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Characteristics of Thoracic CT Findings in Differentiating COVID-19 Pneumonia from Non-COVID-19 Viral Pneumonia

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Abstract

Background: Coronavirus Disease 2019 Reverse-Transcriptase Polymerase Chain Reaction (COVID-19 RT-PCR) positive predictive value is low. COVID-19 RT-PCR negative patients with pneumonia were not rare. It is difficult to distinguish COVID-19 pneumonia between other viral pneumonias radiologically and clinically. We aimed to find whether there was any different radiological finding in COVID-19 pneumonia with the other viral agents that caused pneumonia.

Material and Methods: The study was designed retrospectively. 78 patients who underwent Thoracic Computed Tomography (CT) and COVID-19 RT-PCR were included in the study. Other viral Polymerase Chain Reaction (PCR) tests were performed on 33 patients.

Results: 22 patients had COVID-19 PCR positive and 11 patients had non-COVID-19 PCR positive. 8 patients had influenza A and B, and 3 patients had adenovirus. In both groups, lung parenchymal lesions were predominantly located in the upper lobes and peripheral. 31 (93.9%) patients had ground-glass density lesions, 24 (72.7%) patients had consolidation, and 5 (15.2%) patients had crazy paving lesions. 1(3.0%) patient had a halo sign. There was no statistical difference between the two groups in terms of the features of the parenchymal lesions, except for vascular enlargement. Vascular enlargement was only seen in patients with COVID-19 pneumonia (p: 0.019).

Conclusion: Radiologically, the vascular enlargement sign seems to be specific to COVID-19 disease and it can be used to differentiate COVID-19 pneumonia from other viral pneumonias.

Keywords

COVID-19, Thoracic CT, Vascular Enlargement, Viral Pneumonia

Introduction

In December 2019 the novel coronavirus (2019-nCoV or SARS-CoV-2) has been identified in five family members in Wuhan city of Hubei province in China. It has been determined that the most important cause of mortality in COVID-19 disease caused by the virus is respiratory failure due to acute respiratory distress syndrome (ARDS) [1].

The total number of deaths as a result of ARDS, caused by the influenza A (H1N1) virus at the pandemic in 2009, was 18.449 [1]. Influenza B, one of the seasonal influenza factors, has shown similar epidemic and pandemic episodes. The annual mortality from influenza-related respiratory diseases is estimated to be approximately 650.000 [2]. It has been reported that the transmission and mortality rates of COVID-19 are higher than other seasonal influenza factors [3].

It is difficult to distinguish between viral pneumonias radiologically and clinically. Although fever, weakness, fatigue, joint pain, dry cough, shortness of breath, and gastrointestinal complaints are listed as symptoms of COVID-19, other seasonal influenza agents may also cause the same symptoms [4,5]. Furthermore, laboratory findings such as; lymphopenia, thrombocytopenia, leukopenia, and C-reactive protein elevation are not specific to COVID-19 [5]. Patchy ground-glass opacities, crazy-paving patterns, and consolidations are common chest CT findings in viral pneumonias including COVID-19 pneumonia [6-8].

Recent studies have shown that some of the tomographic findings can be used to distinguish seasonal viral pneumonias from COVID-19 pneumonia to help early and accurate diagnosis. The ground-glass opacities (GGO) are more common in COVID-19 pneumonia and the lesions are located usually peripherally and accompanied by crazy paving patterns [9-12]. CT findings can be used to distinguish COVID-19 pneumonia from other viral pneumonias which peak especially in spring and winter. The aim of this study is to determine whether there is a difference, or not, between CT findings of other viral pneumonias and COVID-19 pneumonia.

Material and Methods

Data Collection:

This study was designed retrospectively. Seventy-eight patients with pneumonic infiltrations on their chest X-ray and/or thoracic CT and hospitalized between March-June 2020 with suspicion of viral pneumonia were included in this study. RT-PCRs were performed for patients. Hemogram, C-reactive protein (CRP), renal and hepatic function tests, ferritin, and d-dimer levels of all COVID-19 suspected patients were routinely checked in our hospital. Chest X-rays and thoracic CT scans were taken when necessary. The demographic information and laboratory findings of the patients were obtained from the hospital information system and radiological images were reviewed via PACS. Thoracic CTs of the hospitalized cases were evaluated by chest physicians and a radiologist independently. Radiologically, viral pneumonia findings were classified based on the COVID-19 Guidelines recommended by the Ministry of Health.

This study was approved by our institutional review board and the requirement for written informed consent was waived due to the retrospective nature of the study.

Thorax CT Acquisition and Image Interpretation:

All CT scans were performed using spiral volumetric acquisition technique with the same scanner (Philips Ingenuity 128), without intravenous contrast administration, and images were obtained with 1.5 mm slice thickness. Detailed technical parameters were as follows: tube voltage=120 kV, pitch=1, collimation=64x0.625 mm and rotation time=0.5 second. An automatic 3-dimensional dose modulation technique is used during image acquisition.

Statistical Analysis:

Variables were analyzed with SPSS (Version 15) program. Numerical variables that had homogeneous distribution were analyzed with t-test and Pearson correlation, and categorical variables analyzed with chi-square test. Non-homogeneous variables were analyzed with nonparametric tests. For all tests, a $p<0.05$ was considered statistically significant.

Results

Comparison of COVID-19 RT-PCR Positive and Negative Cases:

COVID-19 RT-PCR test was found to be positive in 22 of 78 patients, who are involved in this study. 11(14.1%) patients were positive for PCR tests for other seasonal viral factors. The mean age was 58.05 years and 51(65.4%) of the patients were male. All these patients had COVID-19 related symptoms and the most common symptoms were coughing and dyspnea. COVID-19 RT-PCR was negative in 56(71.8%) and positive in 22(28.2%). The demographic findings of all patients were summarized in **Table-1** and CT findings in **Table-2**. Radiological findings were mostly bilateral and dominant at upper lobes in RT-PCR negative patients, but there were no statistically significant differences between PCR negative and positive cases according to the location of the lesions. Although ground-glass opacities were present dominantly in COVID-19 RT-PCR positive and negative cases, they statistically not significant (p: 0.685). Vascular enlargement was detected in 8 (36.4%) of the positive cases, whereas in none of the negative (**Table-2**). This difference was statistically significant (p<0.001) and hence vascular enlargement is thought to be helpful in the differentiation of COVID-19 RT-PCR (+) and (-) cases. The rates of the presence of crazy paving appearance and micronodular findings were significantly different between COVID-19 PCR (+) and (-) cases (respectively p: 0.021; p: 0.011).

Comparison of Thoracic CT Findings COVID-19 Viral RT-PCR Positive and Non-COVID-19 Viral RT-PCR Positive Cases:

The PCR test was performed for other viral agents considering non-COVID-19 viral pneumonia in 23 (29.5%) of 78 cases included in the study. The non-COVID-19 viral PCR test was resulted positive in 11 patients. Influenza A and B were detected positive in 8 patients, and adenovirus was detected positive in 3 patients. Patients with positive COVID-19 RT-PCR mean age was found 58.6 ± 4.0 years; patients with positive non-COVID-19 RT-PCR mean age was found 55.7 ± 3.3 years. In both groups, lung parenchymal lesions were predominantly located in the upper lobes and peripheral. There was no difference in terms of the

Table-1: Demographic Findings of Patients (N:78)

		RT-PCR Positive (N: 22), n (%)	RT-PCR Negative (N: 56), n (%)	p
Age, year, mean±SD		54.77	59.34	0.212
Gender (n)	Male	15(19.2)	36 (46.2)	0,481
	Female	9(11.5)	20 (25.6)	
Smoking behaviors (n)	Smoker	8 (10.3)	33 (42,3)	0.073
	Non-smoker	14 (18.0)	23 (29,5)	
Comorbidity (n)	HT	4(5.1)	14(17,9)	0.52
	KAH	4(5,1)	14(17.9)	0,520
	KBY	0(0.00)	2(2,5)	0.369
	DM	5(6,4)	16(20.5)	0.601
	Immune suppression	2(2,5)	10(12.8)	0,334
Number of patients with a foreign travel history (n)		0(0.0)	1(1,3)	-
Number of patients with a history of contact with patients diagnosed with COVID-19 (n)		8(10.25)	15(19,23)	0.404
Number of patients with symptoms(n)		22(28.20)	56(71.80)	0.128

Table-2: Comparison of the CT Findings of COVID-19 RT-PCR Negative and Positive Cases (N:78)			
CT Findings	**CIVID-19 PCR Positive Cases (N:22), n(%)**	**COVID-19 PCR Negative Cases (N:56), n(%)**	**p**
Bilateral lesions			
Present	13 (16.7)	37(47.4)	0.614
Absent	7(9.0)	17(21.8)	
Upper lobe involvement			
Present	18(23.1)	45(57.7)	
Absent	4(5.1)	11(14.1)	0.579
Peripheral lesions			
Present	21(26.9)	3(71.8)	0.282
Absent	1 (1.3)	0 (0.0)	
Central lesions			
Present	1(1.3)	3(3.8)	0.685
Absent	21(26.9)	53(67.9)	
Ground glass opacity			
Present	21 (26.9)	53(67.9)	0.685
Absent	1 (1.3)	3(3.8)	
Consolidation			
Present	17(21.8)	40 (51.3)	0.413
Absent	5(6.4)	16(20.5)	
Vascular enlargement			
Present	8(10,3)	0(0.0)	**0.001**
Absent	14(17.9)	56(71.8)	
Crazy paving			
Present	4(5.1)	1(1.3)	**0.021**
Absent	18(23.1)	55(70.5)	
Air bronchogram			
Present	4(5.1)	10(12.8)	0.604
Absent	18(23.1)	46(59.0)	
Halo sign			
Present	1(1.3)	1(1.3)	0.487
Absent	21(26.9)	55(70.5)	
Air bubble sign			
Present	2(2.6)	0(0.0)	0.077
Absent	20(25.6)	56(71.8)	
Micro nodules			
Present	1(1.3)	17(21.8)	**0.011**
Absent	8(10.3)	39(50.0)	
Mediastinal lymphadenopathy			
Present	2(2.6)	4(5.1)	
Absent	20(25.6)	52(66.7)	0.546

location of the lesions. 31 (93.9%) patients had ground-glass density lesions, 24 (72.7%) patients had consolidation, and 5 (15.2%) patients had crazy paving lesions. 1 (3.0%) patient had a halo sign. There was no statistical difference between the two groups in terms of the features of the parenchymal lesions, except for vascular enlargement. Vascular enlargement was only seen in patients with COVID-19 pneumonia (p: 0.019) (**Table-3**).

Table-3: Comparison of Thoracic CT Findings of COVID-19 Viral RT-PCR Positive and Non-COVID-19 Viral RT-PCR Positive Cases (N:33)

CT Findings	COVID-19 RT-PCR Positive Cases (N:22), n(%)	Non-COVID-19 Viral PCR Positive Cases (N:11), n(%)	p
Bilateral lesions			
Present	18(54.5)	10 (30.3)	0.482
Absent	4 (12.1)	1 (3.0)	
Upper lobe involvement			
Present	18 (54.5)	11 (33.3)	0.208
Absent	4 (12.1)	0 (0.0)	
Peripheral lesions			
Present	21 (63.6)	11 (33.3)	0.413
Absent	1 (3.0)	0 (0.0)	
Central lesions			
Present	0 (0.0)	1 (3.0)	-
Absent	22 (66.7)	10 (30.3)	
Ground glass opacity			
Present	21(63.6)	10 (30.3)	0.407
Absent	1 (3.0)	1 (3.0)	
Consolidation			
Present	18 (54.5)	6 (18.2)	0.144
Absent	4 (12.1)	5 (15.2)	
Vascular enlargement			
Present	8 (24.2)	0 (0.0)	**0.016**
Absent	14 (42.4)	11 (33.3)	
Crazy paving			
Present	4 (12.1)	1 (3.0)	0.455
Absent	18 (54.5)	10 (30.3)	
Air bronchogram			
Present	4 (12.1)	1 (3.0)	0.455
Absent	18 (54.5)	10 (30.3)	
Halo sign			
Present	1 (3.0)	0 (0.0)	-
Absent	21 (63.6)	11 (33.3)	

Air bubble sign			
Present	2 (6.1)	0 (0.0)	0.342
Absent	20 (60.6)	11 (33.3)	
Micro nodules			
Present	2 (6.0)	3 (9.1)	0.056
Absent	20 (60.6)	8 (24.2)	
Mediastinal lymphadenopathy			
Present	3 (9.1)	1 (3.0)	0.658
Absent	19 (57.6)	10 (30.3)	

Discussion

On February 28, 2020, WHO announced that COVID-19 is a global epidemic that seriously threatens public health [13]. Other common viral pneumonia factors in this period also caused confusion among clinicians regarding the differential diagnosis of these two conditions, which cause similar symptoms and laboratory findings with COVID-19, but with different treatment and clinical course [14,15]. Computer tomography is recommended by experts for first-line screening of suspected COVID-19 patients due to its non-invasive, fast results, high resolution, and easy access [16,17]. In our study, CT findings of COVID-19 were analyzed and compared with CT findings of other viral pneumonia factors. Our study indicates that the localization of lesions and the vascular enlargement sign (VES) in thoracic CT can be used to distinguish COVID-19 pneumonia from other viral pneumonias.

In our study, COVID-19 was confirmed by RT-PCR test in 22 of the patients hospitalized with suspected COVID-19 pneumonia. When CT findings of these 22 patients were compared with the CT findings of 56 patients with negative RT-PCR tests, the location, distribution, and GGO, consolidation, crazy paving, halo, or reverse halo sign were not helped clearly to identify RT-PCR negative COVID-19 pneumonia. Common CT features currently identified for COVID-19 include multifocal or unifocal patchy and round-shaped ground-glass opacity or consolidation, reticulation or interlobular septal thickening, usually bilateral, peripheral, subpleural, inferior, and posterior distribution [16,18]. Special CT findings such as crazy paving, VES, air bronchogram, bronchiectasis or bronchial distortion, fibrosis, halo, or reverse halo may also be seen in COVID-19 pneumonia, whereas cavitations, micronodules, tree-in-bud sign, pleural effusions, and lymphadenopathy are rare [19]. In our study, 95% of our study population, GGOs, and consolidation was regarded in 73.1%. These findings are commonly seen in viral pneumonias. Although Wang et al [13], found that the presence of GGO and especially the accompanying consolidation of GGO is a radiological finding that can be used to distinguish COVID-19 pneumonia from other viral pneumonias. The presence of the halo sign in Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) viruses, which are originating from the same branch of viruses as the novel coronavirus, and in COVID-19 pneumonia, but not in other viral pneumonia factors indicates that this finding is a characteristic finding for COVID-19 [20]. We did not find any significantly difference between groups to identify COVID-19 pneumonia with a halo sign.

While previous studies have reported that GGOs seen in COVID-19 pneumonia show more unilateral, multifocal, and peripheral localization, new studies indicate that the lesions become widespread bilaterally and diffuse within a week with the prominence of symptoms. In our study, all lesions were bilateral and multifocal [1,21]. We could not find a hint to be used to differentiate COVID-19 pneumonia from other viral pneumonias in terms of these radiological characteristics. However, we found that cases with negative COVID-19 RT-PCR mostly involve the upper lobes and this lobar involvement of the lesions

indicates other viral pneumonias, but not COVID-19 pneumonia.

Zhao et al. [22] and Hu et al. [23] points out the finding that VES is a promising early CT finding of COVID-19. In a meta-analysis published recently [24]. 2 out of every 3 COVID-19 cases have VES findings on their thoracic CT scans and the presence of VES increases the risk of COVID-19 by 6.43 times. It is known that COVID-19 causes pulmonary vascular damage and coagulation disorder, and microthrombosis, a complication of these results is increased mortality [25-27]. In the light of this confirmation, it is inevitable that VES will be an important marker in the diagnosis of COVID-19. In our study, VES was detected in 8 cases with COVID-19 RT-PCR positive but were not observed in the tomography of other viral PCR positive cases. Our study supports the diagnostic value of the VES finding in the differential diagnosis of COVID-19 pneumonia from other viral pneumonias. We could not find a significant relationship between VES finding and d-dimer level. We also did not find a prominent relationship between VES findings and other acute phase reactants, but our study had an important limitation because of the small number of cases. However, these findings should be supported by more research with a widely studied population. In our study, radiological findings were not compared with laboratory findings. This was also one of the other limitations of our study.

Conclusion

Computed tomography is a non-invasive tool with a high diagnostic value in the diagnosis of COVID-19 pneumonia. Radiologically, the VES seems to be specific to COVID-19 disease and it can be used to differentiate COVID-19 pneumonia from other viral pneumonias.

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Competing Interests

All authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

Ethics Approval

Yes

Consent to Participate

Our institutional review board approved this observational research, and informed consent was obtained from all patients.

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