

Chest CT imaging features of Covid-19 patients: Single center observational study

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ABSTRACT

Objective: The aim of this study was to explore the chest Computer Tomography (CT) features of COVID-19 patients and compare the diagnostic performance of chest CT with that of RT-PCR at our center.

Material and Methods: The study was conducted by retrospectively scanning the files of patients admitted to the Emergency Department of Karaman State Hospital under suspicion of COVID-19 between March 15 and May 18, 2020. The study included 218 patients (124 males, 94 females, 1-90 years of age, median 48.5) who met the inclusion criteria. Chest CT scan findings were recorded in detail by two radiologists with experience in chest radiology. Furthermore, the CT findings were categorized into four groups in the form of typical, indeterminate, atypical, and negative CT according to the structured reporting system.

Results: The RT-PCR results were positive in 41% of 139 cases with positive CT results, while the RT-PCR results were positive in 15.2% of the cases with negative CT results. Regarding the analysis between CT and RT-PCR, the sensitivity was 82.61%, the specificity was 44.97%, the PPV was 41.01%, and the NPV was 84.81%. The positivity rate was 82.9% in those with typical imaging findings, 51.5% in those assessed as indeterminate. Those with a typical appearance had a higher rate of positivity than others.

Conclusion: The chest CT scan was found to have a high correlation with the RT-PCR in the patients with typical imaging findings in CT. The specificity was found to be low in the CT scan findings without subgroup analysis.

Keywords: COVID-19, Chest CT, RT-PCR, RSNA Reporting System, Single-Center Retrospective Observational Study

INTRODUCTION

COVID-19 infection was first detected in Wuhan, China and has become a pandemic by spreading rapidly (1). A new coronavirus, SARS-CoV 2, is responsible for COVID-19, a respiratory disease that can be very severe. Reverse transcription-polymerase chain reaction (RT-PCR) (2-4) or next-generation sequencing method was used to confirm the diagnosis (4, 5).

RT-PCR is believed to be highly specific but has a low sensitivity (60-70%) (4, 6). Furthermore, due to limitations in the performance of kits, sample transport, or sampling at the time of initial diagnosis (4, 7), the total positive rate of RT-PCR for throat swab samples varies between 30-60% (7).

The imaging strategy for Covid-19 is not yet clearly defined. Chest X-ray has low sensitivity early in the disease (8). Furthermore, the sensitivity of chest computed tomography (CT) has been reported to be relatively high (4-8). Low sensitivity of RT-PCR and waiting time for virus detection may lead to a delay in the diagnosis of pneumonia in patients admitted under suspicion of Covid-19 infection (7-9). Therefore, radiological imaging and evaluation of the chest play an important role in diagnosing COVID-19 suspected cases (9).

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In some patients with typical clinical and imaging findings of COVID-19, cases with positive results after consecutive negative swab samples are increasingly reported (10, 11). The role of CT in COVID-19 is constantly evolving with a lot of scientific evidence (10). However, there are differences of opinion on when and how the technique should be used for clinical trials or treatment decisions (10, 12, 13).

Our main aim in this study was to investigate the chest CT features of COVID-19 patients and compare the diagnostic performance of chest CT with that of RT-PCR at our center, which is designated as a pandemic hospital in Turkey. Also, demonstrating the RT-PCR compatibility with the structured reporting system (13) was another aim of the study.

MATERIAL and METHODS

Patient Population and Study Design:

This retrospective study was conducted with the approval of the academic ethics committee (04-2020/29). Also, the data was collected after the approval of the Directorate General of Public Health of the Ministry of Health, Republic of Turkey and the Ethics Committee of our hospital (11.05.2020/37844338-799).

The study was created by scanning the hospital automation system files of the patients admitted to the Emergency Department under suspicion of COVID-19 between March 15 and May 18, 2020. The inclusion criteria for the study were; 1) the patients whom oropharyngeal and nasopharyngeal (combined) swab was taken for RT-PCR and who concurrently had chest CT from among the patients with fever, cough, shortness of breath, or history of recent travel abroad, close contact history with Covid-19 suspected patients (without distinguishing between paediatric and adult patients) 2) the patients who previously had RT-PCR result and were hospitalized after presenting to the emergency department of our hospital and having a CT imaging, 3) the patients whose clinical and laboratory (included RT-PCR) and imaging data could be accessed clearly, who had mild symptoms and were recommended home isolation,

The exclusion criteria; 1) the patients who had motion artifact restricting CT evaluation, 2) the patients with clinically requested CT for non-COVID-19 reasons and with different indications were not included in the study.

Clinical Data

All patients were administered a preliminary screening questionnaire at one of the Covid-19 outpatient clinics in the emergency department for signs of fever, cough, dyspnea symptoms or a history of recent travel abroad, and suspicious contact with Covid-19 patients. $>38^{\circ}\text{C}$ was considered for the presence of fever. Then, specific blood tests (haemogram, biochemical analyses) and nasopharyngeal and oropharyngeal swab (combined) samples were obtained for each patient. RT-PCR technique was used to confirm SARS-CoV2 positivity. Two consecutive swab samples were required to be negative for RT-PCR negativity. Laboratory results, clinical signs and symptoms, and demographic distribution of the patients were collected for analysis. The patients with CT findings were hospitalized for the detailed analysis of the tests and results,

follow-up of their RT-PCR results, and isolation, while the patients with negative CT findings were decided by the clinician for home isolation or hospital follow-up according to their clinical status. The data of the patients whose clinical data were complete and whose data could be accessed in detail was collected.

CT imaging technique

In the COVID 19 algorithm, which we did in partnership with our hospital's clinicians, chest CT was applied to all patients after the RT-PCR swab samples to show the presence or absence of viral pneumonia. All chest CTs were obtained at end-inspiration (in adult and/or compatible pediatric patients), while other patients were under free-breathing, without contrast, and in the supine position for the chest CT. Chest CT shots were performed at a 16 slice CT scanner (Toshiba Alexion 16 slice CT scanner, Canon medical systems, Tokyo, Japan). The following technical parameters were used; (in adult patients) tube voltage, 120KV; effective mAs, 180-400 mAs; collimation, 0.625 mm or 0.5 mm; pitch, 0.8 or 1; reconstruction algorithm, filtered rear projection. The estimated effective radiation dose in adults ranges from 2.8 mSv to 3.5 mSv. Children: tube voltage, 80-120 kV; mA, automatic exposure control; collimation, 2.0 mm; pitch, 1; reconstruction algorithm: iterative reconstruction was used. The estimated effective radiation dose in pediatric patients ranges from 0.8 mSv to 1.2 mSv.

All images were evaluated by making reconstructions with a 1 mm slice thickness. The scan room was ventilated for 30 minutes after each patient and surface cleaning was done with 0.1% sodium hypochlorite.

CT image analyses

All the data was transferred to the Vitreaworkstation LT (vitrea version 4.1.14/ Vital Images, Inc. Minnesota, USA) to perform the image analysis at best reconstruction and slice thickness. The images were examined simultaneously with no major conflict by two radiologists who have experienced chest radiology for 8 years (I. Karluka) and 10 years (F. Güngördü). The images were recorded as typical, indeterminate, atypical, or no signs of pneumonia according to the categorization made by the RSNA. All of the typical, indeterminate, and atypical imaging features have been recognized as CT-positive. Those without any signs of pneumonia (those who were completely normal or without any signs of pneumonia) were considered CT negative.

Typical imaging findings;

a) Bilateral, peripheral ground-glass opacity (with or without consolidation or intralobular septal thickening "crazy paving pattern" b) Multifocal rounded ground-glass opacity (with or without consolidation or intralobular septal thickening "crazy paving pattern") c) Reverse halo sign or other findings of organizing pneumonia were defined in this group.

Indeterminate imaging findings; (in the absence of typical imaging features)

a) Multifocal, diffuse, perihilar, or unilateral glass ground (with or without consolidation lacking a specific distribution and are non-rounded or non-peripheral) b) A few very small glass ground opacities with a non-rounded and non-peripheral distribution were defined in this group.

Atypical imaging findings: (in the absence of the CT findings in typical or indeterminate groups),

a) Isolated lobar or segmental consolidation without ground-glass opacity **b)** Discrete small nodules (tree-in-bud, centrilobular) **c)** Lung cavitation **d)** Smooth interlobular septal thickening with pleural effusion was defined in this group.

Negative for pneumonia, those without any findings on CT features to suggest pneumonia were included in this group.

(This categorization is used in our hospital and was put into practice in our hospital in a common decision made by clinicians in accordance with the recommendations of RSNA for possible COVID-19 case evaluation on March 2020 (13)).

CT imaging features; ground-glass opacity, distribution and type of ground-glass opacities, the distribution pattern of lesions, consolidation, consolidation type, multiple lobe involvement, pulmonary nodules surrounded by ground-glass, air bronchogram, halo sign, vascular enlargement, lymphadenopathy (defined in the form of short-axis >10 mm), pleural effusion, pericardial effusion, tree-in-bud appearance, and lung lobe segment and involvement were recorded separately.

Statistical Method: The data were analyzed with SPSS (IBM Corp, SPSS ver.23 for Windows, Armonk, N.Y., USA). The link between CT and RT-PCR was examined by diagnostic tests. Sensitivity, specificity, PPV, NPV, and accuracy rates were analyzed and evaluated. The categorical data were evaluated by Chi-square test. The results of the analyses were presented as frequency and percentage for categorical data and median (min-max) for quantitative ones. The level of significance was set at $p < 0.05$. A 95% confidence interval was provided by the Wilson-Score method.

RESULTS

Patient population and clinical data

A total of 218 patients were included in the study. 56.9% (124) of the patients included in the study were male. The median age was 48.5 (1-90) (Table 1). Of the cases, 44.9% had a fever, 67.4% had a cough, and 29.8% had shortness of breath. In 36.7% of the cases, signs of hypertension were present. 80.3% of the patients were hospitalized and followed. (Table 1)

Only 9.6% of the patients had lymphopenia, 73.9% had high CRP levels, 26.6% had high WBC (White blood cells) count, and 28.4% had an increase in the number of neutrophils (Table 1).

Diagnostic performance of CT

The RT-PCR result was positive in 41% of 139 cases with positive CT results, while the RT-PCR result was positive in 15.2% of the cases with negative CT results. Regarding the analyses between CT and RT-PCR, the sensitivity was 82.61%, the specificity was 44.97%, the PPV was 41.01%, the NPV was 84.81%, and the accuracy was 56.88% (Figure 1 and Table 2).

Diagnostic consistency of CT according to the structured reporting system

The positivity rate was 82.9% in those with typical imaging findings, 51.5% in those assessed as indeterminate, 9.5% in those who were atypical, and 14.8% in those who were not related to pneumonia. Those with a typical appearance had a higher rate of positivity than others. There was also a difference between those who were indeterminate and who were non-pneumonia related. There was no difference in positivity between those who were atypical and who were non-pneumonia related (Figure 2 and Table 3).

CT scan analysis

CT imaging findings of the RT-PCR positive cases were analyzed and it was found that 75.4% had ground-glass opacities, 55.1% had multilobar distribution (≥ 2), 53.6% had bilateral distribution pattern, and 66.7% had peripheral distribution. Pericardial effusion (0%), cavitation (0%), and tree-in-bud appearance (1.4%) were recorded as minimal or non-monitored CT imaging findings (Table 4).

The most commonly recorded ones were the right lung lower lobe involvement (60.9%) and the left lung lower lobe involvement (58%), while the least commonly recorded one was the right lung middle lobe involvement (33.3%). There were the right lung lower lobe posterior segment (49.3%) and the left lung lower lobe posterior (44.9%) the most, and the right lung lower lobe anterior segment involvement the least (Table 4). 75.4% had ground-glass opacities. Of these, peripheral distribution was recorded in 69.6%. When subgroup analysis was performed, rounded morphology was observed in 60.9% (Table 4).

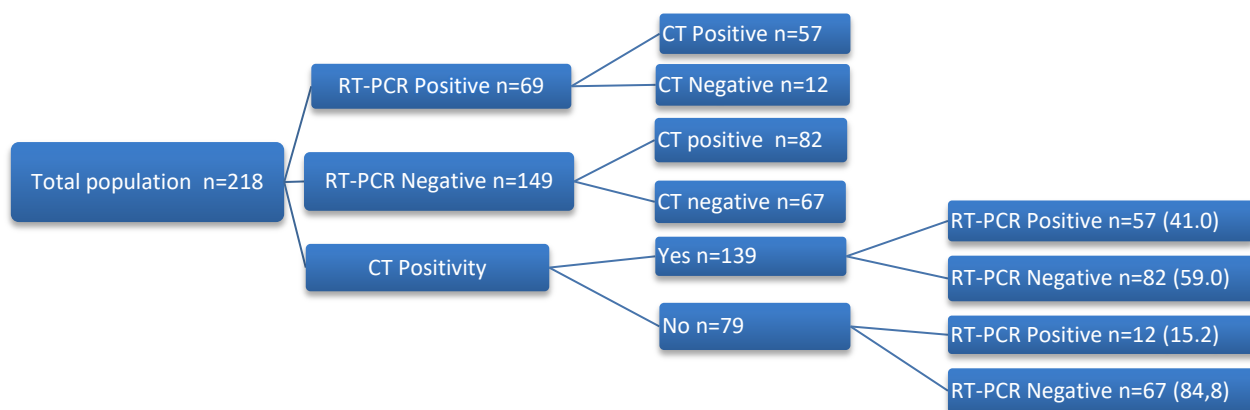


Figure 1: Flow chart of the study and Examination of the RT-PCR/CT correlations. (n=frequency, percentage (%), CT: Computed Tomography, RT-PCR: Real-Time Polymerase Chain Reaction)

Table 1. Clinical data (RT-PCR positive and negative patients)

Patient demographics		
	Frequency (n)	Percentage (%)
Male	124	56.9
Female	94	43.1
Age Median (min-max)	48.5 (1-90)	
Signs, Anamnesis, Hospitalization		
	(n,%)	(n,%)
Fever (>38°C)	98 (44.9)	120 (55.1)
Cough	147 (67.4)	71 (32.6)
Dyspnea	65 (29.8)	153 (70.2)
History of Recent Travel Abroad	16 (7.3)	202 (92.7)
Contact History with Covid-19 Patients	33 (15.1)	185 (84.9)
Hospital Admission	175 (80.3)	43 (19.7)
Comorbidity		
Hypertension	80 (36.7)	138 (63.3)
Diabetes Mellitus	39 (17.9)	179 (82.1)
Coronary Artery Disease	38 (17.4)	180 (82.6)
Chronic Obstructive Pulmonary Disease	22 (10.1)	196 (89.9)
Asthma	6 (2.8)	212 (97.2)
Congestive Heart Failure	12 (5.5)	206 (94.5)
Chronic Renal Failure	9 (4.1)	209 (95.9)
Laboratory test		
Lymphocyte Count (Normal reference range: 0,8-4 K/uL)		
Low	21	9.6
Normal	188	86.2
Increased	9	4.2
C-Reactive Protein (CRP) Level (Normal reference range: 0-5 mg/L)		
Increased	161	73.9
Normal	57	26.1
Wbc (White blood cells) count (Normal reference range 4-10 K/uL)		
High	56	26.6
Normal	151	69.2
Low	9	4.2
Number of Neutrophils (Normal reference range: 2-7 K/uL)		
Increased	62	28.4
Normal	150	68.8
Low	6	2.8

Table 2. Diagnostic Performance of chest CT (RT-PCR as the standard of reference)

Statistics	Value (%)	95% CI (%)
Sensitivity	82.61	71.59 – 90.68
Specificity	44.97	36.82 – 53.32
Positive Predictive Value	41.01	36.71 – 45.45
Negative Predictive Value	84.81	76.42 – 90.58
Accuracy	56.88	50.02 – 63.55

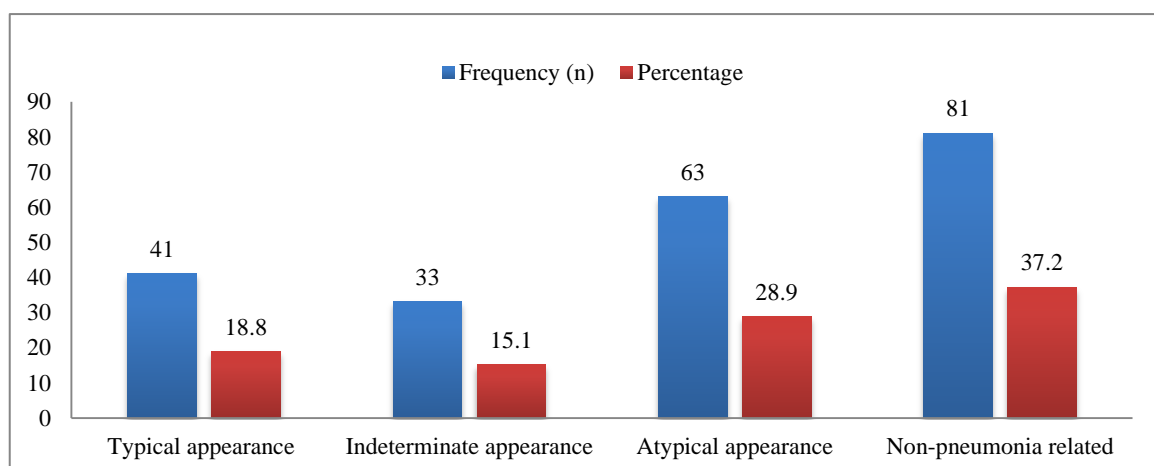
**Figure 2.** Distribution by the reporting system

Table 3. Comparison of the RT-PCR results by the structured reporting system

RT-PCR	According to CT imaging features				p
	Typical appearance	Indeterminate appearance	Atypical appearance	Non-pneumonia related	
Positive (n, %)	34 (82.9) ^a	17 (51.5) ^b	6 (9.5) ^c	12 (14.8) ^c	<0,001
Negative (n, %)	7 (17.1)	16 (48.5)	57 (90.5)	69 (85.2)	

Table 4. Descriptive statistics of the PCR (+) patients CT imaging features

CT Features Analysis	Patients (n=69)	
	Positive (+)	Negative (-)
Ground glass opacities (GG0)	52 (75.4)	17 (24.6)
Multilobar distribution (≥2)	38 (55.1)	31 (44.9)
Bilateral distribution pattern	37 (53.6)	32 (46.4)
Peripheral distribution	46 (66.7)	23 (33.3)
Posterior involvement	39 (56.5)	30 (43.5)
Localization of ground-glass opacities (peripheral)	48 (69.6)	21 (30.4)
Subsegmental vascular enlargement (>3 mm)	14 (20.6)	54 (79.4)
Consolidation	24 (34.8)	45 (65.2)
Subsegmental consolidation	20 (29)	49 (71)
Segmental consolidation	7 (10.1)	62 (89.9)
Lymphadenopathy (Short axis >10 mm)	16 (23.2)	53 (76.8)
Bronchiectasis	12 (17.4)	57 (82.6)
Air bronchogram	8 (11.6)	61 (88.4)
Pulmonary nodule surrounded by ground-glass opacities	9 (13)	60 (87)
Interlobular septal thickening	3 (4.3)	66 (95.7)
Halo sign	1 (1.4)	68 (98.6)
Pericardial effusion	---	69 (100)
Pleural effusion	4 (5.8)	65 (94.2)
Bronchial wall thickening	6 (8.7)	63 (91.3)
Cavitation	---	69 (100)
Tree-in-bud appearance	1 (1.4)	68 (98.6)
GGO patterns		
Crazy paving (ground glass pattern)	8 (11.6)	61 (88.4)
Rounded morphology (ground glass pattern)	42 (60.9)	27 (39.1)
Linear opacities (ground glass pattern)	25 (36.2)	44 (63.8)
Frequency of lobe involvement		
Right lung upper lobe involvement	24 (34.8)	45 (65.2)
Right lung middle lobe involvement	23 (33.3)	46 (66.7)
Right lung lower lobe involvement	42 (60.9)	27 (39.1)
Left lung upper lobe involvement	27 (39.1)	42 (60.9)
Left lung lower lobe involvement	40 (58)	29 (42)
Frequency of segment involvement		
Right lung lower lobe posterior segment	34 (49.3)	35 (50.7)
Right lung lower lobe anterior segment	12 (17.4)	57 (82.6)
Right lung lower lobe lateral segment	24 (34.8)	45 (65.2)
Right lung lower lobe medial segment	15 (21.7)	54 (78.3)
Right lung lower lobe superior segment	26 (37.7)	43 (62.3)
Right lung middle lobe lateral segment	19 (27.5)	50 (72.5)
Right lung middle lobe medial segment	12 (17.4)	57 (82.6)
Right lung upper lobe apical segment	16 (23.2)	53 (76.8)
Right lung upper lobe posterior segment	16 (23.2)	53 (76.8)
Right lung upper lobe anterior segment	20 (29)	49 (71)
Left lung lower lobe posterior segment	31 (44.9)	38 (55.1)
Left lung lower lobe lateral segment	26 (37.7)	43 (62.3)
Left lung lower lobe anteromedial segment	18 (26.1)	51 (73.9)
Left lung lower lobe superior segment	25 (36.2)	44 (63.8)
Left lung upper lobe inferior lingular segment	18 (26.1)	51 (73.9)
Left lung upper lobe superior lingular segment	15 (21.7)	54 (78.3)
Left lung upper lobe anterior segment	14 (20.3)	55 (79.7)
Left lung upper lobe apicoposterior segment	14 (20.3)	55 (79.7)
	Med. (Min. –Max.)	
Subsegmental vascular enlargement diameter (mm)	3.59(3.08-4.64).	
Number of Involved Lobes	2 (1-5)	

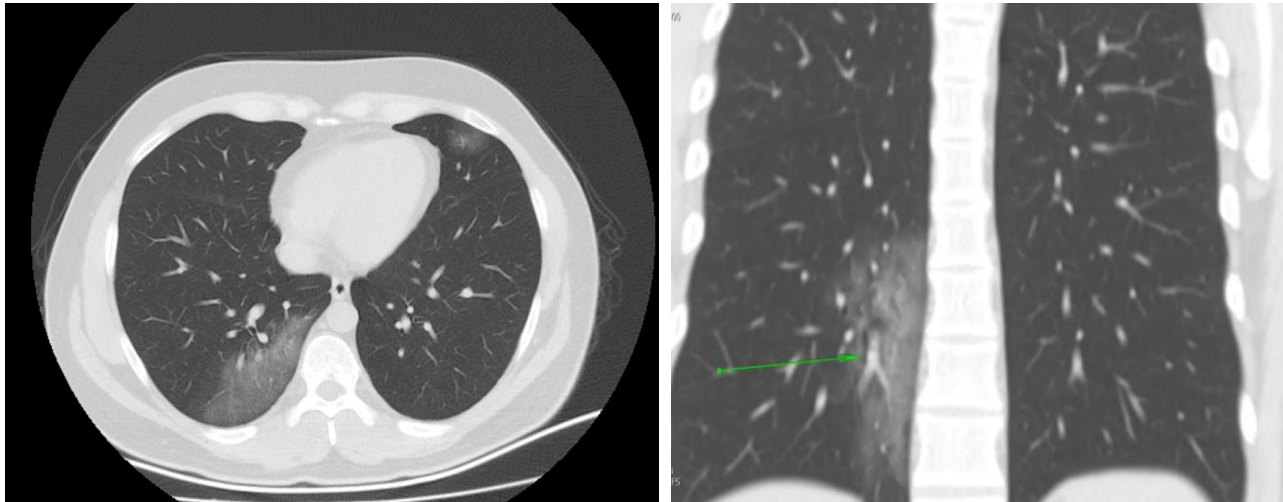


Figure 3. A 32-year-old male patient presented to the Covid-19 emergency department with fever and cough that were continuing for 2 days. A typical imaging finding was observed on chest CT in terms of COVID-19. The patient, whose RT-PCR was positive as a result of the oropharyngeal and nasopharyngeal (combined) swab samples taken simultaneously; GGO with bilateral and peripheral distribution; a) In the axial slices, GGO are observed in the right lung lower lobe posterobasal segment and left upper lobe inferior lingular segment. b) Subsequent segment vascular enlargement in the coronal sections (a-b) Typical imaging findings for COVID-19.

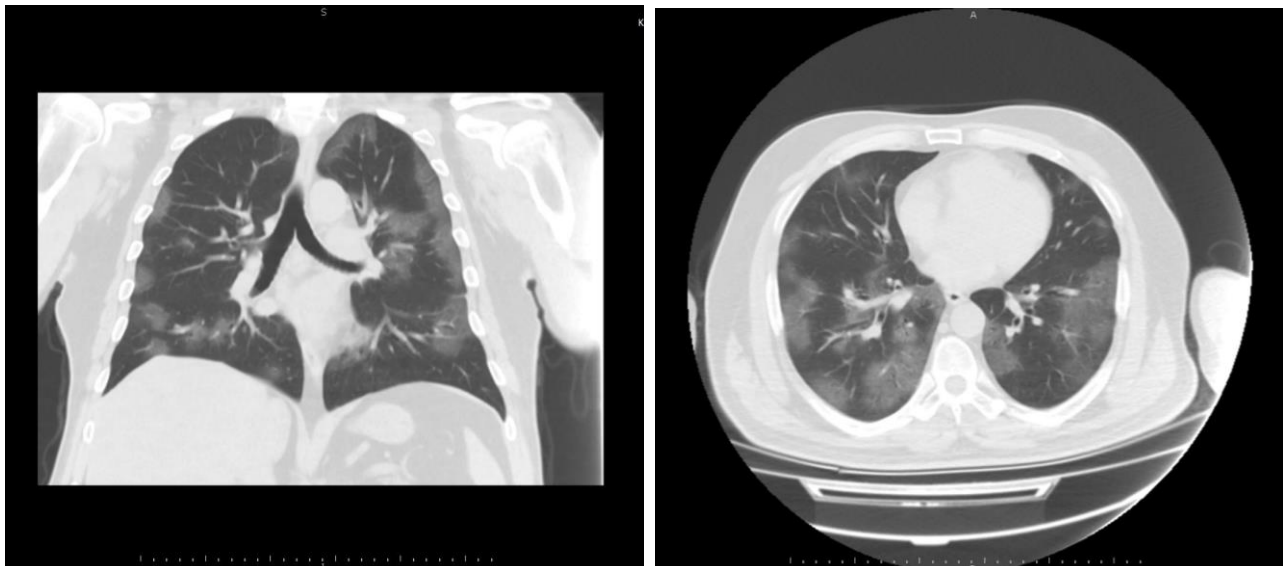


Figure 4: A 51-year-old male patient with high fever and dry cough who was considered as a possible COVID 19 case. Some of his relatives were also RT-PCR positive for COVID-19 and had taken treatment. Chest CT imaging findings were considered typical imaging findings for COVID-19. However, two consecutive swab samples for RT-PCR resulted negatively. a) coronal plane, b) GGO with bilateral and peripheral distribution in the axial plane, multilobar involvement

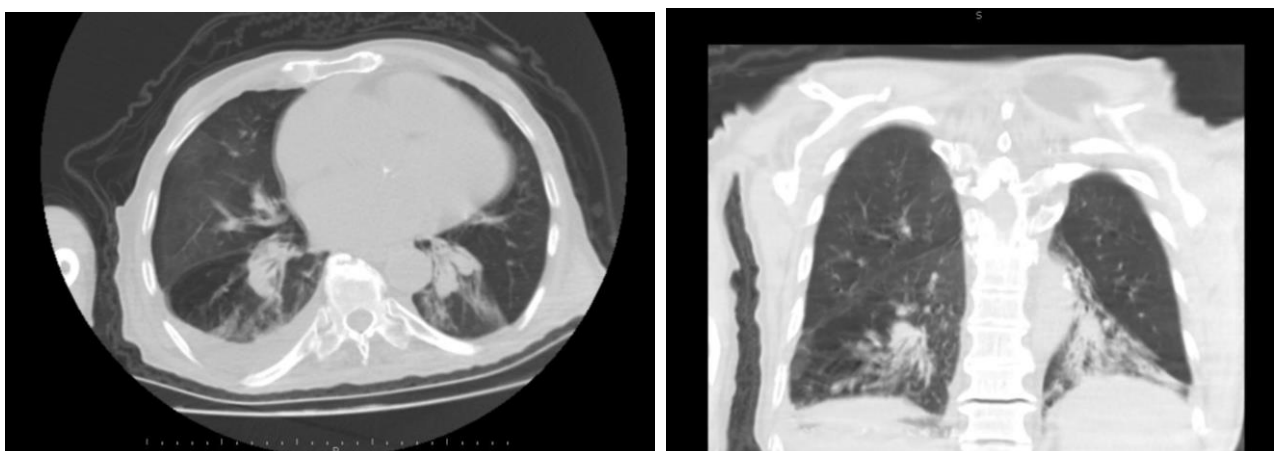


Figure-5: A 78-year-old male patient presented with the complaint of shortness of breath. Chest CT examination at the time of initial application was evaluated atypically for COVID-19. RT-PCR resulted positively. a) More prominent pleural effusion is observed on the bilateral right in the axial plane. b) Peribronchial wall thickening, peribronchial infiltrations in both lungs' lower lobes in the coronal plane were evaluated as (a-b) Atypical imaging findings for COVID-19. RT-PCR (+) resulted for COVID-19

DISCUSSION

COVID 19 is a highly contagious disease and is prevalent across the world. Early diagnosis of the disease is important in reducing its spread and controlling it. Largely normal chest radiographs in the early stages of the disease may give many false-negative results. Thin-section CT is highly sensitive and is used as an important diagnostic method for showing signs of lung parenchyma in the early stages of the disease (5). However, most radiology professional organizations and communities make counter-recommendations for the screening of COVID-19 (13, 14).

The predominant imaging findings in the CT imaging of Covid-19 are the ground glass opacities with peripheral distribution, accompanied by occasional consolidation (13, 15). It was reported that posterior involvement occurred and the ground glass opacities often had a rounded morphology or 'crazy paving' pattern (13, 15, 16). Dominant perihilar pattern of involvement, bronchial wall thickening, mucoid effects, and nodules ("tree in bud" and centrilobular) were reported to be not typically observed in the other COVID-19 (13 16). Pleural effusion and lymphadenopathy were the rarely reported imaging findings (13, 17). For example, in a prospective study with 158 patients, the typical CT features of COVID-19 were 100% ground-glass opacities, 93% multilobar involvement (>2) and posterior involvement both, 91% bilateral distribution pattern, and 89% subsegmental (>3 mm) vascular enlargement (4). In a systematic review by Salehi et al.; ground-glass opacity was 88%, peripheral distribution was 76%, bilateral distribution was 87.5%, multilobar involvement was 78.8%, pulmonary consolidation distribution was 31%, and posterior involvement was 80.4% (18). In this study conducted in our own population, the ground glass opacity was found to be 75.4%, the bilateral distribution was 53.4%, the multilobar involvement was 55.1%, the peripheral distribution was 66.7%, and the posterior involvement was 56.5%. The consolidation was determined at 34.8%. Cavitation (0%), pleural effusion (5.8%), tree in bud pattern (1.4%), and bronchial wall thickening (8.7%), which were also reported as rare or atypical in other studies, were also recorded as very low or not found at all. Ground glass opacities were found in rounded morphology at a rate of 60.9%.

In the literature review on the correlation of chest CT with RT-PCR, it was reported that the studies that included RT-PCR results and CT findings were generally consistent (18). However, the time of imaging of infected patients affects the frequency of CT findings (13). Xie et al. reported five patients with imaging findings of typical COVID-19 pneumonia but with a negative RT-PCR result; the control RT-PCR results of these patients were positive. Although the initial RT-PCR result was positive in seven patients in the same study, no abnormalities were observed in CT (18, 19). Chung et al. reported in their study that no CT findings were observed in three of the 21 patients with laboratory approval on initial imaging (17, 18). In this study, there were 12 (12/69, 17.4%) cases whose initial RT-PCR results were positive and who had no findings consistent with pneumonia or were completely normal on CT imaging at the time of initial presence. However, we reported 7 cases (7/218, 3.2%) with clinical and laboratory findings suggesting COVID-19,

with typical radiological imaging characteristics, although their twice-performed RT-PCR results were negative.

In reviewing the literature on the diagnostic performance of CT in Covid-19, the sensitivity and specificity of CT were reported to be highly variable (respectively 60-98% and 25-53%) (7, 11, 13). However, the sensitivity of RT-PCR varies between 42% and 71%, according to the initial reports (13). The lack of strict diagnostic criteria for imaging and the fact that the sensitivity of RT-PCR is so variable is the likely cause of differences in the diagnostic performance of CT between the studies (13, 20). Fang et al. reported in their study that they found the sensitivity of CT in a series of 51 patients by 98% (11). Caruso et al. reported in their study that sensitivity, specificity, and accuracy were 97%, 56%, 72%, respectively (4). Ai et al. reported the sensitivity, specificity, and accuracy to be 97%, 25%, 68%, respectively (7). In this study, we found the sensitivity, specificity, and accuracy 82.6%, 44.9%, and 56.8%, respectively.

Many radiology professional organizations and associations made recommendations to reduce the variability of COVID-19 reporting, help radiologists identify the findings and clinicians understand these radiological findings, provide a standard communication, and evaluate the suspicion of involvement (10, 13). CO-RADS, which was recommended by the Radiological Society of the Netherlands, is one of them and provides a categorical evaluation scheme of suspicion of pulmonary involvement of COVID-19 from highly unlikely (CO-RADS-1) to very high (CO-RADS-5) (10). According to the report of the Radiological Society of North America (RSNA), the American College of Radiology (ACR), and the Society of Thoracic Radiology published on March 2020 in consensus, CT imaging findings were categorized as typical, indeterminate, atypical, and pneumonia negative and a reporting language was proposed (13). We used the reporting language recommended by the RSNA with the joint decision we took with clinicians at our hospital. In this study, the positivity rate was 82.9% in those with typical imaging findings, while it was 51.5% in those who were evaluated as indeterminate, 9.5% in those who were atypical, and 14.8% in those who were not related with pneumonia. In those with a typical appearance, the positivity rate was obtained higher than in others. These rates have provided valuable information, especially in terms of how much we may be mistaken for those in the indeterminate, atypical, and pneumonia-negative groups. Bai et al. found that radiologists were able to distinguish COVID-19 from other causes of pneumonia with high specificity (21). In our study, the high rate of positivity (82.9%) in those with typical imaging findings supports this.

CONCLUSION

The most intriguing feature of the results of our study was that it correlated with RT-PCR with high accuracy in those with typical imaging findings in CT. The specificity was found to be low in CT imaging findings without subgroup analysis (typical/indeterminate/atypical/pneumonia negative).

Our study has some limitations. The first is that our study was designed retrospectively and with a limited population. The second was that it was done based solely on the observations and findings of two radiologists.

Author Contributions: All authors contributed to the study conception and design. The study was performed material preparation (Ismail Karluka, Fahrettin Gungordu, Ahmet Aslan, Ali Avcı, Orhun Öztürk), data collection (Ismail Karluka) and analysis (Ismail Karluka, Fahrettin Gungordu). The first draft of the manuscript was written by (Ismail Karluka) and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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