients.[25,26] Lee et al. reported an increase in fat tissue echogenicity in 100% of right colon diverticulitis cases and 89% of AA cases.[12] Kessler et al. reported that 91% of patients diagnosed with AA had changes in the adipose tissue.[13] Another study showed an increase in periappendiceal tissue echogenicity in 89.8% of patients with AA.[10] In this study, increased periappendiceal tissue echogenicity was found in 95.9% of patients with AA, and this result is consistent with the literature.

In a previous study, periappendiceal tissue examined by USG was classified into three grades. According to this classification, the average appendix diameter in Grade 3 patients (1.1 cm) was significantly larger than that in Grade 1 (0.82 cm) and Grade 2 (0.9 cm) patients (10). This indicates that in cases of severe inflammation where the appendix diameter increases, there is significant inflammation of the periappendiceal fat tissue. In this study, classification of periappendiceal tissue on CT revealed that the diameter of the appendix was 6.4 mm (±1.8) in Grade 1, 10.9 mm (±2.5) in Grade 2, and 13.8 mm (±2.3) in Grade 3 patients, and there was a significant correlation between appendix diameter and periappendiceal fat tissue echogenicity. Furthermore, appendix wall thickness was found to be 1.7 mm (±0.4) in Grade 1, 2.5 mm (±0.7) in Grade 2, and 3.7 mm (±1.1) in Grade 3 patients, with a correlation also found between periappendiceal fat tissue echogenicity and appendix wall thickness. These findings are consistent with the results of Walid et al. who investigated these parameters using USG. This study concluded that perforation, infected exudates, abscesses, and adhesions were higher in patients with hyperechoic periappendiceal fat tissue.[10] Noguchi et al. also concluded that hyperechoic periappendiceal fat tissue suggests advanced appendiceal inflammation and accompanying complications.[9] In the present study, the frequency of appendicolith, free fluid, free air, abscess, and lymphadenopathy was significantly higher in Grade 3 patients compared to Grade 2 and Grade 1 patients. Consistent with the literature, this finding indicates that increased echogenicity of periappendiceal fat is significantly associated with advanced appendiceal inflammation and complications such as abscess and perforation in complicated cases of AA.

Walid et al. showed that hyperechoic periappendiceal fat tissue was present in 100% of cases of gangrenous appendicitis, 29% of phlegmonous appendicitis, and 0% of early appendicitis.[10] In this study, the frequency of phlegmonous appendicitis was higher in Grade 2 and 3 patients compared to Grade 1 patients. In contrast, the frequency of lymphoid hyperplasia was higher in Grade 1 patients compared to Grade 2 and 3 patients. The percentage of cases with a normal appendix was significantly higher in Grade 1 patients compared to Grade 2 patients, and no cases of normal appendicitis were observed in Grade 3 patients. In patients with normal periappendiceal fat, the frequency of phlegmonous appendicitis was lower, and the frequency of lymphoid hyperplasia and normal appendix was higher. This suggests that the increase in echogenicity of periappendiceal fat significantly reduces the likelihood of a negative appendectomy. Additionally, although not statistically significant, there is an increasing likelihood of gangrenous appendicitis as the grade increases. As previously mentioned in the literature, the argument that echogenicity of periappendiceal fat increases in complicated cases of appendicitis was confirmed by the pathology results in the present study.

Walid et al. reported six patients (10.2%) who were diagnosed with AA but had normal periappendiceal fat tissue. In these patients, histopathological examination revealed no signs of inflammatory changes in the surrounding mesentery. This indicates that the echogenicity of periappendiceal fat does not increase in all patients with AA. These were most likely early-stage cases of AA or patients with deep-seated appendicitis, such as in a retrocecal location.[10] In the present study, periappendiceal tissue echogenicity was normal in eight patients (4.1%) with AA. Several previous studies have reported this rate in the range of 9-11%.[12,13]

Some parameters not mentioned in previous studies were included in our study. One of these parameters, operative time, increased proportionally with the grade and was found to be significantly higher in Grade 3 patients compared to Grade 2 patients. Additionally, as the duration of symptoms increased, the AA grade also increased. Another parameter, the length of hospital stay, was found to be the longest in Grade 3 patients. This suggests that the clinical presentation of appendicitis becomes more complicated with delayed admission, which may contribute to the increased echogenicity of periappendiceal fat tissue. Additionally, as the grade increases, the cases may become more complicated, leading to longer operative times and potentially influencing the length of hospital stay.

CONCLUSION

Previous studies examining the periappendiceal tissue with ultrasound have reported that hyperechoic fat tissue is an indicative factor in aiding the diagnosis of AA. The most significant limitations of these studies include the small number of cases and the inability to fully compare the obtained findings with pathological and clinical outcomes. Additionally, apart from USG studies, no research has investigated the importance of periappendiceal tissue in diagnosing AA using CT and its correlation with clinical and pathological outcomes. In cases where the appendix is not fully visualized on ultrasound and other diagnostic parameters cannot be clearly identified, the increased echogenicity in the periappendiceal tissue observed in CT scans strengthens the diagnosis of AA. Especially when the diagnosis of acute appendicitis is uncertain in clinical practice, normal periappendicular tissue may distract clinicians from this diagnosis. Furthermore, close examination of the periappendiceal tissue on preoperative CT provides surgeons with crucial insights into what to expect dur-

ing surgery. A limitation of this study is that it did not address the effect of patients' BMI on CT findings. Previous studies have reported that evaluating these findings is more challenging in thin patients because they have less intra-abdominal fat. The retrospective design also constitutes another limitation of the present study.

Ethics Committee Approval: This study was approved by the University of Health Sciences Ethics Committee (Date: 07.04.2023, Decision No: 23/194).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Akut apandisit tanısında bilgisayarlı tomografi ve klinik sonuçlar: Periapendiküler yağ dokusunun önemi

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AMAÇ: Bu çalışma, akut apandisit (AA) tanısında bilgisayarlı tomografide (BT) periapendiküler yağ dokusu değişikliklerinin tanısal önemini aydınlatmayı amaçladı.

GEREÇ VE YÖNTEM: Çalışmaya 1 Ocak 2020 ile 31 Aralık 2020 tarihleri arasında BT ile AA tanısı konularak ameliyat edilen hastalar alındı. Hastalar BT'ye göre 3 sınıfa ayrıldı. Grade 1'de periapendiküler doku hipoekoik yani normaldir. Grade 2'de periapendiküler doku hafif hiperekoiktir ancak bu periapendiküler alanla sınırlıdır. Grade 3'te sadece periapendiküler dokuda değil aynı zamanda çevre organlara ve derin dokulara da uzanan yoğun hiperekoik alanlar mevcuttur. Gruplar klinik, laboratuvar ve patolojik sonuçlar açısından karşılaştırıldı.

BULGULAR: Çalışmaya 131'i erkek, 64'ü kadın olmak üzere toplam 195 hasta dahil edildi. Grade ile apendiks çapı, apendiks duvar kalınlığı, lenfadenopati varlığı ve semptomların başlangıç süresi arasında korelasyon olduğu belirlendi ($p<0.001$). Apandikolit, serbest hava ve karın içi apseler grade III hastalarda grade I ve II hastalara göre daha sık görüldü ($p=0.002$, $p<0.001$). Ameliyat süresi ve hastanede kalış süresi grade III hastalarda en yüksekti ($p<0.001$). Patoloji sonucu normal apendiks olan hastaların oranı grade I'de grade II'ye göre anlamlı derecede yüksekti ($p=0.03$).

SONUÇ: Tanının kesin olmadığı durumlarda BT'de periapendiküler dokuda gözlenen hiperekojenite AA tanısını güçlendirmektedir. Ayrıca periapendiküler dokuda ekojenite arttıkça AA vakaları giderek daha komplike hale gelir.

Anahtar sözcükler: Akut apandisit; bilgisayarlı tomografi; periapendiküler doku; hiperekojenite.

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