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THE ROLE OF CHEST COMPUTERIZED TOMOGRAPHY IN COVID-19 DIAGNOSIS IN EMERGENCY DEPARTMENT SETTINGS

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Abstract: In this study, the chest computed tomography (chest CT) findings of patients with suspected COVID-19 admitted to the emergency department were examined, and it was evaluated whether chest CT should be performed in each patient with suspected COVID-19. Patients with suspected COVID-19 and who had chest CT were included in the study. Swab samples were taken from the throat and nose of the patients for RT-PCR. Chest CT was applied to the patients according to the physician's decision. A team of 5 radiologists evaluated the chest CT reports. 251 patients were included in the study. In the chest CT of 154 patients (61.4%), findings compatible with COVID-19 pneumonia were found. The number of patients who were found to have COVID-19 by PCR test result was 138 (55.0%). The most common pneumonia finding was found to be ground glass (55.8%) Most of the patients had findings in both lungs (25.9%). Less frequently, the right lung (23.1%) was affected. The least affected was the left lung (14.7%). The most frequently affected part of the left lung was the lower lobe. In emergency services, the use of chest CT after the physical examination of the patients with suspected lung involvement may be useful in the diagnosis of COVID-19.

Keywords: COVID-19 RT-PCR testing, Computed tomography, Pneumonia, Emergency department

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1. Introduction

Coronavirus disease (COVID-19), which first emerged as viral pneumonia cases of unknown etiology in Wuhan, China, at the end of 2019, became a pandemic over time that has affected the whole world (Anonymous, 2020a, Becker et al., 2020). The World Health Organization (WHO) agreed that the outbreak met the criteria for a Public Health Emergency of International Concern (PHEIC) on January 30, 2020 (Anonymous, 2020b). On February 11, 2020, the WHO named the disease COVID-19, short for "Coronavirus Disease 2019" (Anonymous, 2020c).

Symptoms of COVID-19 disease are fever, fatigue, and dry cough. Patients may also more rarely present with diarrhea, nausea, and vomiting (Anonymous, 2020d). Although the majority of patients have mild disease, 14% need oxygen due to lung involvement and require hospitalization (Munster et al., 2020). The diagnosis of COVID-19 is made by detecting 2019 novel coronavirus (2019-nCoV) ribonucleic acid (RNA) in samples taken from the nasopharynx and oropharynx using the reverse transcription polymerase chain reaction (RT-PCR) method (Anonymous, 2020e). However, due to variations in sample collection, transport, and test kit performance, the total positivity rate of RT-PCR for throat and nose swab samples was found to be between 60% and 73.3% (Yang et al., 2020). Failure to diagnose patients both creates delays in the treatment of patients and poses a risk of infection for a larger population, given the highly contagious nature of the virus (Ai et al., 2020).

Since COVID-19 is a disease that directly affects the respiratory system, lung imaging is recommended. The diagnostic value of chest radiography in the early stages is low in this disease. However, chest computed tomography (chest CT) can show lung involvement even before symptoms begin. Even if patients are diagnosed with RT-PCR, that method cannot determine the severity of the disease and lung involvement; rather, chest CT is required for this (Ai et al., 2020). There are not enough studies in the literature regarding the necessity of chest CT for every suspected COVID-19 patient admitted to the emergency department (ED).

In this study, the chest CT findings of suspected COVID-

19 patients admitted to the emergency department were examined, and it was evaluated whether chest CT should be performed for each patient with suspected COVID-19.

2. Materials and Methods

This study was designed as a cross-sectional clinical study and was conducted in the ED of a pandemic hospital between May 1 and May 31, 2020. Patients with suspected COVID-19 who applied to the ED and who underwent chest CT were included in the study. Hemodynamic unstable patients with a definite or suspected diagnosis of COVID-19 were excluded from the study.

Patients who applied to the ED were evaluated in the triage room and those who met the following criteria of the COVID-19 Guidelines of the Scientific Committee of the Ministry of Health were included in the study:

• Patient has at least one of the signs and symptoms of fever or acute respiratory tract infection, the clinical presentation cannot be explained by another cause/disease, and s/he or a family member was abroad within 14 days before the onset of symptoms.

• Patient has at least one of the signs and symptoms of fever or acute respiratory tract infection and has been in close contact with a confirmed case of COVID-19 within 14 days prior to the onset of symptoms.

• Patient has at least one of the signs and symptoms of fever and severe acute respiratory tract infection and requires hospitalization for severe acute respiratory infection, and the clinical presentation cannot be explained by another cause/disease.

• Patient has sudden onset of fever, cough, or shortness of breath and no nasal discharge, identified as a suspected COVID-19 patient.

• Patient has positive RT-PCR results, accepted as a definite COVID-19 patient.

All patients admitted to the ED were evaluated in the triage area, and patients with suspected COVID-19 were taken to the COVID-19 area wearing a mask. After anamnesis and examination, hematological and biochemical tests were applied to all patients with suspected COVID-19. Then, chest CT was performed with the decision of the physician (examination findings and anamnesis). Patients with the need for hospitalization (patients with acute respiratory tract infection, fever, cough and dyspnea, tachypnea, hypoxemia, hypotension, common radiological findings on lung imaging, and consciousness change) were determined according to the COVID-19 guidelines of the Turkish Ministry of Health Scientific Committee on March 23, 2020. Patients without an indication for hospitalization were quarantined at home.

Swab samples were taken at the ED for RT-PCR (Bio-Speedy® Direct RT-qPCR SARS-CoV-2, İstanbul, Turkey) from the throat and nose of the patients who were decided to be hospitalized or quarantined at home. Swab samples were studied at the National Public Health Laboratory. Patients whose test results were negative but

who were suspected of having COVID-19 were not discharged, and their follow-up and treatment continued. Patients with positive test results and patients with negative results were hospitalized in different rooms.

Chest CT was performed with a Toshiba Medical Systems Corporation CT device (16-row multislice Alexion™ CT scanner, Ōtawara, Tochigi, Japan). Chest CT was performed in 5-mm sections without contrast.

A team of five radiologists evaluated the chest CT reports. This team worked in the pandemic hospital and has been interpreting the CT scans of COVID-19 patients since the beginning of the pandemic. Therefore, they had gained experience in interpreting CT scans of COVID-19 patients. Radiologists were informed about the patient's clinical presentation in advance. Radiologists evaluated chest CT not only in terms of COVID-19 but in terms of all pathologies. It was specifically mentioned by radiologists if there was evidence of viral pneumonia (in terms of COVID-19). Radiologists reported CT findings (normal, ground-glass opacity, mosaic perfusion, nodular density, lobar pneumonia) and localizations (right, left lung, and upper, lower, and middle lobes) in their reports. (Figure 1).
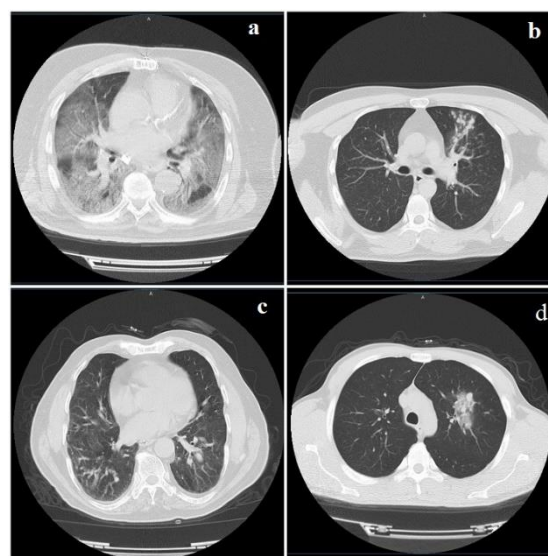
Figure 1. Chest tomography findings: a) ground-glass opacity; b) nodular density; c) mosaic perfusion; d) lobar pneumonia.

2.1. Statistical Analysis

All data were analyzed using IBM SPSS for Windows version 25.0 (IBM Corp., Armonk, NY, United States) While evaluating the study data, besides descriptive statistical methods (frequency, percentage, mean and standard deviation), the chi-square (χ^2) test was used to compare qualitative data. The compliance of the data to normal distribution was evaluated by Kolmogorov-Smirnov test, skewness-kurtosis, and graphical methods (histogram, Q-Q plots, stem and leaf, boxplot). The independent samples t-test was used to compare data compatible with normal distribution. The statistical significance level was accepted as $\alpha = 0.05$.

3. Results

A total of 251 people suspected of COVID-19 who underwent chest CT were included in this study. Of these patients, 163 (64.9%) were men and the mean age of all patients was 47.6 ± 17.5 years. The most common symptom was fever, which was seen in 107 patients (42.6%). In the chest CT of 154 patients (61.4%), findings compatible with COVID-19 pneumonia were identified. The number of patients found to have COVID-19 by RT-PCR test results was 138 (55.0%) (Table 1). While 77.7% of the patients had symptoms, the most common 3 of these symptoms were fever (42.6%), cough (17.1%), and dyspnea (6.1%), respectively.

The mean age of the patients diagnosed with COVID-19 (n = 138, 54.9%) according to the RT-PCR results was 45.8 ± 16.1 years, and 39 (28.2%) of these patients were women. Findings were detected in the chest CT results of 91 (65.9%) patients diagnosed with COVID-19. Of the 113 suspected COVID-19 patients whose RT-PCR results were not positive, 63 (45.8%) had pneumonia findings by chest CT (Table 2). In the comparisons made according to the RT-PCR test results, no statistically significant difference was found between diagnosed and suspected COVID-19 patients in terms of age (P = 0.073). A statistically significant difference was found between men and women in terms of receiving a definitive diagnosis of COVID-19 (P = 0.013). No difference was found between diagnosed and suspected patients in terms of pneumonia findings on chest CT (P = 0.099) (Table 2).

Table 1. Demographic characteristics and test results of the patients

		n	%
Gender	Women	88	35.1
	Men	163	64.9
CT Findings	Pneumonia	154	61.4
	Non-Specific findings	97	38.6
COVID-19 diagnosis	COVID-19	138	55.0
	Suspected COVID-19	113	45.0
		Mean ± SD	Median (Min-Max)
Age (Years)	All	47.6 ± 17.5	46 (18-91)
	Women	54.0 ± 19.0	57 (18-91)
	Men	44.1 ± 15.6	41 (19-83)

Table 2. Comparison of RT-PCR test results

	Positive (n = 138)	Negative (n = 113)	P
Gender*			
Women	39 (28.3%)	49 (43.4%)	0.013[a]
Men	99 (71.7%)	64 (56.6%)	
Age (years)**			
All	45.8 ± 16.1	49.8 ± 18.8	0.073[b]
CT findings			
Normal and nonspecific findings	47 (34.1%)	50 (44.2%)	0.099[a]
Pneumonia	91 (65.9%)	63 (55.8%)	

*= n (%), **= mean ± standard deviation, [a]Chi-Square Test, [b]Independent Samples t Test, RT-PCR= reverse transcriptase polymerase chain reaction, CT= computed tomography

The mean age of the patients with signs of pneumonia by chest CT was 48.2 ± 16.9 years, and the majority of these patients (66.2%) were men. There was no statistically significant difference in chest CT findings between the genders (P = 0.588) or age groups (P = 0.494). It was found that the mean age of women was statistically higher than that of men among patients with normal chest CT findings (P = 0.010) and among patients with pneumonia findings (P = 0.001) (Table 3).

When the chest CT findings of the patients were examined, the most common pneumonia finding was ground-glass opacity (55.8%; 46.9% in the RT-PCR-negative group and 63.0% in the RT-PCR-positive group) (Table 4). When the chest CT results of the patients were examined, no findings were seen for 36.3% of the patients. Most of the patients had findings in both lungs (25.9%). Patients with findings in both lungs often had diffuse involvement in all lobes. Less frequently, only the right lung (23.1%; often the lower lobe of the right lung) was affected. The least affected was the left lung (14.7%). The most frequently affected part of the left lung was the lower lobe (Table 5).

Table 3. Comparison of computed tomography findings

	Normal (n = 97)	Pneumonia (n=154)	P
Gender*			
Women	36 (37.1%)	52 (33.8%)	0.588[a]
Men	61 (62.9%)	102 (66.2%)	
Age (years)**			
All	46.6 ± 18.5	48.2 ± 16.9	0.494[b]
Women	53.3 ± 20.9	54.4 ± 17.7	0.790[b]
Men	42.7 ± 15.7	4.0 ± 15.5	0.360[b]
P	0.010[b]	0.001[b]	

*=n (%), **= mean ± standard deviation, [a]Chi-Square test, [b]Independent samples t test

Table 4. Chest computed tomography findings of patients

CT Findings	PCR (-)*	PCR (+)*	Total*
Ground-glass opacity	53 (46.9%)	87 (63.0%)	140 (55.8%)
Mosaic perfusion	3 (2.7%)	2 (1.4%)	5 (2.0%)
Nodular density	6 (5.3%)	(0.0%)	6 (2.4%)
Lober pneumonia	7 (6.2%)	2 (1.4%)	9 (3.6%)
Normal	44 (38.9%)	47 (34.1%)	91 (36.3%)
Total	113 (100.0%)	138 (100.0%)	251 (100.0%)

*Column percentage, CT = computed tomography; PCR = polymerase chain reaction

Table 5. Location of computed tomography findings

	Ground-glass opacity	Mosaic Perfusion	Nodular Density	Pneumonia	Normal	Total
Right	53 (21.1%)	--	2 (0.8%)	3 (1.2%)	--	58 (23.1%)
Lower	26 (10.4%)	--	1 (0.4%)	2 (0.8%)	--	29 (11.6%)
Middle	7 (2.8%)	--	--	1 (0.4%)	--	8 (3.2%)
Middle-lower	6 (2.4%)	--	--	--	--	6 (2.4%)
Upper	7 (2.8%)	--	1 (0.4%)	--	--	8 (3.2%)
Middle-lower	6 (2.4%)	--	--	--	--	6 (2.4%)
Common	1 (0.4%)	--	--	--	--	1 (0.4%)
Right-Left	59 (23.5%)	5 (2.0%)	1 (0.4%)	--	--	65 (25.9%)
Lower-lower	9 (3.6%)	2 (0.8%)	1 (0.4%)	--	--	12 (4.8%)
Middle-lower	4 (1.6%)	--	--	--	--	4 (1.6%)
Upper-upper	2 (0.8%)	--	--	--	--	2 (0.8%)
Common	44 (17.5%)	3 (1.2%)	--	--	--	47 (18.7%)
Left	28 (11.2%)	--	3 (1.2%)	6 (2.4%)	--	37 (14.7%)
Lower	17 (6.8%)	--	2 (0.8%)	3 (1.2%)	--	22 (8.8%)
Upper	9 (3.6%)	--	1 (0.4%)	3 (1.2%)	--	13 (5.2%)
Common	2 (0.8%)	--	--	--	--	2 (0.8%)
--	--	--	--	--	91 (36.3%)	91 (36.3%)
Total	140 (55.8%)	5 (2.0%)	6 (2.4%)	9 (3.6%)	91 (36.3%)	251 (100.0%)

4. Discussion

Although RT-PCR offers a diagnosis of COVID-19, positivity cannot be detected in every patient by this method, the results of the RT-PCR test take a long time to obtain, and mere RT-PCR positivity does not give an idea about the patient's lung involvement. Therefore, chest CT has an important place in the evaluation of patients with suspected or diagnosed COVID-19. In the study conducted by Lui et al. (2020) was found that the most common chest CT finding in COVID-19 patients was ground-glass opacity (59%). In another study on lung involvement in COVID-19 patients, it was reported that lung involvement in patients over the age of 45 was often revealed by a ground-glass finding (Chen et al., 2020a). In our study, most of the patients (61.4%) had COVID-19

findings by chest CT. Similar to the literature, ground-glass opacity was the most common finding in both RT-PCR-positive (63.0%) and RT-PCR-negative (46.9%) patients in our study.

The mean age of the patients in our study was 47.6 ± 17.5 years, and 163 patients (64.9%) were men. In the study of Guan et al. (2020) the median age was 47 years and most of the patients (58.1%) were men. The patients in our study often had the symptom of fever (42.6%). In a study by Chen et al. investigating the clinical characteristics of COVID-19 patients, similar to our study, the most common finding was fever (Chen et al., 2020b).

In a study by Ai et al. (2020) evaluating COVID-19 patients who underwent RT-PCR and chest CT, 59% of the patients were found to be RT-PCR-positive, and 88% of these patients had chest CT findings. In the same study, 75% of RT-PCR-negative patients had chest CT findings compatible with COVID-19 (Ai et al., 2020). In our study, while the rate of RT-PCR positivity was 54.9%, the rate of chest CT findings in patients with positive RT-PCR results was 59.1%. Furthermore, 63 (45.8%) of our 113 patients with negative RT-PCR results were found to have pneumonia upon chest CT. We think that the reason why we found lower rates of RT-PCR positivity and chest CT findings compared to the previous literature is that our study was conducted in a different setting than other studies. For example, while the study of Ai et al. (2020) was conducted with patients who underwent RT-PCR throughout the hospital, our study was specifically conducted in the ED. Thus, this difference could have been caused by the early presentation of the patients to the ED during symptom onset.

In a study conducted by Mo et al. (2020) with COVID-19 patients, 55.5% of the patients were found to be men. The same study suggested that being male was a risk factor for COVID-19. In our study, in accordance with the literature, it was found that the rate of COVID-19 diagnosis by RT-PCR in men was higher than that in women. In addition, 66.2% of our patients with COVID-19 findings in chest CT being men also supports the literature.

In the study conducted by Pan et al. (2020) it was determined that, in patients who underwent chest CT, mostly 5 lobes (44.4%) were affected. In another study evaluating the chest CT findings of COVID-19 patients, it was reported that the most frequently affected lobe was the right lower lobe (76%) (Chung etl al, 2020). In another study by Long et al. (2020) it was found that there were multiple lesions in both lungs (69.4%), and lesions were most frequently seen in the right lower lobe (72.2%). Similar to the literature, findings were most commonly seen in both lungs (25.9%) in the patients in our study. Patients with findings in both lungs often had diffuse involvement in all lobes. Less frequently, the right lung (23.1%; often the lower lobe of the right chest CT) was affected. The least affected was the left lung (14.7%). The most frequently affected part of the left lung was the lower lobe.

5. Conclusion

Although COVID-19 patients are diagnosed based on positive RT-PCR test results, not every COVID-19 patient has a positive RT-PCR test result, the test results are not immediately available, and this test cannot provide information about lung involvement. Therefore, in emergency departments, the use of chest CT after the physical examination of patients with suspected lung involvement may be useful in the diagnosis of COVID-19.

Limitations

The most important limitation of our study was that the radiologists were not blind to the patients. Therefore, radiologists may have diagnosed bacterial or other viral pneumonia agents as COVID-19 disease. In addition, they may have missed other diagnoses that cause ground-glass findings because they were looking for COVID-19 findings in patients. The other limitation of our study is that the patients' tomography findings and their clinics were not correlated.

Author Contributions

BB conceived the study and designed the trial. FAK and İŞ gathered and analyzed the data. EU and AŞ drafted the manuscript and all authors contributed substantially to its revision. BB takes the responsibility for the paper as a whole.

Conflict of Interest

The authors declared that there is no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Ethical Approval/Informed Consent

The study was approved by the Ethics Committee of the University of Health Sciences, Abdullah Yurtaslan Ankara Oncology Training and Research Hospital (approval number: 2020-05/604; 20.05.2020).

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