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Contribution of ethical approach and effective communication to the correct diagnosis of acute appendicitis – a single center experience from a pragmatic perspective

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Abstract. – OBJECTIVE: In this study, we reviewed the data of patients who presented to the Emergency Department with abdominal pain, underwent ultrasonography (USG) and computed tomography (CT), and were pathologically diagnosed with acute appendicitis and non-appendicitis. We aimed to emphasize the ethical importance of specifying a clinical diagnosis with its effect on radiologically correct diagnosis and patient management method.

PATIENTS AND METHODS: A total of 1047 patients, 971 patients with acute appendicitis due to pathology, and 76 patients with non-acute appendicitis, who applied to the Emergency Department with acute abdominal pain, underwent ultrasound and/or CT of the whole abdomen were evaluated. According to their clinical diagnoses, both patient groups were divided into acute appendicitis (Group I) and other diagnoses (Group II). After the patients were screened retrospectively, pathology and imaging results were compared with clinical diagnoses.

RESULTS: According to their clinical diagnosis, the pathology result of 654 patients in Group I and 317 patients in Group II was acute appendicitis. Appendicitis was diagnosed in 569 patients in Group I and 240 patients in Group II by performing at least one of the radiological imaging methods. In 162 patients, the diagnosis of appendicitis could not be made by imaging.

CONCLUSIONS: Considering the low negative predictive values in USG and CT examinations for the diagnosis of appendicitis is important. An indication of the clinical diagnosis in accordance with deontology and effective communication between the clinician and the radiologist is important for making a rapid and accurate diagnosis by determining the effective imaging method.

Key Words:
Acute appendicitis, Clinical preliminary diagnosis, USG, CT.

Introduction

Acute appendicitis is one of the most common surgical emergencies. It is more common between 2nd-4th decades and in women[1-5]. The diagnosis is based on clinical findings obtained from the patient's history and physical examination[3,6]. The clinical presentation of acute appendicitis may be atypical and may be confused with other differential diagnoses[7,8].

Delay in diagnosis may cause complications such as peritonitis, phlegmon, and abscess resulting from rupture of appendicitis, and an increase in disability and mortality[8]. In case of misdiagnosis, unnecessary surgical intervention may be applied to the patient[6]. Therefore, the accurate diagnosis of appendicitis is very important. Although clinical observation and physical examination findings are important, imaging is often used. USG is recommended as the first imaging method and CT is recommended as a further imaging method in suspicious cases[9,10]. Diagnostic accuracy in patients who underwent USG and CT before the operation is between 83-98%[4]. Sometimes, USG findings may be unclear, and this may cause a delay in diagnosis and treatment and additional costs. The diagnosis of acute appendicitis substantially depends on the operator's experience, ability, and knowledge[11,12]. Sometimes patients may not have the typical symptoms of acute appendicitis and laboratory findings may not be clear. In this case, more specific diagnostic methods such as laparoscopy, USG, barium enema, CT, magnetic resonance imaging (MRI), and radiolabeled leukocyte scanning may be required[13-15].

Errors in medical applications are inevitable and human-induced errors can be observed[16]. There is a great multitude of data on the frequen-

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cy of radiological errors. In a retrospective study, this rate is 30% and 3-5% of daily radiology practice contains errors. But most of the errors have low importance[17]. Reducing diagnostic error can improve patient care and lower costs by decreasing mortality, morbidity, length of hospital stays, and health care costs[18].

The radiology report is important in terms of providing communication between radiologists and clinicians and should contain answers to clinical questions[16]. Since a good radiological examination and interpretation is possible by knowing the clinical situation that requires that examination, clinical information, or the international code of the disease should be reported to the radiologist. The task of the radiologist is to create a differential diagnosis list and reach a definitive diagnosis. Approximately 10% of the errors that occur in radiology practice are due to communication. Lack of clinical information due to the communication malfunction between the clinician and the radiologist may be the only reason for the error[19,20]. Besides, this unethical approach may cause a delay in the diagnosis of the radiologist and application of off-label examinations containing ionizing radiation such as X-ray and CT.

In a study in which x-rays were examined, 23% error was found in the absence of clinical data, while this rate decreased to 20% when clinical data were provided[21]. Experienced radiologists and careful examination reduce the effect of clinical information on radiological diagnosis. However, it is very important to consider clinical information in routine applications and fast working conditions. In addition, clinical-radiological councils have been shown to have a significant positive effect on clinical diagnosis and advanced patient management[22].

In this study, the contribution of indication of accurate and adequate clinical pre-diagnosis and continuous communication between the clinician and the radiologist to the correct diagnosis was investigated when using diagnostic imaging techniques to identify cases of acute appendicitis.

Patients and Methods

The study included 971 patients with acute abdomen symptoms such as pelvic pain, nausea, vomiting, and fever in clinical examination, operated for suspected acute appendicitis, and appendicitis as a pathology result, and 76 patients with similar symptoms but pathology results other than acute appendicitis, between 2015 and 2021. After the patients were evaluated in the emergency room, at least one of the USG and CT scans were performed as well as laboratory examinations. The patients were taken to the operating room and operated on. Periappendix fluid collection, increased appendiceal fat inflammation, perforated appendicitis, and phlegmon appendicitis positivity were evaluated retrospectively. Preoperative imaging results were compared with the clinical pre-diagnosis of patients who underwent appendectomy and had appendicitis as a pathology result, and patients with diagnoses other than appendicitis. Pathology results, imaging findings, and clinical pre-diagnoses of the patients were recorded, and the relationship between imaging findings and clinical pre-diagnoses was evaluated. Our study was approved by the non-interventional Clinical Research Ethics Committee of our institution. Informed consent was obtained from all participants included in the study. The conformity of the age variable to the normal distribution was examined with the Kolmogorov-Smirnov test. Since the age variable did not show a normal distribution, descriptive statistics were given as the median (25%-75%). Pathology results were considered the gold standard and diagnostic statistics were calculated accordingly.

Results

A total of 1047 patients including 971 patients with pathological diagnosis of acute appendicitis and 76 patients with pathological diagnosis of non-acute appendicitis were included in the study. Of the patients, 616 were male and 431 were female, with a median age of 28 (17-42). All patients underwent at least one of the pre-operative USG and CT examinations. In addition, both patient groups were divided into two groups those with a clinical pre-diagnosis of acute appendicitis (group I) and those with a clinical pre-diagnosis of abdominal pain and other diagnoses (group II).

There were 654 patients in group I and 316 patients in group II who had a pathological diagnosis of acute appendicitis. There were 25 patients in group I and 51 patients in group II who had pathological diagnoses other than acute appendicitis.

Of the patients who were pathologically diagnosed with acute appendicitis, 389 were women with a median age of 30 (20-46) and 582 were men with a median age of 26 (15-42). Of the

patients who were not pathologically diagnosed with acute appendicitis, 37 were female with a median age of 40 (28-57) and 39 were male with a median age of 23 (13-45).

According to clinical preliminary diagnoses, 202 of the group I patients were diagnosed by only USG (29. 7%), and 326 of them by CT alone (48%). Among the patients who underwent both USG and CT, 2 patients were diagnosed with only USG, but not diagnosed with CT. 15 patients were diagnosed only with CT, but no diagnosis could be made with USG. 5 patients could not be diagnosed with both USG and CT, while 32 patients were diagnosed with both USG and CT. No diagnosis could be made in 72 patients who had only USG or CT examinations.

In the group II, 109 patients were diagnosed with only USG (29.6%), and 112 patients with only CT (30%). Among the patients who underwent both USG and CT, 2 patients were diagnosed with only USG, but not with CT. 9 patients were diagnosed only with CT, but not with USG. While 7 patients were diagnosed with both USG and CT, 4 patients could not be diagnosed with both USG and CT. Only USG was performed on 53 patients and the diagnosis could not be made. Only CT was performed on 20 patients and the diagnosis could not be made (Pearson square test $p = 0.007$).

In patients with a pathological diagnosis of acute appendicitis, symptoms suggestive of appendicitis such as non-compression of appendicitis, and a double wall thickness of more than 6 mm were detected (Figure 1a-c). Among 971 patients diagnosed with pathologically acute appendicitis, 739 patients had appendicitis, 115 patients had perforated appendicitis, and 117 patients had phlegmon appendicitis. Periappendicitis symptoms accompanied these diagnoses in 258 patients.

According to clinical preliminary diagnoses, in group I appendicitis was diagnosed in 510 patients, phlegmon appendicitis in 75 patients, and perforated appendicitis in 69 patients. In group II, 231 patients were diagnosed with appendicitis, 39 patients with phlegmon appendicitis, and 46 patients with perforated appendicitis. In the diagnosis of appendicitis, pre-diagnosis sensitivity

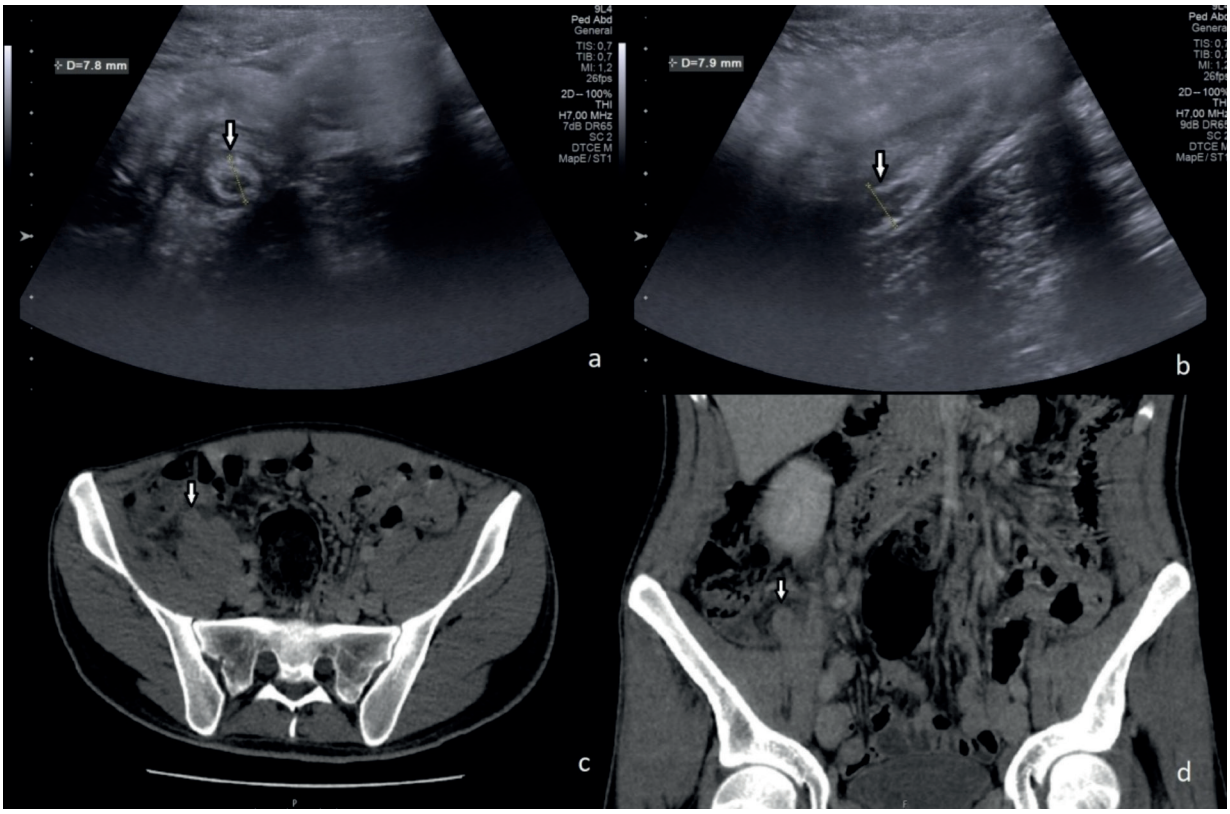

Figure 1. Diameter increase compatible with acute appendicitis in the non-compressed appendix in USG. **a, b,** Axial and coronal reformat planes. **c, d,** Contrast-enhanced CT image of acute appendicitis in the same patient in axial and coronal reformat planes.

Table I. Pre-diagnosis, sensitivity, and specificity values of USG and CT in patients with acute appendicitis as pathology result.

	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Pre-diagnosis	67.4	67.1	96.3	13.9
USG[a]	70.9	75	96.1	23
CT[b]	89.3	54.8	97.2	22.7

[a]Ultrasonography; [b]Computed tomography.

was 67.4% and specificity was 67.1%. The positive predictive value was 96.3% and the negative predictive value was 13.9%. In 541 patients who underwent USG, the sensitivity was 70.9% and the specificity was 75%. The positive predictive value was 96.1% and the negative predictive value was 23%. In 574 patients who underwent CT, the sensitivity was 89.3%, the specificity was 54.8%. The positive predictive value was 97.2% and the negative predictive value was 22.7% (Table I).

In the diagnosis of appendicitis, the sensitivity of USG was 75.5% and the specificity was 41.2% in group I. The positive predictive value was 95.8% and the negative predictive value was 8.6%. CT sensitivity was 91.3% and specificity was 44.4%. The positive predictive value was 98.6% and the negative predictive value was 10.5% (Table II). In group 2, the sensitivity of USG was 63.3% and the specificity was 89.7%. The positive predictive value was 96.7% and the negative predictive value was 34.3%. CT sensitivity was 84.3% and specificity was 59.1%. The positive predictive value was 93.5% and the negative predictive value was 35.1% (Table III). 37 of the patients with pathological diagnoses other than appendicitis were female with a median age of 28 (19-40), and 39 were male with a median age of 13 (8-23). Among these patients, 16 of group I patients (2.3%) underwent only USG and 8 of them (1.2%) only CT. 10 of the patients who underwent USG and 5 of the patients who underwent CT were reported as acute appendicitis. There was only one patient who underwent both USG and CT, and it was reported as edema and reactionary fluid in the intestinal loops. In group II patients, only USG was performed in 29 (7.9%), and only CT was performed in 12 (3.3%). 2 of the patients who underwent USG and 6 of the patients who underwent CT were reported as acute appendicitis. 10 patients underwent both USG and CT, and it was reported as only 1 patient was acute appendicitis in the CT result, and 2 patients in both USG and CT. In group I, lymphoid hyperplasia was diagnosed in 18 patients, inflammatory bowel disease in 2 patients, fibrotic appendix in 2 patients. Furthermore, colonic tubular adenoma, tubular Waltherd's remnant, and paratubal cyst were diagnosed in one patient each. In group II, lymphoid hyperplasia was diagnosed in 35 patients, inflammatory bowel disease in 3 patients, neuroendocrine tumor in 2 patients, diverticulitis in 2 patients, dermoid cysts in 2 patients, normal appendix tissue in 2 patients. More mucinous cystadenoma, submucosal lymphatic dilatation, mucinous adenocarcinoma, chronic active adipose tissue inflammation and colonic ulceration were diagnosed in one patient each.

Discussion

USG and CT have a very high accuracy rate in the diagnosis of acute appendicitis, but clinical observation and examination findings are still of primary importance in diagnosing.

In our study, the sensitivity of the preliminary diagnosis was generally lower than USG and CT in patients with acute appendicitis. Its specificity was lower than USG but higher than CT. The sensitivity of USG was lower than that of CT,

Table II. Sensitivity and specificity values of USG and CT in Group I patients.

	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
USG[a]	75.5	41.2	95.8	8.6
CT[b]	91.3	44.4	98.6	10.5

[a]Ultrasonography; [b]Computed tomography.

Table III. Sensitivity and specificity values of USG and CT in Group II patients.

	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
USG[a]	63.3	89.7	96.7	34.3
CT[b]	84.3	59.1	93.5	35.1

[a]Ultrasonography; [b]Computed tomography.

but its specificity was higher. We observed that the sensitivity of USG and CT increased but the specificity decreased in group I patients, while the sensitivity of USG and CT decreased but the specificity increased in group II patients.

In studies with USG in parallel with our study, Sezer et al[23] reported a sensitivity of 71.4%, specificity of 78.5%, a positive predictive value of 94.8%, and a negative predictive value of 33.3%[23]. Nasiri et al[24] reported sensitivity of 71.2%, specificity of 83.3%, a positive predictive value of 97.4%, and a negative predictive value of 25%. The values obtained show that USG provides reliable and valuable findings for the diagnosis of appendicitis[24]. In another study, the sensitivity and specificity values of USG were 84.8% and 83.3%, respectively, and the positive and negative predictive values were 93.3% and 66.7%, respectively[25]. Kaneko and Heinz[26] stated that USG is an important technique in making a differential diagnosis. In another study evaluating the diagnostic accuracy of USG with graduated compression techniques, the sensitivity was found to be low, and it was recommended to combine it with clinical and laboratory findings[27]. In our study, we observed that the sensitivity increased, and the specificity decreased in patients who underwent imaging with the pre-diagnosis of acute appendicitis.

Diagnosis of appendicitis is generally thought to be more difficult in children due to communication and examination difficulties, and the incidence of appendicitis complications is also higher[28]. In a study by Karabulut et al[29], the sensitivity and specificity of USG in children were found to be 66.6% and 64.2%, respectively, in cases of pathologically confirmed appendicitis.

Considering the very low negative predictive value in education centers, as in our study, USG is recommended for the diagnosis of appendicitis only in cases of complex appendicitis and differential diagnosis. Since clinical observation and a careful examination are still the most effective method in the diagnosis of acute appendicitis, USG should be definitely evaluated together with clinical examination[30].

Another imaging method used in the evaluation of patients with suspected acute appendicitis is CT examination. Due to the carcinogenic effects of ionizing radiation, CT in children and young adults is recommended especially as a further imaging method in suspicious cases[9,10,31].

In the literature, there are studies showing that CT is more effective in the diagnosis of acute appendicitis, but it should not be forgotten that children are ten times more susceptible to radiation-induced cancer than adults. In a meta-analysis study, the sensitivity and specificity rates were found to be 91% and 90% with standard radiation dose CT, respectively, and 78% and 83% with USG, respectively[32].

In a study conducted on children, the sensitivity and specificity values were found to be 94% and 95% with CT, respectively, and 88% and 94% with USG, respectively[30]. Recently, low-dose CT has also been used as an alternative due to advantages such as its excellent diagnostic performance and less exposure to ionizing radiation[33]. It is estimated that one billion radiological examinations are performed and interpreted by radiologists annually worldwide[34]. All imaging procedures should include the counsel of a specialist radiologist and be provided in a written report[35]. According to the American College of Radiology (ACR), the radiology report should contain answers to clinical questions that require examination[16]. Therefore, clinical information or the international disease code of the disease should be reported to the radiologist. In one study, it was shown that there was a large disagreement rate of 5-9% between two observers and an error incidence of 3-6% per observer[36]. In a study conducted with CT examinations of oncology patients, inconsistent interpretations were reported in 31-37% of the cases[37]. Studies are reporting that the daily radiologist error rate was 3-5% on average, and the retrospective error rate was 30% on average[17]. According to this rate, applying a 4% error rate in one billion radiological studies performed worldwide annually equals approximately 40 million radiologist

errors per year[34]. Communication errors are the fourth most common claim against radiologists in malpractice claims. Therefore, the communication standard between the radiologist and the referring clinician is a very important issue[18]. In a study, premortem clinical diagnoses and postmortem diagnoses of 100 patients who died in the intensive care unit were reviewed[38]. In 16% of autopsies, data suggest that knowledge of premortem clinical diagnoses can lead to a change in treatment and long-term survival. It has been shown that the reporting error rate in CT increased significantly when the number of cases exceeds the daily threshold of 20[39]. In a study conducted by Tudor et al[21] using plain radiography examinations, the effect of the availability of clinical information on error rates was investigated and the average accuracy rate was 77% without clinical information. On the contrary, the accuracy rate was 80% when clinical information was provided. In a study examining normal and abnormal x-rays, the error rate was found to be 23% when clinical information was not provided, and this rate dropped to 20% when clinical information was available[21]. Clinical-radiological meetings have a significant impact on diagnosis and advanced patient management[22].

The relatively low accuracy, specificity, and sensitivity of USG in our study may be attributed to the lack of sufficient clinical experience and the evaluation of the results by a different radiology assistant every day. Our study has limitations such as being retrospective and a limited patient group consisting of non-acute appendicitis diagnoses as a pathology result. There are a few studies in the literature using more conventional examinations such as x-rays to investigate the importance of clinical information. However, we think that the sample size of our study using advanced imaging methods such as USG and CT is also remarkable and will make a significant contribution to the literature.

Establishing effective and accurate communication between the clinician and the radiologist is very crucial because this is decisive in making the operation decision or preventing unnecessary operations. In this way, correct patient and examination selection, and diagnoses will be made, thus, the loss of patients due to complications that may develop will be prevented. Inattentive providing of insufficient clinical information or lack of it is an important ethical issue because it may cause a delay in correct diagnosis, failure to diagnose, or misdiagnosis. In addition, unnecessarily performing radiological examinations such as x-rays and CT without consulting a radiologist may increase the risk of developing cancer in patients in the future. A good physician fulfills the requirements of the medical profession technically and scientifically, and also attaches importance to ethical values, and carries out this profession with a scientific and contemporary understanding of responsibility. Medical ethics has four basic principles: autonomy, non-harming, beneficence, and justice. Therefore, we thought that effective communication might be more important and vital especially in this patient group. With this study, we aimed to show that a complete clinical diagnosis is necessary to reduce diagnostic errors and the importance of a patient-centered approach with the responsibility of good medicine.

Conclusions

Clinical observation and physical examination are still the most effective methods of diagnosis in many cases. Diagnosis in radiological examinations may not be as precise as in histopathological diagnosis. Therefore, imaging and clinical examination findings should be evaluated together. Making mistakes is natural, but they can be prevented. Factors such as innovations in imaging techniques and processing of radiological images, management of staff, knowledge of radiologists, and communication with the clinician may play a role in making mistakes. Since one of the most important factors among these is the lack of communication between the radiologist and the clinician, we think that effective patient-oriented communication can increase the quality, prestige in health services, and value of the radiology report.

Conflict of Interest
The Authors declare that they have no conflict of interests.

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Informed Consent
Informed consent was obtained from all individual participants included in the study.

Ethical Statement

All procedures performed in studies involving human participants were in accordance with the Ethical Standards of the Institutional and/or National Research Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Ethical Approval

This study was approved by the Ethics Committee of Adnan Menderes University on 01/02/2022 with the approval number 2022/12.

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