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Original Article

Correlation of laboratory and chest computed tomography findings with clinical severity of COVID-19 pneumonia

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ABSTRACT

Objectives: The aim of this study was to investigate the correlation between clinical and laboratory findings of the disease and chest computed tomography (CT) features in patients diagnosed with novel coronavirus-2019 (COVID-19).

Materials and methods: The prospective study included a total of 53 patients (30 males, 23 females; mean age: 54.8±19.9 years; range, 17 to 96 years) who were hospitalized due to COVID-19 between March 2020 and May 2020. A detailed chest CT examination was performed to the patients during hospitalization by a blinded radiologist. The radiological findings were classified according to the literature and frequencies of ground-glass opacities, the number of lobe involvement, consolidation, and posterior lung involvement and bilateral pneumonia. The C-reactive protein (CRP) level was established as the laboratory criterion. The clinical manifestation and severity of the disease and health status of the patients during hospitalization were recorded by a blinded pulmonologist. The severity classification of the disease was classified as mild = 1, common = 2, severe = 3, and critical = 4.

Results: The mean CRP levels was 18.1±27.1 U/mL in the mild disease group (n=11) and 108±23.6 U/mL in the critical group (n=8) (p=0.001). The most common findings in the chest CT were ground-glass opacities (n=36, 67.9%). Six (11.3%) patients had no CT findings, while 43 (81.1%) patients had bilateral pneumonia. The presence of ground-glass opacities and consolidation exacerbated the classification of the disease significantly (p=0.001 and p=0.001, respectively). A significant positive correlation was found between age, CRP level, and the number of lobes with pneumonia and severity disease (p=0.049, p=0.001, and p=0.001, respectively; r=0.270, r=0.587, and r=0.625, respectively).

Conclusion: Multilobar involvement and consolidation in COVID-19 pneumonia significantly correlate with the clinical severity of the disease and laboratory findings. Therefore, widespread involvement in chest CT during hospitalization may be a warning for the clinician.

Keywords: Chest computed tomography, COVID-19, ground-glass opacities, prognosis, viral pneumonia .

Severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) is a member of coronavirus family and has caused a pandemic which was officially named novel coronavirus-2019 (COVID-19) by the World Health Organization (WHO).[1] The definitive diagnosis is made by detecting nucleic acids of the virus by reverse transcription-polymerase chain reaction (RT-PCR).[2,3] A positive lung computed tomography (CT) result is recommended as an indication for admission to the quarantine, instead of the positive nucleic acid test, and repeated CT examinations are recommended in hospitalized patients in the recent literature.[4] The sensitivity of CT for COVID-19 has been shown to be about 97% according to RT-PCR as the standard of reference.[5] Indeed, chest CT has a higher sensitivity according to the RT-PCR test.[6,7] The most common chest CT findings are ground-glass opacities, multilobar involvement, peripheral distribution, consolidation, and bilateral pneumonia.[5,8-10] The features of CT images have

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proven that CT has a high consistency and high diagnostic value and, in accordance with clinical classification, supports that CT can guide the diagnosis, the clinical treatment, and follow-up of COVID-19 prognosis.[4,8,11,12]

In the present study, we aimed to investigate the correlation between clinical and laboratory findings of the disease and chest CT features in patients diagnosed with COVID-19.

MATERIALS AND METHODS

This single-center, prospective study was conducted at Nusaybin State Hospital, Department of Radiology between March 2020 and May 2020. A total of 53 patients with COVID-19 (30 males, 23 females; mean age: 54.8±19.9 years; range, 17 to 96 years) according to the RT-PCR test who were hospitalized in our second-line referral state hospital were included in the study. Patients with immunosuppressive disease, or malignancy were excluded. Written consent was obtained from each patient. The study protocol was approved by the Institutional Review Board (IRB) of the Provincial Health Directorate of Mardin. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Baseline demographic and clinical characteristics of the patients were recorded. Chest CT was performed on a 16-slice CT (Toshiba, Activion16 Multislice CT, Kyoto, Japan) with 1-mm thick high-resolution sections in patients diagnosed with COVID-19. A detailed chest CT examination was performed by a blinded radiologist. The radiological findings were classified according to the literature and classified depending on the frequencies of ground-glass opacities, the number of lobe involvement, consolidation, and peripheral distribution and bilateral pneumonia (Figures 1-4). The C-reactive protein (CRP) level was established as the laboratory criterion. The clinical manifestation and severity of the disease were classified by a blinded pulmonologist. The severity classification of the disease was classified as mild= 1, common= 2, severe= 3, and critical= 4

Figure 1. A 20-year-old male patient with mild disease. Mild nodular ground-glass appearance in the posterior segment of lower lobe in the right lung.

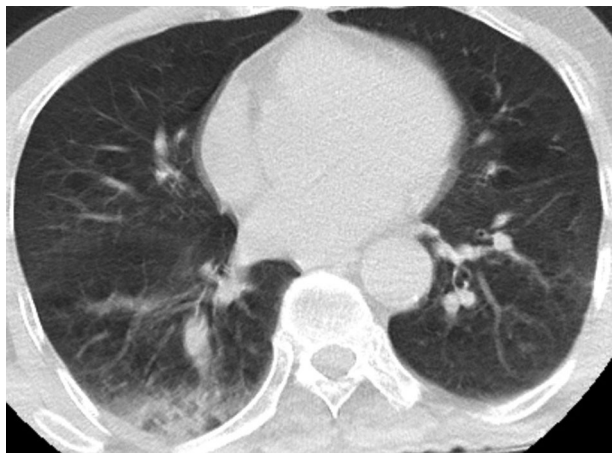

Figure 2. A 78-year-old male patient with common disease. Thickening of the peribronchovascular sheath on the right and subpleural reticulonodular infiltration areas in the lower lobes of the both lungs.

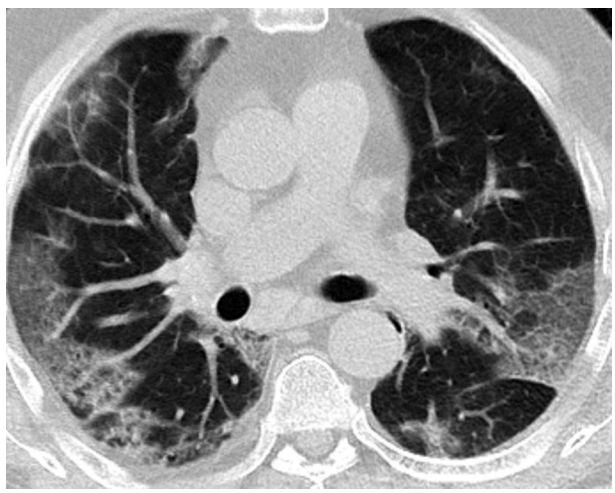

Figure 3. A 63-year-old female patient with critical disease. Ground-glass - consolidated areas with tendency to merge, more prominent in the lower lobes of both lungs.

Figure 4. A 63-year-old male patient with severe disease. Lymph nodes <1 cm in the mediastinum. Diffuse and widespread multifocal patch-style ground-glass opacities and consolidated areas; from the apex to the basal segment in both lungs.

according to the study of Feng et al.[11]

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency. Normality assumption was checked using the Kolmogorov-Smirnov test and normality assumption were provided. The analysis of radiological categorical dependent variables for the severity of disease was analyzed using the Mann-Whitney U test and Spearman correlation test. A *p* value of <0.05 was considered statistically significant.

RESULTS

The overall mean CRP level was 51.1±53.7. The mean CRP level was 18.1±27.1 U/mL in mild disease group (n=11) and 108±23.6 U/mL in the critical group (n=8) (p=0.001) (Table 1).

The most common findings in the chest CT were ground-glass opacities (n=36, 67.9%). Six (11.3%) patients had no CT findings, while 43 (81.1%) patients had bilateral pneumonia. All of the lobes of the lung were detected with involvement in 17 (32.1%) patients. The most common symptoms were cough (n=38, 71.6%), fever (n=32, 60.3%) and dyspnea (n=2, 41.5%). The mild and common disease was found in 28 (52.9%) patients and the severe and critical disease was found in 25 (47.2%) patients (Table 2). Progression of the disease from mild to common disease was seen in five (9.4%) patients and from common to severe disease in four (7.5%) patients. All patients with progressive disease had pneumonia in all five lobes at the time of admission.

The severity of the disease was not affected significantly by bilateral pneumonia and peripheral distribution of the disease

Table 1. Clinical classification of COVID-19 pneumonia

	Age (years)	CRP (U/mL)	Lobes
	Mean±SD	Mean±SD	Mean±SD
Clinical classifications			
Mild	53.8±23.8	18.1±27.2	1.3±1.3
Common	47.8±15.2	33.1±39.8	3.6±1.4
Severe	59.2±16.8	63.8±49.8	3.9±1.0
Critical	61.8±27.0	108.3±67.0	4.7±.5
Total	54.8±19.9	51.2±53.7	3.4±1.6

SD: Standard deviation.

Table 2. Demographic and clinical characteristics of patients

	n	%
Sex		
Female	23	43.4
Male	30	56.6
Bilateral involvement		
No involvement	6	11.3
Unilateral	4	7.5
Bilateral	43	81.1
Numbers of lobes		
0.0	6	11.3
1.0	2	3.8
2.0	4	7.5
3.0	11	20.8
4.0	13	24.5
5.0	17	32.1
Ground-glass opacities		
-	17	32.1
+	36	67.9
Consolidation		
-	24	45.3
+	29	54.7
Peripheral distribution		
-	27	50.9
+	26	49.1
Clinical classifications		
Mild	11	20.8
Common	17	32.1
Severe	17	32.1
Critical	8	15.1

(p=0.193 and p=0.095, respectively). However, the presence of ground-glass opacities and consolidation exacerbated the classification of the disease significantly (p=0.001 and p=0.001, respectively). A significant positive correlation was found between age, CRP level, and the number of lobes with pneumonia and clinical-stage severity (p=0.049, p=0.001, and p=0.001, respectively; r=0.270, r=0.587, and r=0.625, respectively). Also, the CRP level showed a significant positive correlation with the number of lobes with pneumonia (p=0.011 and r=0.345).

DISCUSSION

The significant correlation between the severity of chest CT features and the severity of the disease is not a surprising result. However, as the findings of chest CT can predict patients who would have a poor prognosis, early and intensive treatment can be provided to appropriate patients and recovery rates may increase. Guan et al.[13] reported that progression to severe disease occurred in 15.7% of the patients after hospitalization. Ding et al.[14] reported that, during the first four days of the disease, 21.2% of symptomatic COVID-19 patients had normal CT scans, and ground-glass opacities were the most important imaging manifestations (76.5%) of the disease. In this study, we observed that disease progression from mild to common was seen in five (9.4%) patients and from common to severe disease in four (7.5%) patients.

The most common symptoms reported in the recent literature were cough, fever, and dyspnea.[15-17] The frequency of these symptoms in our study is consistent with the literature. Feng et al.[11] showed that increased lung lobes with the disease were involved in the severe and critical groups, compared to the moderate group. They found ground-glass opacities in 425 of 442 (96.2%) patients, bilateral lung involvement in 373 (84.4%) of patients, and consolidation in 87 (19.7%) of patients. Also, the authors detected changing of the ground-glass opacification to the consolidation during the progression of the disease. In the aforementioned study, pleural effusion was found to be a significant poor prognostic factor for severe and critical groups. In another study, Zhou et al.[12] reported the major characteristic of COVID-19 pneumonia as ground-glass opacity (61.3%) and consolidation (35.5%).[12] They proved statistically that the CT scores (range: 0 to 25, according to distribution and features of the disease) of the progressive-stage group were significantly higher than the early-stage group (p=0.004). Also, the authors showed that the CT scores were positively correlated with the diameters of the lesions (r=0.531, p<0.001). According to a systematic review by Salehi et al.,[18] common CT features were bilateral involvement in 435 of 497 (87.5%) patients, peripheral distribution in 92 of 121 (76.0%) patients, multilobar involvement in 108 of 137 (78.8%) patients, ground-glass opacification in 346 of 393 (88.0%) patients, and consolidation in 65 of 204 (31.8%) patients. In this study, a considerably high number of consolidation was reported (n=29, 54.7%), unlike the literature. The authors attribute this increased rate to the fact that patients usually perceived this disease as a stigma in the region where the study was conducted and to the hesitation of the patients to apply to the hospital, until they became worse. In addition, consistent with these findings, the infection was detected in all lung lobes in all patients with progressive disease and in the critical group in our study.

Huang et al.[19] reported that 40 (98%) of patients had bilateral lung involvement and patients with severe cases were more likely to have bilateral multiple lobular and subsegmental areas of consolidation on admission. Similarly, Chung et al.[20] mostly detected pulmonary lesions involving bilateral lungs with multiple lung lobes which were mainly distributed in the posterior and peripheral part of the lungs. Li et al.[21] also showed that consolidation was a sign of the progression of the disease in their review. Likewise, Song et al.[22] suggested that development of the consolidation on a base of ground-glass opacification was an alert in the management of patients. These findings are also supported by other studies.[10,23,24] Ding et al.[14] detected crazy-paving patterns (36.1%), consolidation (25.5%), and linear opacities (6.3%) on early-stage CT and they found that these features indicated the rapid progression of the disease with poor prognosis. In this study, we also found a significant and more severe clinical stage in patients with consolidation and multilobar involvement.

The relatively small sample size is the main limitation of this study. Despite small sample size, however, all clinical and radiological assessments were carried out by blinded specialists, which yield robust statistical evidences.

In conclusion, the chest CT plays a major role in the diagnosis of COVID-19, as well as in the clinical severity and prognosis of the patient. Multilobar involvement and consolidations in CT have a significant relationship with the poor prognosis of the disease. In addition, a considerable amount of patients are found to have an unexpected progression of the disease after the initial diagnosis. Based on these CT findings, intensive and rapid treatment decisions can be included in the management, even if the clinical status of the patient seems to be good and mild. Radiological and clinical investigation can be performed by different specialties to reduce the risk of bias. Further large-scale, prospective studies are needed to gain a better understanding on this disease.

Declaration of conflicting interests

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