Chest CT and Clinical Features of COVID-19 Patients in the Early Stage of the Epidemic: An Observational Study from China

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Abstract

Background: COVID-19 had caused more than 2.8 million deaths globally, and the epidemic will persist for an extended period of time. We analyzed clinical features of patients in the early stage of the epidemic, so as to deepen the understanding of the disease.

Methods: In this retrospective study, we included 84 confirmed cases of COVID-19 during February 1, 2020 and March 31, 2020. Baseline data were used to classify patients as moderate (57%) or severe/critical based on Chinese protocol. We focused on analyzing the differences in chest computed tomography (CT) between the two groups.

Results: Of the 84 cases, 50 were male and the median age was 69 years. 55 (65%) patients had comorbidities at admission, more in the severe/critical group ($P=0.040$). 94% patients had bilateral lesions on CT, up to 68% had lesions involving all lobes. Ground glass opacification (GGO) (96%), consolidation (44%), Linear opacities (50%) and Air bronchogram (23%) were the mainly lesions. The lesion was gradually absorbed over time, but imaging abnormalities can persist for a long time. Compared with moderate cases, the severe/critical group had more pulmonary consolidation changes ($P=0.044$) and significantly higher CT severity Score (CTSS) ($P=0.040$). Lymphocyte counts were significantly lower ($P=0.011$) and NLR were higher ($P=0.029$) in severe/critical cases.

Conclusions: Chest CT showed bilateral and multiple GGO and consolidation mainly. After treatment, pulmonary lesions were gradually absorbed over time, and imaging abnormalities can be persistent for a long time. Lung consolidation, CTSS, comorbidity, lymphocyte counts, and NLR may be predictors of severe COVID-19.

Introduction

Coronavirus disease 2019 (COVID-19) has spread rapidly around the world [1, 2]. By March 2020, WHO has officially declared COVID-19 to be a Worldwide Pandemic. Globally, as of 9 April 2021, there have been 133,552,774 confirmed cases of COVID-19, including 2,894,295 deaths(<https://covid19.who.int/>). More seriously, the global epidemic continues to spread and is likely to persist for a long time. The number of deaths due to infection with COVID-19 will continue to increase. So far, our understanding of the disease is limited,

COVID-19 is caused by SARS-CoV-2 (previously known as 2019-nCoV) [3], which belongs to the beta genus of coronaviruses. SARS-CoV-2 is highly homologous to SARS-CoV, and has 40 different strains. RT-PCR detection has greatly improved the diagnostic efficiency of the disease[4], but it is still limited by the sensitivity and accessibility[5]. More important, PCR detection does not reflect the condition of pulmonary lesions, while pneumonia is often an important cause of poor prognosis and death in COVID-19. Chest CT plays a pivotal role in the diagnosis and evaluation of pulmonary diseases[6]. Since the early stage of the epidemic, Chest CT has been used as an adjunct for screening patients suspected of COVID-19 and

monitoring treatment responses based on dynamic changes in imaging. So, although Chest CT is somewhat deficient in specificity, we still unremittingly analyze the images.

Methods And Materials

Study design and participants

In this retrospective, single-center, observational study, we enrolled 100 consecutive patients confirmed COVID-19, who were treated by the medical team of Shandong University Qilu Hospital in the RENMIN HOSPITAL OF WUHAN UNIVERSITY (East Branch). All patients had positive nucleic acid test results of SARS-CoV-2 [7], and had a non-contrast chest CT on admission. The study design was approved by the institutional ethics board and written informed consent was waived.

We excluded 16 cases that did not meet the inclusion criteria, including: age younger than 18 years old ($n = 1$); data missing ($n = 10$); negative CT test ($n = 5$). Finally, 84 cases were included in the study. According to Diagnosis and Treatment Protocol for COVID-19 Patients (Tentative 8th Edition) 48 patients 57% were moderate and 36 were severe/critical. Severe cases: 31 Critical cases 5 (Table 1).

Table 1

Clinical classification in Diagnosis and Treatment Protocol for COVID-19 Patients (Tentative 8th Edition)

Clinical classification	
Mild	The clinical symptoms are mild, and there is no evidence of pneumonia in chest radiology
Moderate	Patients have fever and respiratory symptoms. Chest radiology suggests pneumonia
Severe	Adult patients meeting any of following: Shortness of breath, $RR \geq 30$ breaths/min; $SpO_2 \leq 93\%$ on room air in resting status; PaO_2/FiO_2 ratio ≤ 300 mmHg (1 mmHg = 0.133kPa); In areas with high altitude (more than 1000 meters above sea level), PaO_2/FiO_2 ratio should be adjusted according to the following formula: $PaO_2/FiO_2 \times [760/\text{atmospheric pressure (mmHg)}]$ rapid progression of clinical symptoms, with > 50% progression in the lung lesions in chest radiology.
Critical	Meeting one of the following conditions: severe respiratory failure requiring mechanical ventilation; Shock; Any other organ failure requiring intensive care

Data collection

Clinical information was collected during hospitalization, and all the data came from their electronic medical records. Patient data, including demographics, medical history, comorbidities, laboratory findings, symptoms, signs, and chest CT features were collected and analyzed. The ORF1ab and nucleocapsid (N) genes were detected by performing real-time PCR. All patients were scanned in same type of helical CT scanners (Optima CT680 Series, 120.0 KV, 249 mA, 0.6 thk, 600 ms, 512*512) while lying supine.

Statistical analysis

Continuous and categorical variables are presented as median (interquartile range [IQR]) and number (%), respectively. Differences between groups are analyzed using Student's t-test or Mann-Whitney U-test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. All statistical analyses were conducted using SPSS Statistics. Two-sided P-values are reported. A P-value ≤ 0.05 was used to indicate statistical significance.

Results

Baseline clinical characteristics

Of the 84 patients with COVID-19 pneumonia, 50 (60%) were male and 34 (40%) were female, with a median age of 69 years old. 65% patients had at least one disease at admission, with hypertension (38%), diabetes (17%) and coronary heart disease (12%) being the most common. The main symptoms and signs were fever (82%), cough (73%), fatigue (54%), chest tightness (45%), dyspnea (69%) and sputum (31%), and a percentage of the patients appeared chills (12%), diarrhea (23%), poor appetite (10%), headache (7%), and other discomfort (Table 2).

Table 2
Baseline characteristics of patients with Coronavirus disease 2019 in our study.

Variables	Patients (n = 84)	Variables	Patients (n = 84)
Demographics		CT features	
Median age, years (range)	69 (27-93)	Distribution	
Men	50 (60%)	Bilateral involvement	79 (94%)
Comorbid conditions		Peripheral distribution	43 (51%)
Any	55 (65%)	Central distribution	0(0)
Diabetes Mellitus	14 (17%)	Mixed distribution	41(49%)
Hypertension	32 (38%)	Number of lobes involved	
Coronary heart disease	10 (12%)	One lobe	4 (5%)
Bronchiectasis	1 (1%)	Tow lobes	6 (7%)
COPD	3 (4%)	Three lobes	7 (8%)
Arrhythmia	5 (6%)	Four lobes	10 (12%)
Uremia	2 (2%)	Five lobes	57 (68%)
Others	25 (30%)	Patterns of the lesion	
0	29 (35%)	Ground glass opacification (GGO)	81 (96%)
1	25 (30%)	Consolidation	37 (44%)
2	18 (21%)	GGO with consolidation	37 (44%)
≥ 3	12 (14%)	Air bronchogram	19 (23%)
Personal history		Linear opacities	42 (50%)
Smoking	7 (8%)	Pleural effusion	11 (13%)
Drinking	6 (7%)	Time between CT examination and symptoms onset (days)	18 (13–29)
Symptoms and Signs		Laboratory findings	
Fever	69 (82%)	White blood cell count ($\times 10^9/L$)	5.51(4.33–7.2)

Data are presented as median or n (%).

Variables	Patients (n = 84)	Variables	Patients (n = 84)
Myalgia	10 (12%)	Lymphocyte count ($\times 10^9/L$)	1.25(0.81–1.72)
Weakness	45 (54%)	Neutrophil count ($\times 10^9/L$)	3.34(2.33–4.87)
Cough	61 (73%)	NLR	2.51(1.74–4.64)
Sputum production	26 (31%)	Platelet count ($\times 10^9/L$)	199(166.5–256)
Diarrhea	19 (23%)	PCT	0.06(0.04–0.10)
Chills	5 (6%)	C-reactive protein increased	38(46%)
Sore throat	5 (6%)	HGB	123(111–133.5)
Chest distress	38 (45%)	Alanine aminotransferase (U/L)	26(17–37.5)
Dyspnea	58 (69%)	Aspartate aminotransferase (U/L)	25(19–37)
Poor appetite	8 (10%)	Total bilirubin ($\mu\text{mol/L}$)	10.6(8.13–14.76)
Headache	6 (7%)	Creatinine ($\mu\text{mol/L}$)	61(49.5–69)
Vomit	2 (2%)	Creatine kinase (U/L)	53(32–79)
Nausea	3 (4%)	Lactic dehydrogenase (U/L)	237(189–302)
Data are presented as median or n (%).			

We performed a statistical analysis of radiological findings of all enrolled patients (Table 2). The median time interval from the first Chest CT after admission to the symptom onset was 18[13–29] days, and the time of the last CT examination was 41.5[33–52.75] days. According to imaging examination, 94% patients showed bilateral pneumonia, and about half showed peripheral distribution. Up to 68% of patients had lesions involving all lobes, and the lesions were mainly ground-glass opacities (96%), consolidations (44%), Linear opacities (50%) and Air bronchogram (23%) (Fig. 1). Eleven patients (13%) experienced pleural effusion.

In this study, 89.3% of patients had undergone at least two Chest CT examinations during hospitalization, and the longest observation was 65 days after the onset of symptoms. Repeat Chest CT was obtained at approximately one-week intervals. Through the comparative analysis of chest CT at different time points, we found that: in the second week after the onset of symptoms, the pulmonary lesions in CT were the most serious, mainly bilateral and multiple ground-glass opacities and consolidation, mostly involving

multiple lobes. A few have unilateral or bilateral pleural effusion. With continuous treatment, 94.7% of the patients showed reduced lesion scope and gradual absorption of lesions on CT (Fig. 2). However, we also found that pulmonary lesions may be manifested on CT for a long time. In one patient included in this study, reexamination of chest CT 65 days after the onset of symptoms still showed significant multiple ground-glass opacities in both lungs.

Comparison between moderate and severe/critical patients

The clinical and CT characteristics of moderate patients and severe/critical patients are presented in Table 3. There was no significant difference in age, gender composition, smoking history and other demographic information between the two groups, but more patients with comorbidities were found in the severe/critical group than in the moderate group ($P = 0.040$). The main symptoms and signs were generally similar between the two groups, but sputum production appeared to be more common in the moderate cases ($P = 0.048$) and headache slightly more frequent in the severe/critical group ($P = 0.079$). Compared with the moderate patients, severe/critical patients had significantly lower lymphocyte count ($P = 0.011$), higher NLR ($P = 0.029$), and slightly more patients with elevated C-reactive protein ($P = 0.076$). There were no significant differences between the two groups in white blood cell count, neutrophil count, PCT, platelet count, HGB, ALT, AST, total bilirubin, creatinine, creatine kinase, lactate dehydrogenase, etc.

Table 3
Clinical and CT features between the Moderate and Severe/Critical patients

Variables	Moderate (n = 48)	Severe/Critical (n = 36)	P
Demographics			
Age (years)	68 (57.3–72.0)	69 (55.3–75.5)	0.762
Men	26 (54.2%)	24 (66.7%)	0.248
Smoking history	6 (12.5%)	1 (2.8%)	0.231
Comorbid conditions			
Any	27 (56.3%)	28 (77.8%)	0.040
Diabetes Mellitus	10 (20.8%)	4 (11.1%)	0.375
Hypertension	15 (31.3%)	17 (47.2%)	0.136
Coronary heart disease	5 (10.4%)	5 (13.9%)	0.384
Bronchiectasis	1 (2.1%)	0 (0)	1.000
COPD	1 (2.1%)	2 (5.6%)	0.799
Arrhythmia	3 (6.3%)	2 (5.6%)	1.000
Uremia	0 (0)	2 (5.6%)	0.181
Others	9 (18.8%)	16 (44.4%)	0.011
Symptoms and Signs			
Fever	38 (79.2%)	31 (86.1%)	0.411
Myalgia	7 (14.6%)	3 (8.3%)	0.593
Weakness	26 (54.2%)	19 (52.8%)	0.899
Cough	37 (77.1%)	24 (66.7%)	0.289
Sputum production	19 (39.6%)	7 (19.4%)	0.048
Diarrhea	12 (25.0%)	7 (19.4%)	0.547
Chills	2 (4,2%)	3 (8.3%)	0.647
Sore throat	3 (6.3%)	2 (5.6%)	1.000
Chest distress	20 (41.7%)	18 (50.0%)	0.448
Data are presented as median (IQR) or n (%). Difference between groups is analyzed using Student's t-test or Mann-Whitney U-test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. Two-sided P-values are reported.			

Variables	Moderate (n = 48)	Severe/Critical (n = 36)	P
Dyspnea	32 (66.7%)	26 (72.2%)	0.586
Poor appetite	4 (8.3%)	4 (11.1%)	0.720
Headache	1 (2.1%)	5 (13.9%)	0.079
Vomit	1 (2.1%)	1 (2.8%)	1.000
Nausea	1 (2.1%)	2 (5.6%)	0.574
Laboratory findings			
White blood cell count ($10^9/L$; normal range 3.5–9.5)			0.837
Decreased	4 (8.3%)	7 (20.0%)	
Normal	42 (87.5%)	23 (65.7%)	
Increased	2 (4,2%)	5 (14.3%)	
Neutrophil count ($10^9/L$; normal range 1.8–6.3)			0.768
Decreased	3 (6.3%)	5 (14.3%)	
Normal	42 (87.5%)	24 (68.6%)	
Increased	3 (6.3%)	6 (17.1%)	
Lymphocyte count ($10^9/L$; normal range 1.1–3.2)			0.008
Decreased	14 (29.2%)	20 (57.1%)	
Normal	32 (66.7%)	15 (42.9%)	
Increased	2 (4.2%)	0 (0)	
Lymphocyte count	1.3 (1.0-1.8)	1.0 (0.7–1.5)	0.011
NLR	2.2 (1.6–3.7)	3.5 (1.8-7.0)	0.029
C-reactive protein (mg/L; normal range 0–10)			
Increased	18 (37.5%)	20 (57.1%)	0.076
PCT (ng/mL; normal range ≤ 0.1)			
Increased	10 (28.6%)	8 (26.7%)	0.864

Data are presented as median (IQR) or n (%). Difference between groups is analyzed using Student's t-test or Mann-Whitney U-test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. Two-sided P-values are reported.

Variables	Moderate (n = 48)	Severe/Critical (n = 36)	P
Platelet count (10 ⁹ /L)	201 (166.5–254.0)	193 (160.0–278.0)	0.813
HGB (g/L)	125.5 (117.0–135.0)	121.0 (106.0–131.0)	0.159
Alanine aminotransferase (U/L)	24.0 (18.0–38.0)	29.5 (15.3–37.8)	0.811
Aspartate aminotransferase (U/L)	23.0 (19.0–37.0)	28.5 (18.0–37.0)	0.703
Total bilirubin (μmol/L)	10.8 (8.10–14.8)	10.6 (8.1–14.9)	0.892
Albumin (g/L)	37.4 (35.0–41.6)	36.0 (32.1–39.2)	0.149
Creatinine (μmol/L)	60.0 (50.0–68.0)	63.0 (48.3–77.3)	0.268
Creatine kinase (U/L)	53.0 (31.0–70.0)	53.0 (31.3–90.5)	0.686
Lactic dehydrogenase (U/L)	230.0 (178.0–297.5)	247.0 (202.5–317.8)	0.129
CT features			
Number of lobes involved			0.468
One lobe	0 (0)	3 (8.3%)	
Two lobes	6 (12.5%)	1 (2.8%)	
Three lobes	4 (8.3%)	1 (2.8%)	
Four lobes	7 (14.6%)	4 (11.1%)	
Five lobes	31 (64.6%)	27 (75.0%)	
Distribution			0.133
Peripheral	28 (58.3%)	15 (41.7%)	
Central	0 (0)	0 (0)	
Mixed	20 (41.7%)	21 (58.3%)	
Ground glass opacification (GGO)	46 (95.8)	35 (97.2%)	1.000
Consolidation	20 (41.7%)	23 (63.9%)	0.044
GGO with consolidation	20 (41.7%)	23 (63.9%)	0.044

Data are presented as median (IQR) or n (%). Difference between groups is analyzed using Student's t-test or Mann-Whitney U-test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. Two-sided P-values are reported.

Variables	Moderate (n = 48)	Severe/Critical (n = 36)	P
Air bronchogram	9 (18.8%)	10 (27.8%)	0.328
Linear opacities	26 (54.2%)	18 (50.0%)	0.705
Pleural effusion	5 (10.4%)	6 (16.7%)	0.401
Time between CT examination and symptoms onset (days)	16 (12.5–29.5)	19 (14.3–29.0)	0.546
CURB-65	16 (12.5–29.5)	19 (14.3–29.0)	0.570
CT severity score	11 (6.0–15.0)	15 (8.5–19.0)	0.040
Data are presented as median (IQR) or n (%). Difference between groups is analyzed using Student's t-test or Mann-Whitney U-test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. Two-sided P-values are reported.			

Subsequently, we analyzed the chest CT features of patients in both groups, and the imaging features were relatively consistent. Inflammatory lesions mostly involved multiple lobes in both lungs and were widely distributed, mainly including ground glass opacities, consolidation, linear opacities and air bronchogram (Fig. 3). However, pulmonary consolidation was more common ($P = 0.044$) and CT severity score (CTSS) was significantly higher ($P = 0.040$) in the severe/critical group than in the moderate group (Table 3). The total CTSS was the sum of the individual lobar scores (score 1–5 for each lobe, range 0–25)[8, 9].

Discussion

COVID-19 is an acute respiratory infectious disease caused by SARS-CoV-2. It is mainly transmitted through respiratory droplets and close contact and has developed into a worldwide pandemic[10, 11]. Infected with SARS-CoV-2, most patients had mild symptoms and good prognosis, and some patients rapidly progressed to severe or critical pneumonia (14% and 5% of laboratory-confirmed patients, respectively [12]), with a significantly increased mortality rate. The clinical manifestations of COVID-19 are diverse[13, 14], and existing studies suggest that older age and male gender may be associated with higher disease severity[15–18]. Fever[15, 19], shortness of breath/dyspnea[19, 20] and gastrointestinal symptoms seems to be important risk factors for severity of COVID-19[21]. What's more, some comorbidities, such as Hypertension, Diabetes, obesity, Metabolic Syndrome, COPD and so on, may increase severe outcome[22–31]. The Charlson Comorbidity index (CCI) score has been identified in studies as a prognostic factor for COVID-19-related death [32]. Patient age and disease burden (number and severity of conditions) are directly and significantly associated with an increased risk of unfavorable clinical outcomes [33]. In this study, we did not find significant differences in age, gender and other demographic indicators between patients with severe/critical pneumonia and those with moderate pneumonia. Statistics of the clinical symptoms of COVID-19 revealed that sputum production was more

common in patients with moderate pneumonia, while headache appeared to be more pronounced in severe/critical patients. Some studies suggest that SARS-CoV-2 virus is not only confined to the respiratory tract, but may also invade the central nervous system [34–37], and further studies are needed to clarify whether central nervous system infections are more pronounced in critically ill patients[38]. In addition, we similarly found that, the prevalence of comorbidities is found to be significantly different according to disease severity: higher in the severe/critical group.

We conducted simple statistics on the laboratory indicators, and the results showed that lymphocyte count, NLR and severity of COVID-19 were related. Lymphocyte count of the severe/critical pneumonia group were significantly lower, and NLR was significantly higher. This is consistent with some previous studies. A number of studies have shown that, compared with mild cases, the absolute number of lymphocytes in severe patients is significantly reduced [39, 40], and the continuous decrease of peripheral blood lymphocyte count may be an early indicator for severe/critical patients with COVID-19. A meta-analysis showed that high NLR levels on admission were associated with severe COVID-19 and mortality[41]. In addition, factors associated with low lymphocyte count and high lactate dehydrogenase levels are important and independent risk factors for adverse clinical outcomes [42, 43]. Han et al. found that serum LDH and CRP were significantly correlated with the severity of COVID-19. And Smilowitz NR et al. also came to the conclusion that CRP was strongly associated with critical illness and mortality in COVID-19[44]. In our study, CRP elevation appeared to be higher in the severe/critical group than in the moderate group ($P = 0.076$). However, due to the limitation of detection methods, the CRP value below 0.5 cannot be measured and accurate numerical analysis cannot be carried out.

Chest CT is a routine examination for COVID-19. At the beginning of the epidemic, clinicians selected chest CT as an important assessment tool for COVID-19 based on their experience in managing similar diseases. It has also been proved that chest CT plays an irreplaceable role in the diagnosis, differential diagnosis, clinical classification, prognosis and therapeutic effect evaluation of COVID-19 [9, 45]. In particular, CTSS has important reference value for the assessment of disease severity and the prediction of mortality [46, 47]. In addition, several studies have described the temporal changes of chest CT, and it is believed that chest CT lesions are most obvious and CT severity score highest about 9–12 days after symptom onset[47, 48]. We also found that about 2 weeks after the onset of symptoms, the lesions on chest CT were gradually absorbed over time with reduced density. Moreover, pulmonary consolidation was evident in severe/critical patients, with higher CT severity scores. These conclusions corroborate with previous studies to some extent. It should be noted, however, that imaging abnormalities in patients may persist for long periods of time. In the chest CT reexamined 50 days after the onset of symptoms, obvious ground-glass opacities and other lesions can still be seen, and the extent of the lesions is mostly smaller than before, with significantly reduced density. At this time, the patient's condition must be assessed in combination with the patient's clinical manifestations. In addition, we also observed that in a few cases, during the absorption and dissipation of the lesion, there was a significant deterioration (expansion of the extent of the lesion, appearance of new consolidation, etc.) This also reminds us that our understanding of COVID-19 is still very limited and cannot be taken lightly prematurely, especially in severe /critical patients.

Conclusions

At the early stage of the outbreak, in order to ensure that all those in need have been tested, isolated, hospitalized or treated, China launched the "mobile cabin hospitals", concentrated on the treatment of patients with COVID-19. A large number of mild or asymptomatic confirmed patients were admitted to "mobile cabin hospitals" for isolation and treatment. During this period, various designated hospitals for COVID-19 in Wuhan mainly admitted symptomatic or critically ill patients. Therefore, among the patients included in this study, the proportion of severe/critical patients was high, and most of them were admitted after one week of onset. Based on the above premise, we observed that after the patient developed symptoms for more than one week, chest CT was dominated by bilateral, multiple ground-glass opacities and consolidation. After treatment, the lung lesions were gradually absorbed over time, showing a reduction in the extent and density of the lesions. In some patients, imaging abnormalities persisted for a long time, and multiple ground-glass opacities were still observed until 65 days after the onset of symptoms in this study. The presence of pulmonary consolidation and higher CT severity scores may be associated with severe disease. In addition, the presence of headache symptoms, comorbidity, reduced lymphocyte counts and elevated NLR may be predictors of COVID-19.

Abbreviations

COVID-19 Coronavirus

SARS-CoV-2 Severe acute respiratory syndrome coronavirus 2

CT Computed Tomography

GGO Ground glass opacification

CTSS CT severity Score

NLR Neutrophil to Lymphocyte Ratio

PCT Procalcitonin

HGB Hemoglobin

ALT Alanine aminotransferase

AST Aspartate aminotransferase

COPD Chronic obstructive pulmonary disease

CCI Charlson Comorbidity index

LDH Lactate dehydrogenase

Declarations

Ethics approval and consent to participate

This study has been approved by the Ethics Committee of Qilu Hospital of Shandong University in China (No. KYLL-2020-254), and we have obtained the informed consent of the patients.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

M.Z. designed study and wrote manuscript. N.Z., Y.L., Z.H., J.F., X.H., F.M., T.L., Y.L., Y.Q., Y.Z., W.B., H.S., X.M., S.Y., Y.B., H.W., and X.Y. collected and revised clinical, laboratory, and radiological data. G.Y., T.J., and C.S. provided valuable suggestions for study design and data analysis. X.J. designed the project, edited manuscript, and supervised the study. All authors have approved the final version of this paper.

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Figures

Figure 1

Chest CT characteristics of patients with Coronavirus disease 2019. a Unilateral involvement: GGO in the right lower lobe; b Bilateral involvement and peripheral distribution; c Bilateral involvement and mixed distribution; d Ground glass opacification; e Consolidation; f Air bronchogram; g Linear opacities.

Case 1 70Y, Female

Case 2 69Y, Female

Figure 2

Representative chest CT of two patients with COVID-2019 at different time.

Figure 3

CT features between moderate and severe/critical cases.